UNIVERSITY OF WINCHESTER
DEPARTMENT OF ARCHAEOLOGY
FACULTY OF HUMANITIES AND SOCIAL SCIENCE

Managing Human Skeletal Collections: A Rapid Assessment System

Rose Drew

Doctor of Philosophy

May 2014

This Thesis has been completed as a requirement for a postgraduate research degree of the University of Winchester

Abstract

THE UNIVERSITY OF WINCHESTER

ABSTRACT FOR THESIS

Managing Human Skeletal Collections:
A Rapid Assessment System

Rose Drew

Doctor of Philosophy

May 2014

Research Imperative: This project describes an observation-based protocol to rapidly assess skeletonised human remains. Up to 60% of British museums are unaware of the quality and quantity of their holdings; almost all lack databases. Thousands of remains are disturbed annually during commercial and private development, but funding, time and skills rarely align to provide basic assessments, a true impediment to research. Several well-known collections are examined repeatedly, with others under-studied or inspected randomly; data accumulates haphazardly as scholars research specific questions. A rapid assessment system is needed.
Aims: This 'Rapid Assessment System' (RAS) aims to capture information using affordable and available resources: curators, students and volunteers. RAS answer sheets offer multiple options using non-specialist language. In this way, basic data about a skeleton can be collected.
Methods: Volunteers without osteological training were provided with RAS answer sheets and specimen skeletons to examine. Observations were 'correct' when in agreement with the author. The RAS was divided into an Inventory segment, assessing presence, absence and condition of skeletal elements, and assessing traits associated with age and sex; and a Paleopathology segment assessing normal and abnormal appearance of teeth and bones. In Winchester, 37 volunteers (undergraduates, semi-retired amateur archaeologists) trialed the RAS over three weekly two-hour sessions, with 22 volunteers assessing at least three skeletons: 91 RAS answer sheets were analysed.
Results: Pooling results for all three weeks, volunteers were correct 70.4% of the time for Inventory, and 75.3% of the time in the third week. Paleopathology results were mixed: some participants attained 85.2% correct, others less than 10%. Overall condition of remains, a primary assessment recommended by English Heritage enjoyed 90% success (score of 81 from 91 forms). Assessing skull condition was correct 96.2% (87.5/91). Differentiating between 'robust', 'gracile' and 'moderate' long bones was 79.7% effective (72.5/91); recognising tooth wear (none, mild, moderate) accomplished 78.6% (71.5/91). Robusticity and dental wear inform on estimations of sex and age at death.
Implications: Basic data can be accurately amassed by novices. Two separate forms are proposed: Inventory for general use; complex Paleopathology assessments for workers with some training or considerable patience. The Paleopathology segment can act as an aid for early-stage researchers and students and help them avoid missing out observations when examining large collections. The RAS can be tailored to assess specific diseases such as leprosy or tuberculosis. Future versions should utilise electronic formats to simplify processing. If adopted by commercial firms, universities and museums, data can be captured, permitting information to be shared, and reducing handling of these delicate, poignant and unique 'artefacts'.

Table of Contents

Table of Tables

Table of Figures

Table of Photographs

Declaration and Copyright

No portion of the work referred to in this Thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

I confirm this Thesis is entirely my own work.

Acknowledgements

To Frances Rosenbluth, who initiated this endeavour with a simple question: “You wouldn’t want to fly all the way to *England,* would you?”

The resultant project depended on nearly 60 enthusiastic volunteers: the York 2008 team and of course members of HOPI York; and the undergraduates and adult amateur archaeologists in Winchester 2012. All of my volunteers willingly donated patience, thoughtful advice, and many hours of their time.

The work had a good start at York University, and Matthew Collins is directly responsible for so much of the project’s eventual design. Matt, the simple suggestion to keep a detailed lab diary made everything more manageable. Thank you, thank you. My Winchester advisors, Paul Everill and Tony King, helped me stay focused; Nick Thorpe read an awful lot of words; John Batten managed to teach *even me* to understand statistics; and Katie Tucker led me here with a marvelous suggestion over dinner at BABAO 2011.

Everyone thanks their family. I must thank the family I have created and who have selected me as their own: Alan, Emily, Sarah, Gary, Sarah W, Cheri, Muriel, Gwyn, Kat, Della, Dawn, Rose (“The Other Rose”), Cos and Rob. Like all true family we can be separated by many years and thousands of miles but are still connected.

Thank you to colleagues, mentors, teachers and dear friends (many all four) who have lent support to my archaeological/anthropological journey the past 20 years. To minimize name-dropping, only given names and initials are used for those still with us: but the staggering wealth of knowledge in this list testifies to the mentor-student and colleague-colleague relationships upon which anthropology – the study of humankind – is by necessity based:

Ernie W, Mary-Frances C, Nick B, Rika K, Dennis D, Steven S, Eric S, Andrew H, John V, Marcello C, Tom T, Jesper B, Frances R, Rita W, Ana LS, Lynne G, Fernando LC, Glenis MT, Clark SL, Megan B, Della CC, Mary LP, Simon M, Simon H, Charlotte R, Sheila MdS, Jane B, Rachel W, Bob C, Anthea B, Richard J, David H, Allison F, Susan S, Larissa C, Carlina dlC, Georgia HM, Robert J, Don B, Matthew C, Michael F, John C, Charles O, Mary L, Chris R, Michael S, Maja K, Anna K, Erika H, Per H, Doug U, Judy S, Alan O, Pia B, Bob T, Andrew C, Holgar S, Jo B, Chris K, Martin B, Martin S, Piotr B, Gwyn M, Jerry R, Katie T, Kate W, Karl A, Courtnay K,

and Irving ‘Ben’ Rouse, Don Ortner, and Phil Walker.

And especially: my deep love and admiration for the very much still here Marie Selvaggio, who started all of this.

Chapter 1: Introduction: The Analysis of Human Remains

1.1 Background

Why do we need to study ancient skeletons? Can we justify disturbing them?

To many people, the need to analyse human remains is beyond question: humans are curious about past ways of life, and past health and activity (the 'archaeological' dead); law officers have an unidentified body, cause and manner of death perhaps unknown and so possibly, a crime to solve (the 'forensic' dead); an unmarked, forgotten cemetery has appeared in the middle of a commercial development, and the graves need to be moved aside, or removed entirely (the archaeological and also inconvenient dead).

But to many other people, such as indigenous groups from the Americas and Australia, the question is: "Why analyse the ancient dead at all?" This is a fair question, and **Appendix 1.A** addresses various controversies, legal battles, and laws that deal with the processes of either examining, or not examining the ancient skeletonised dead in the US. Discussions of ethical handling of remains that are specific to Britain and in a related way to Australia are discussed in **Appendix 1.B**. Many battles waged over remains are between scientists and groups that oppose the study of certain human remains (Zimmerman 1981; Rose *et al.* 1996; King 1998; Fforde 2004). These groups are usually members of the pertinent indigenous tribe or culture; an 'ethnic group' such as African-Americans; or perhaps a religious sect such as Honouring the Ancient Dead (Alberti *et al.* 2009: 134; Orr 2009: 1-2). If associated with remains at issue, they are typically trying to maintain control over what they believe or know to be remains from their own ancestral populations.

Some people are against the study of *any* human remains (as cited in Zimmerman 1987), except in the course of medical investigation, such as an unexplained death, or during research on disease (Alberti *et al.* 2009). They do not protest against crime scene investigations of course, but the medico-legal (forensic) implications of a skeleton are not always readily apparent; remains need to be examined to ascertain demographics and possible post-mortem interval. In countries and regions with cultural taboos regarding human remains, adequate standards for identification may not even exist: South African forensic anthropologist Alan Morris discusses how this can damage court proceedings, bound by legal acceptable scientific standards, when few exist (Morris 2012). Legal jurisdiction over human remains does not apply if they are estimated to be older than 50 years (Byers 2002: 2); the reasoning being crimes or unexplained deaths from more than 50 years earlier will no longer have living witnesses, relatives, or perpetrators.

Population affinity, age at death, sex, stature and unusual pathologies need to be determined from undocumented skeletonised remains: information as important as whether the time elapsed since death will be measured in months, years, decades, or centuries. Skeletal analyses depend on both previous studies and ongoing work with human skeletons; ideally, a physical anthropologist will have experience with remains from a wide range of temporal and spatial contexts (Ubelaker 1990; Ousley *et al.* 2005). People who measure and study skeletonised remains generally consider such investigations to be critical to the advancement of our understanding of the *modern* human body, as well as providing information about the past (Walker 1995; Roberts and Cox 2003).

The main aim of this project is to come up with a more efficient methodology for early-stage analysis of the ancient dead, so that handling is kept to a minimum: a sort of ‘triage’ for future assessment, which supports a researcher’s precious time and helps ensure it is well spent. The benefits of examining archaeological human remains include establishing basic data for museum collections, adding context to archaeological investigations, and perhaps of most value, identifying bone anomalies and pathologies relevant to ongoing medical research, and forensic investigations.

An evaluation of remains for indicators of health, disease and injury is necessary for current projects and also for future work. Vast collections need to be assessed at least minimally in order for a visiting researcher to determine its applicability for a project, such as investigating the impact of tuberculosis (a re-emerging disease) on hard tissue; or prevalence of anemia among children in a certain region or time period. Without an existing database, a researcher must examine as many sets of remains as possible in order to amass adequate data for their project. This is time consuming, and important remains might be missed out (Giesen *et al.* 2013)

Remains that have been determined to be of medieval, prehistoric or otherwise non-forensic nature are generally curated by an approved facility. These remains are of the long-dead and have been placed in some form of long-term storage, perhaps in a museum, or as is becoming ever more popular in the UK, in consecrated storage facilities, such as a former church (Stroud and Kemp 1993). These remains are problematic for reasons that go beyond religious, cultural or ethical restraints.

Some collections are more studied than others, with the resultant damage from even careful handling, and the accumulation of multiple little insults to fragile remains, endangering future investigations (Roberts and Mays 2011). Ironically, ongoing research using the same collection will uncover old mistakes, confirm previous findings, and offer testing for innovative techniques. Other collections languish in relative obscurity. In the UK, fairly recent guidelines recommend that museums create public databases of their skeletal remains, but similarly to NAGPRA requirements, the initiative is unfunded, and so few museums have complied (ibid: 627).

Space for large collections curated by museums is a legitimate concern. It becomes a question of where to store the remains as well as a logistics problem of how to store them. Remains must be kept dry. They cannot be subjected to extreme fluctuations in temperature or humidity (Bowron 2003). And someone must determine their relative ‘value’, especially if space is limited.

Museum audits are situations that require remains to be systematically and efficiently examined. In the United States, in order to satisfy NAGPRA legislation, all government funded museums, laboratories and universities with holdings of indigenous remains were required to provide an inventory that includes information on tribal affiliation, original location of burial, estimated age at death, and determination of sex (US Dept of Interior 2006). Many universities have struggled to comply with the documentation and reporting processes of the law (Rose *et al.* 1996), particularly since only about 10% of requested grant money is awarded.

Medical examiner offices in large urban areas have many unidentified remains, collected from crime scenes for cases that grow ever colder (S Symes personal communication May 2001; A Falsetti personal communication March 2005). As a visiting lecturer once said to students attending a course in a laboratory analysis of forensic human skeletal remains, “Every medical examiner’s department needs their own pet anthropologist!” (Symes pers. comm. May 2001). As of 2012, based on information from the US Department of Justice- sponsored National Missing and Unidentified Persons System (NamUs), there were more than 9000 unidentified skeletal remains in the database (Kuba 2012: 145). And some countries, such as South Africa simply do not have adequate standardised observations to apply to unidentified remains: the data have rarely been collected; studies are only recently being undertaken to create ‘ethnic’ and tribal skeletal profiles (Morris 2012).

1.2 Anthropometry and Standardised Recording Systems

> *“The techniques for measuring these two diameters….have led to such confusion and error that a comparison of results is often impossible”*
> Comas 1960, 435.

In the evaluation of human skeletal remains, the need for a standard set of measurements and consistent set of observations is recognised and understood to be of critical value (Brothwell 1981; Buikstra and Ubelaker 1994; Bass 1995; Brickley and McKinley 2004; Bass 2005; English Heritage/Church of England 2005; Roberts and Manchester 2005).

The most often-cited assessment protocol in the Western, English language speaking arena is the American 1994 handbook of collected metric, non-metric, dental and paleopathological assessment forms, *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994), hereafter refered to as ‘*Standards*’. This handbook was compiled in direct response to pending NAGPRA legislation, and is designed to be used by researchers who possess familiarity with skeletal remains, who comprehend technical terms, and who have access to, and can properly use, the expensive, requisite specialized equipment (spreading calipers, sliding calipers, osteometric board).

In England, several guides have been created to aide excavation, analysis and curation of human skeletal remains. *Guidelines to the Standards for Recording Human Remains* (Brickley and McKinley 2004), hereafter refered to as '*Guidelines'*, is an edited volume published jointly by the Institute of Field Archaeologists (IFA) and the British Association for Biological Anthropology and Osteoarchaeology (BABAO) as a regional version of the Buikstra and Ubelaker (1994) protocol. For specific diseases such as treponemal disease, leprosy, and endocrine disease, and particular traumas such as dislocation, professional terminology and references to standard paleopathology texts such as Aufderheide and Rodriguez-Martin (1998) are referenced (Roberts and Connell 2004: 37-38). This is a very practical guide but is primarily designed to be used by practiced osteologists and novices under the direct supervision of experts.

As part of the Global Health Project, based on the *Backbone of History* (Steckel and Rose 2002), a fairly detailed document called *The Global History of Health Project Data Collection Codebook* (Steckel *et al.* 2006) can be downloaded from the internet. It covers the original seven criteria selected for meta-analysis by Steckel and Rose (2002), and extends these basic observations to include increasingly more complex paleopathological conditions. Initially the downloadable protocol supplies supportive illustrations, but increasingly depends on the existing experience of those amassing the information. The *Codebook* (Steckel et al. 2006) is designed for use by experienced osteologists, and students under direct supervision.

1.2.1 Regional variation in assessment; areas of special interest

Various protocols have been devised to collect information from a skeleton in a standardised, systematic manner. Some systems have attempted to offer an industry-wide synthesis of recommended measurements and observations (Buikstra and Ubelaker 1994; Brickley and McKinley 2004; Bass 2005). Museums, universities and commercial archaeological firms create individualised data capture forms, in order to score or in some way record specific anomalies, such as Roman beheadings (Tucker 2012). Protocols have been devised to accommodate repatriation requests (Buikstra and Ubelaker 1994; Department for Culture, Media and Sport 2005). Some systems are tailored to specific geographic regions. Examples include publications outlining 'best practice' for excavation (if justified) of burials from Church of England cemeteries, and subsequent analysis and storage (English Heritage and Church of England 2005).

The traits assessed from human skeletal remains include basic demographic data such as estimated age at death; probable biological sex; population affiliation; and stature estimate. Most detailed analyses also include diagnoses of common disease and injury such as dental caries, tooth loss, osteoarthritis, chronic ailments that persisted long enough to have affected bone, and trauma such as fractures. The most commonly assessed criteria have been utilised by researchers so routinely that a meta-analysis of reports on 12,520 individuals was able to compare data on remains that ranged from prehistoric to modern, documented individuals (Steckel and Rose 2002).

When confronted by a large collection, visiting scholars require basic information on the condition of the remains, and demographic information about each skeletonised individual in order to determine the most optimal remains to examine. The latter criteria are interdependent; for example, one's biological sex and population affinity influence formulae for determining stature (White and Folkens 2000: Bass 2005), and older adulthood affects sexing estimates (Walker 1995). Ageing and sexing methodologies and specific criteria for determining probable age at death and probable sex have been continually evaluated for much of the 20th century onward (Todd 1920; Krogman 1962; Phenice 1969; Brothwell 1981; Işçan *et al.* 1984; Walker 1995; Hillson 2000; Buckberry and Chamberlain 2002; Scheuer and Black 2004; Bass 2005; Walker 2005).

Diseases and disorders have been more recent avenues of investigation (Ortner and Aufderheide 1991; Rogers and Waldron 1995; Larsen 1997; Lovell 1997; Aufderheide and Rodriguez-Martin 1998; Jurmain 1999; Ortner 2003; Brickley and Ives 2008; Waldron 2009), as have controversial musculo-skeletal 'markers' of past activity (Isçan and Kennedy 1989; Hawkey and Merbs 1995; Jurmain 1999; Peterson 2002; Stirland 2005; Henderson and Gallant 2006; Knüsel 2007; Alves Cardoso and Henderson 2010, 2012).

Mass grave analyses, undertaken as part of Human Rights initiatives have in the past relied on interdisciplinary teams of mortuary personnel, physical anthropologists, and forensics specialist with training in recognition of violent injury (Byers 2002; Scheuer 2002a). Recently, portable DNA labs have come into use; examples of extreme violence have been previously well-documented, and the focus of Human Rights investigations is shifting to the identification of specific individuals in order to provide the information to their families (D Ubelaker, personal communication August 2008).

1.2.2 USA systems

A range of protocols, based on metric analysis (anthropometry) and designed to standardise the observations taken on a human skeleton have been developed over the years, notably the Moore-Jansen *et al.* (1994) system, which began as a collection of recommendations prior to 1986. The edited volume *Standards* (Buikstra and Ubelaker 1994) was designed to collect data from prehistoric Native American remains in advance of loss due to NAGPRA legislation (Rose *et al.* 1996) and was modeled on the Moore-Jansen and Jantz report (1986) and Moore-Jansen *et al* (1994), which were created to standardise data collected from forensic remains. Moore-Jansen and Jantz (1986) and Moore-Jansen *et al*. (1994) were stepping-stones to FORDISC, the forensic software system used as an aide to identify source population of human remains when the specific identity of the individual is required for forensic (medico-legal) purposes (Dirkmaat 2001).

Many of the cranial and long bone measurements in Moore-Jansen *et al* (1994) and Buikstra and Ubelaker (1994) are based on lengths and diameters devised by 19th and early 20th century anthropologists, and have never been examined for utility (Armelagos *et al.* 1982: 310). Bass in *Human Osteology: A Laboratory and Field Manual, 5th Edition* (2005) provides a field guide on the basics of identification, such as left versus right and specific elements. Bass first compiled the manual in

1971, with subsequent editions; the most recent is the fifth edition (Bass 2005). His tables for determining the so-called race or sex of an individual, created using metric data from both archaeological remains and documented individuals, allow assessment using almost every element, such as the humerus and femur, as well as the pelvic bones and skull (Bass 2005). Bass also provides the formulae used with these metric measurements to determine and mathematically express the robusticity of a long bone, degree of a long bone’s flatness, and the formulae that utilise cranial measurements to determine a skull’s overall shape such as round headed (brachycephalic) versus longer, narrower skulls, the latter termed dococephalic (Brothwell 1981; Bass 2005).

The most comprehensive data capture plan for ancient remains is that used by the Smithsonian Institution in Washington DC. (Ousley *et al*. 2005). During the 1970s and into the 1980s, concern over museum retention of Native American remains escalated (Rose *et al.* 1996; King 1998), which eventually led to the signing of the Native American Graves Protection and Repatriation Act (NAGPRA) in 1990 (Rose *et al.* 1996) (discussed in detail in **Appendix 1.A**). This Act provided for the repatriation of indigenous skeletal remains and sacred objects to tribal communities that requested them.

The Smithsonian curated such extensive holdings of indigenous remains that it received its own NAGPRA-type legislation, Public Law 101-185, enacted the year before NAGPRA itself became law (Ousley *et al.* 2005). With funding provided for comprehensive analyses, the Smithsonian was able to create an exhaustive data collection protocol, set training standards for its osteological staff, and proceed to amass data from the skeletal remains. For the Smithsonian, the problem to solve was the impending loss of its extensive collections; the solution was to measure, evaluate and photograph *everything* (Jones and Ubelaker 2008).

In response to the pending NAGPRA legislation, and anticipating the potential for the loss of all indigenous skeletal holdings, members of the American Paleopathology Association, a branch of the American Association of Physical Anthropologists began to discuss methods of data capture that would standardise the observations (Buikstra and Ubelaker 1994: 3). The initial concern was a lack of comparability between reports on remains, with researchers often collecting data of interest rather than a standard set. Between 1988 and 1991, committees were formed to create specific criteria to be observed and recorded, such as age at death, estimated biological sex, and other variables (ibid). The resultant protocol has since been referred to (if not fully used) as the standard protocol since publication.

The physical anthropologists who met in 1991 to hone the protocol that became *Standards* (Buikstra and Ubelaker 1994) created an exhaustive list that is meant to record, possibly for the one and only time, Native American remains that will be repatriated. Their objective is clear: "Many archaeologists and physical anthropologists, while sympathetic to concerns of Native Americans, are deeply concerned with the loss of knowledge…..Also of concern are the collections that are….buried today……with only limited analysis by qualified physical anthropologists." (Buikstra & Ubelaker 1994: 2). Despite the 78 individual cranial and post-cranial metric measurements, and the 60 non-metric traits of "Primary Importance" (ibid: 87) that they recommend (in addition to other relevant forms found in the 29 Attachments), this level of documentation is still considered by its authors as only partial at best: "We recognise that the standards presented here are only a limited set of those necessary to meet the needs of contemporary and future researchers." (ibid: 4).

A massive American-based comparative study of skeletal remains, *The Backbone of History* was compiled by Steckel and Rose (2002). For their meta-analysis, data was assembled from old reports, existing databases, and collected by researchers specifically for this project, so that eventually the study included information on 12,520 individuals. About 80 percent of the data was from North and South American indigenous people (but not the Caribbean), with African chattel slaves and their descendants, and white / European settlers comprising the remaining 20 percent (ibid).

The most recent and widely cited data collection protocol in use is Buikstra and Ubelaker (1994). While Bass (2005) and the IFA / BABAO *Guidelines* (Brickley and McKinley 2004) are also used, the former manual is cited in virtually every post-1995 study involving, even peripherally, assessments of age and sex.

1.2.2.1 USA and now global

After publishing *The Backbone of History* (Steckel and Rose 2002), Steckel and colleagues went on to instigate the Global History of Health Project. This ambitious project comes with its own guidebook, *The Global History of Health Project Data Collection Codebook* (Steckel *et al.* 2006), and extends the data collection across Europe, with the aim that paleodemographic data thus collected can be compared across collections. Indeed, the *Codebook* (Steckel *et al.* 2006) includes a wide range of support illustrations to help the novice and early researcher collect comparable data. As the goal of the project is to amass standardised sets of information that may already be in existence, this document aims to ensure uniformity of submitted data. Also, teams of physical anthropologists are examining collections for this project. However, not all collections will be subjected to this process; it is a global initiative, not an inclusive one, and aims to collect data from a wide variety of temporal and geographic parameters.

1.2.3 Britain

Many collections of human skeletal remains in the UK and Europe are large assemblages that may never have been given a basic preliminary assessment (Roberts and Manchester 1995; Roberts and Cox 2003; White 2013), whilst a limited number of collections are examined far more often (Roberts and Mays 2011). Some collections are vast and need to be assessed at least minimally in order for a visiting researcher to determine its applicability for a directed project such as the prevalence of anemia among children in a certain region or time period.

In 2005, two publications were created to provide best practice procedures for human remains: *Guidance for best practice for treatment of human remains excavated from Christian burial grounds in England*, published collaboratively by English Heritage and Church of England; and *Guidance for the Care of Human Remains in Museums*, published by the Department for Culture, Media and Sport (DCMS).

The first guide book lists seven criteria that at minimum should be available for graves that must be moved, for whatever (legitimate) reason, in order for any remains to offer maximum scientific value. These include the ‘identity’ of the remains (as much as can be known, such as area of habitation; location in graveyard), the approximate dates of inhumation, associated artefacts, and the condition and completeness of the remains (English Heritage and Church of England 2005: 43). The minimum information to be recorded from any fairly complete individuals include age range, probable sex, metric data, non-metric traits that may trend in populations, and disease and trauma that has affected the bones and teeth (ibid: 44).

The second publication was created to aide museums in repatriation requests for Australian, Tasmanian and other non-UK remains (White 2011) (discussed in detail in **Appendix 1.B**). The resulting set of recommendations also addressed remains not bound by repatriation request, and suggested minimum inventory data that should be known for all remains curated by a museum. These include the number of individuals curated, the completeness of the individuals, and the condition of the skeletal elements (DCMS 2005: 22).

The British-based *Guidelines to the Standards for Recording Human Remains* (Brickley and McKinley 2004) admits that the Buikstra and Ubelaker (1994) coding system is too “cumbersome and restrictive to be of practical use in most cases,” (Roberts and Connell 2004: 36) and offers, instead, an observational methodology whereupon the bone anomaly is identified as to pattern of location, and a selection of descriptions referring to bone loss, bone deposition, and the edges of defects (lesions). *Guidelines* scatters references to Buikstra and Ubelaker (1994) throughout the 47 pages of text, assembled from separate papers by a wide range of British authors: for example regarding skeletal completeness and data recording sheets (Brickley 2004: 6); photography (ibid: 7); dental inventories (Connell 2004: 8); commingled remains (McKinley 2004: 15), age at death categories for adults and juveniles (O’Connell 2004: 18, 20; Brickley 2004: 22); sexing remains (Brickley 2004: 23); metric and non-metric data (Brothwell and Zakrzewski 2004: 27-30) and paleopathology (Roberts and Connell 2004: 34-36, 39; Boylston 2994: 40). Importantly, the British guidelines do not rely completely on Buikstra and Ubelaker (1994), and indeed discuss in detail cultural practices (such as cremated remains) and patterns of disease and trauma most often or even primarily found in the UK and Europe, such as DISH, Paget's disease, and leprosy. The guidelines also include a few data collection forms which resemble condensed and simplified Buikstra and Ubelaker (1994) forms (Brickley and McKinley 2004).

The Museum of London has undertaken measures to manage their extensive collection of human skeletal remains, all of which were obtained consequent to archaeological excavations in the London area (Redfern and Bekvalac 2013: 89). In 2003, supported by funding from the Wellcome Trust, The Museum established the Centre for Human Bioarchaeology to facilitate research on remains in their collection. In addition, the Wellcome Osteological Research Database is the only searchable osteological database available online at no cost to the user. Museum osteologists are reportedly able to record demographic and skeletal inventory data on two skeletons a day (ibid: 88).

1.3 Anthropometry

> Anthropometry *may perhaps be most simply and comprehensively defined as the conventional art or system of measuring the human body.*
>
> Ales Hrdlička 1919.

1.3.1 The Skull as Population Marker

One of the earliest researchers of human variation was Johann F Blumenbach (1752-1840) who received instruction in archaeology and natural history as well as medical training (Marx 1865: 4, in Bendyshe 1865). One of Blumenbach's great works, "On the Natural Variety of Mankind" was originally written as his doctoral dissertation in 1775 (Marx 1865:8, in Bendyshe 1865). Blumenbach held a monogenistic view – that all humans shared a common origin – and was among the first scientists to suggest organising human types into races using the skull instead of skin colour (Bendyshe 1865: x-xi). The early history of anthropometry and the manner in which nineteenth century craniometry was used to justify European and American colonial practices is examined in more detail in **Appendix 1.C.**

For much of the next 100 years after Blumenbach, the study of the human skeleton was concerned with creating and standardising measurements, and categorising human variation into several 'races' (Brace 1982: 12). By the mid-nineteenth century, monogenism was giving way to polygenism, the view that humans are descended from multiples lineages (Juzda 2009: 158). In 1859, Paul Broca (1824-1880) founded the Societe d'Anthropologie de Paris (Spencer 1982: 5) and focused on measuring the cranial capacities of skulls from various populations in order to assign a 'type' to the population. Samuel Morton (1799-1851) had been doing similar work in America since the 1830s (Todd 1923). Other cranial measurements were developed to record maximum skull length and breadth, and skull height. Meetings and conferences were convened to determine the optimal base points for measurements, and to establish a standard plane in which to take the measurements (Hrdlička 1919: 45; Howells 1938: 187).

This reliance on just one body part to determine racial affiliation and one's place in the evolution of races made several key assumptions: that human races and indeed skeletal morphology was fixed; that the skulls of sometimes very few individuals represented an entire population; and that the skull was the most important part of the body (Hrdlicka 1919d: 401; Todd 1923; Armelagos *et al.* 1982: 307-308; Brace 1982; Juzda 2009: 158). Until the early 20th century, apart from examination and retention of highly abnormal specimens, such as by 18th century anatomist John Hunter for example (Moore 2005), post-cranial remains were often discarded (Armelagos *et al.* 1982: 316). Indeed, anthropometry was referred to as 'craniometry' (Brace 1982).

Craniometry continues to be an area of study, particularly for establishing ancestry, for both population and migration studies, and for determining potential identity of unidentified remains in military and forensic contexts (Krogman 1962; Gill 1998; Byers 2002). Modern cranial studies of South American indigenous specimens have been undertaken to investigate theories of population movement into the Americas (Brace *et al.* 2001). Hominid evolution and functional morphology are other areas of study that depend on craniofacial measurements (O'Higgins 2000; O'Higgins *et al.* 2011).

Depending on one's view, craniometrics and biological distance studies (population movement) are useless enterprises due to 'hyperplasticity' of the skull; or it is even more crucial to take every conceivable data point to maximize the possibility of placing a skull into a specific culture-historic category. The latter method, currently using geometric morphometrics, (O'Higgins 2000; Zelditch *et al.* 2004) is derived from bio-distance studies. Geometric morphometrics also considers the shape of cranial aspects, such as eye orbit; and attempts to correct for ambiguous landmarks by increasing data points.

The debate over plasticity versus secular change continues. Mays briefly discusses the problems with interpreting the underlying causes of variation, described as the "genetic and non-genetic factors influenc[ing] skull form" (Mays 2000: 278) and contends that large-scale studies utilising known populations can overcome the slight "extraneous factors" (ibid). He then discusses the "attempts at standardization" (Mays 2000: 279) made throughout the 19th and 20th century, and that these are still the basis for modern osteometric textbooks. In the end, Mays rather approves of craniometry and bemoans the dearth (as of 2000) of craniometrics being employed in migration studies.

1.3.1.1 Baby and Bathwater

In rejecting the typological analyses of the past, we refute decades of previous work. However, the concept of typology, that of collecting information – in the example of craniometry, data on skull width, length and height – and using it to apportion skulls into categories and 'types' (races, populations) is still used to this day (Howells 1973; Brace *et al.* 2001; Konigsberg 2006); and craniometric data is duly collected to determine ancestry, sex, and pathology. The types we sort people into are hard to quantify, and the primary unit of study must be defined, whether "the individual, the population, the site, or the type" (Cook 2006: 69). Further, there are questions as to where we draw the line on our collection; whom we do we include and how to we determine outliers, be they odd due to happenstance or to disease (ibid). The genealogy of the accepted and 'basic' set of craniometrics includes measurements that were systemized in the craniometric conferences such as Frankfurt, which gave us the 'Frankfurt Plane', and were carried back by the conference attendees to their students (Howells 1938; Cook 2006). The origin of comparative indices can be traced from Broca to Boas, from Hooton to Pearson, Howells and Morant; passing through Oxford, Harvard, Cambridge, the Smithsonian, to modern forensic databases in use today (Cook 2006).

Try as one might to ‘simplify the list’ of meaningful data to collect, we are still tied to the basic set, despite its history. For example, the 35 craniometric measurements espoused in Buikstra and Ubelaker (1994) and which are recommended in the British guidelines (Brickley and McKinley 2004) are a subset of the original and highly complex attempts to identify and quantify the so-called multiple races or ‘types’ within population groups (such as Neumann’s eight types of Native Americans: Cook 2006: 62), and other such efforts to identify groups (Howells 1973) or to tease out the assumed differences in brain size and skull capacity (Todd 1923). When correctly taken, these data sets can be used to support sex assessment, cranial modification, and population affinity, particularly for forensic investigations (Moore-Jantzen and Jantz 1986; Dirkmaat 2001; Ousley 2001).

Topinard was a student of Broca. Continuing Broca’s work on metrical analysis, Topinard writes,

> “All measurements need to have a definite reason. Craniometric characteristics are of two sorts: rational, that is to say based on physiology, and empirical, that is to say collected without a firm motive.” (Topinard 1876: 237, translation M Gernay and R Drew).

Topinard was a firm believer in selecting sensible landmarks that could be readily explained to others, replicated by other researchers and were clearly based on definable anatomical points (“reference points that are really fixed”, ibid: 236) rather than obscure flights of fancy (“particular ideas being pursued for the moment”: ibid). He writes,

> “It's better to sacrifice the idea you are pursuing than to discard reference points, in order to work not just for yourself; and that researchers who publish their data, without precising their method, expose themselves to not convincing anyone.” (Topinard 1876: 237, translation M Gernay and R Drew).

This belief was echoed 135 years later by O’Higgins in relation to geometric morphometrics, which is a method of statistical shape analysis based on utilising landmarks (O’Higgins 2000, Zelditch *et al.* 2004). O’Higgins asserted, “Every landmark must have a hypothesis behind it. No data should ever be taken without scientific rationale to back it up" (O'Higgins 2006, personal communication).

1.3.2 Cranial and Postcranial Metrics

The examination of the human skeleton to ascertain age, sex, stature and ancestry developed during the early 20th century (Hrdlička 1919e) and gained legitimacy following Krogman's 1939 work for the State Department (Krogman 1962). The practice of collecting measurements of archaeologically obtained human skeletons was also extended to taking data from local living populations, presumed to be descendants (Baker and Eveleth 1982: 33). Museums were mostly involved in the teaching of anthropology and training in anthropometric techniques, but once Hooton established a programme in Harvard, the Peabody Museum at Harvard became involved, thus connecting a university department to the practice. By the late 1930s and into the post WWII era, other universities were also routinely funding expeditions, such as Yale with its Caribbean School (Drew 2009), although Yale had been involved with Hiram Bingham's Peruvian expeditions, including to the famous Machu Picchu, in 1911 and 1912 (Bingham 2000).

Federal government support for anthropometry developed around WWII, with Harvard students measuring military personnel to aid in the design of uniforms, oxygen masks and even cockpits (Baker and Eveleth 1982: 34). This was extended, after WWII, to identification of war dead. By 1939, W M Krogman had created a manual on determining age, sex, ancestry and stature for the FBI (Thompson 1982: 358). Thus by the 1940s onward, physical anthropology had moved from measuring cranial capacity to support theories of 'racial' stratification, and onto the now prevalent practice of measuring the living and the dead to determine demography.

Along with the development of anthropology as a method of studying the living human body to create appropriate military gear, anatomical collections were being assembled from unclaimed bodies in morgues. Whilst comprised of individuals who had presumably been socially and economically deprived (Meindl *et al.* 1990), and thus biasing the collections, the benefits of amassing skeletons of known age, sex, ancestry and disease state were substantial. American collections such as the Terry Collection, the Hamann-Todd collection and the extensive holdings of the Smithsonian Institute presented anthropologists with the means to test ageing and sexing techniques (Hrdlička 1919e; Todd 1923: 117).

1.3.3 Conclusion: Ideal Data Capture Using Current Protocols

Collecting metric data from human skeletons, if taken accurately, provides a wealth of information. Craniometric data can be used to assess for age and sex estimations; cranial modification; ancestry; and by using overall vault shape, to place the individual temporally; for example, rounded, high cranial vaults are considered derived from long low vaults (Howells 1973; Brothwell 1981; Bass 2005). Pelvic bone data can inform on sex: pubis length compared to ischial length; ilium width versus breadth; sacrum width versus breadth (Washburn 1949; Meindl *et al*. 1985a; Lovejoy *et al*. 1985a; Steyn and Isçan 2008; Drew 2013). Long bone and other postcranial metrics can be used to assess long bone morphology and 'geometry', which can suggest degree of sedentism and overall health, and indicate robusticity, stature, and sex (Trotter and Gleser 1952; Larsen 1997; Ruff 2000; Chamberlain 2006). To an extent, variation in morphology provides information on cultural traits and activities (Phenice 1969; Larsen 1997; Ruff 2006; Mays 2010).

The so-called 'non-metric variations' observed in the skull, vertebrae, and larger long bones (humerus, femur) can inform on familial/epigenetic traits, ancestry, and age and sex estimations. Observations of tooth morphology and dental health, such as caries, wear and attrition, periodontal disease and premortem tooth loss can be used to assess caries prevalence in a population, diet, disease, ageing, and sexing (Brothwell 1981; Goodman and Rose 1996; Hillson 2005).

Accurately recording evidence of paleopathology can be used to determine relative age at death, overall level of good health and disease, and to identify evidence consistent with violence, cause and manner of death. Indicators or 'markers of physical stress', such as traumatic injury to the lowest cervical vertebra suggesting strenuous anterior weight-bearing activity ('clay shoveller's fracture':Apley 1970:

211) can suggest potential habitual activity (Lovell 1997; Aufderheide and Rodriguez-Martin 1998; Jurmain 1999; Ubelaker 2003; Bass 2005). Burial type (if known) informs on cultural and temporal practices, and possibly manner of death (Thomas 2004; English Heritage and Church of England 2005; Gilchrist and Sloane 2005; Fiorato *et al*. 2007).

The following chapter will consider difficulties and roadblocks to using existing protocols, and will outline this project, which offers a system that can create a basic profile of the condition and completeness of a set of human skeletal remains. This 'Rapid Assessment System' can be used as a complementary system when existing metric and non-metric data capture methods can be employed. For some museums, the user-friendly protocol described in this project can be a viable alternative to not having any records on existing holdings.

Chapter 2: Problems with Current Protocols and the Need for a Rapid Assessment System

"Our problem is to sex the individual, and not the measurement."
Fred P Thieme and William J Schull (1957: 250).

Chapter 1 provided an overview of the recent and contemporary methods for assessing skeletal remains, outlined the theory and methodology applied to the study of human remains over the past 200 years, and touched briefly on the unsavoury involvement of physical anthropology in colonial and racial politics. This chapter will discuss shortcomings of the current protocols, defining the need for an alternative assessment system. Most importantly, this chapter will describe the development of the project from its initial incarnation through to the outline of potential consumers.

The project began as an early attempt to gather skeletal information 'rapidly'. A ten day visit to the Duckworth Laboratory in Cambridge became the genesis for this project, which is a rapid assessment system (RAS) with a wide range of potential users. The subsequent two chapters on Methodology will examine the design of a user-friendly questionnaire, including the first volunteer trial at York. The traits selected to be assessed in Winchester 2012 will be defined and linked to the studies underlying the selected queries. The text for the questionnaire is provided in **Table 4.1**, the actual protocol in **Appendix 2**, and the Information Booklet in **Appendix 3.**

2.1 The Original project (Rosenbluth)

In 2004, in order to investigate modern global health and provide an approximation of socioeconomic status (SES) for a World Health Organization project (Boix and Rosenbluth 2007), a list of skeletal traits was devised, with associated negative and positive scores added to designate 'good' health indicators or those consistent with health challenges. The project, referred to as the Rosenbluth Project in deference to the professor who requested the data, related to stature. Rosenbluth needed information on stature, social status and health during life from populations across a wide temporal and spatial span and had requested both status and stature estimates from undocumented medieval British remains. Her project dealt with access to resources and how health, as measured by stature, was impacted by inadequate nutrition and a stressful life. Skeletal remains in Cambridge (UK) were examined by this author in order to assist her in gathering data. The author had already completed her Master's degree at Yale (May 2003) and thus this work was performed as an independent contractor.

Rosenbluth was unfamiliar with the limited scope of medieval church records (if any even remained), and was therefore unaware that despite knowing the original location of a cemetery, and hence regional and even temporal ranges of an assemblage, actual occupation, health and status information were not possible to assign to individual sets of remains. If such information had ever been recorded, such records were long gone.

2.1.1 Assigning Socioeconomic Status

Assigning SES is not straightforward even when named individuals are examined, as has occurred when historical cemeteries such as Spitalfields are disturbed (Grauer 1995; Saunders and Herring 1995). How one ends life is not always how one begins; work with the Coimbra Identified Skeletal Collection has uncovered instances of 'hard work' found in men self-identified as 'office workers' in older age (Alves Cardoso and Henderson 2012). In addition to unknowable social status movement during life, age at death and biological sex can only be estimated in undocumented remains, and any status can only be ascribed based on burial location, and possible grave furnishings.

For example, the cemetery of St Andrews Priory Fishergate York was dated using historical information on known church alterations, and the presence of datable pottery (Stroud and Kemp 1993); certain periods were determined based on church records of the dedication of the Priory in 1202 AD (ibid: 127). The excavated burials were assigned to either Period 4 described as "11^{th} / 12^{th} century" or Period 6, described as "13^{th} to 16^{th} century priory" (ibid: 130).

The 412 remains in the St Andrews cemetery were interred in seven different styles of burial, the most common of which were simple grave cuts, with 245 of 412 individual interred in this manner. Other more elaborate burials included stone coffins (11 individuals), graves lined with roofing tiles or stone slabs (four instances) or with slabs at the head (two instances); and one example of a "cradle of cobbles placed around the skull" (Stroud and Kemp 1993: 153). The stone coffins were reserved for more high status burials, as would be burial inside the church itself. But aside from such information on burial style, assigning occupation, habitual activities or SES to unknown individuals of *assumed* sex and an age *range* at death is not certain.

The Rosenbluth Project included comparing stature attained during life to an individual's putative SES during life. While living stature can be estimated from dry skeletal elements using regression formulae and multiplying various long bone lengths by constant values (as in Trotter and Gleser 1952; Bass 2005), SES is more difficult to determine without access to demographic records and, ideally to an individual's life history.

Other than information on whether an individual had been interred inside versus outside a church, no SES documentation was available on the medieval skeletons examined in 2004. The response to the immediate knowledge gap facing the author was to devise an SES 'scoring system'. This system is the doctoral project initially proposed when enrolling in York University in 2005, and ideally would have acted as an aid to osteologists desiring to collect information on social status when few if any documents exist to augment their search.

2.1.2 Scoring Socioeconomic Status

In order to provide an approximation of SES, the criteria observed were estimated age at death; probable sex; the condition of the teeth, specifically the presence of caries or jaw abscesses, and whether teeth had been lost pre-mortem; and evaluation of so-called stress-linked skeletal markers. The latter, presumed to indicate difficult and stressful circumstances, included evidence for infectious disease, traumatic injuries, and osteological changes attributed to pathologies such as anemia and osteoarthritis. Please refer to **Table 2.1** for a comparison of the traits used for the Rosenbluth Project with those as used in Steckel and Rose (2002). Age and sex estimates and diagnosis of diseases were based on standard texts as available in 2004 (Buikstra and Ubelaker 1994; Bass 1995; Aufderheide and Rodriguez-Martin 1998; White and Folkens 2000; Ortner 2003); stature formulae were used from Bass (1995) and White and Folkens (2000). Except for estimates of biological sex, each of the other traits or pathologies was assigned a negative or positive score, based on the estimated age at death: for example, severe osteoarthritis at an advanced age would be scored less negatively than severe osteoarthritis in a young adult.

The aspects chosen for examination are similar to the seven markers used by Steckel and Rose in their comparative study of skeletal remains, *The Backbone of History* (2002) (**Section 1.2.2).** These traits are commonly recorded from remains, and by 2002 were well discussed in the literature (Brothwell 1981; Brooks and Suchey 1990; Goodman and Rose 1990; Buikstra and Ubelaker 1994; Larsen 1997; Aufderheide and Rodriguez-Martin 1998). In the introduction the authors report that economic studies were increasingly using biometric information to assess population health, particularly stature, which reflected an individual's access to adequate nutrition during growth (Steckel and Rose 2002: 4).

Table 2.1 Comparing the observations used by Steckel and Rose (2002) and the ones used in the Rosenbluth project. The numerical values assigned to the assessed traits were selected to reflect the presumed positive or negative aspects to each trait, such as death estimated at age 25 or younger or relatively more benign disorders such as tooth loss after age 40. All ages at death are estimates based on anthropological assessment. See text for details.

Assessed Traits in Drew 2004	Scores used in Drew 2004	Assessed Traits in Steckel and Rose (2002)
Age at death under 25	-2	Age at death
Age at death over 40	+1	
Age at death over 50	+2	

Stature (estimated using regression formulae for White individuals)	As measured	Stature
Osteoarthritis before 30 Osteoarthritis after 30	-3 -1	Degenerative joint disease
Anemia: Cribra orbitalia Porotic hyperostosis	-3	Cribra orbitalia Porotic hyperostosis Enamel hypoplasias (all three assessed as 'evidence of stress in childhood')
Fractures well healed Fractures poorly healed or poorly set Wounds or cut marks	-1 -3 -1	Trauma
Lesions	-1	Infectious disease
Tooth loss before 25 Alveolar loss before 40 Alveolar loss after 40 Caries Wear/chipping Lesions (dental)	-3 -2 -1 -1 -1 -2	Dental health: tooth loss, caries, dental cysts/abscesses

The scoring system devised for the Rosenbluth Project seemed to allow the work to proceed smoothly, with approximately 15 minutes spent on a set of appropriate remains: that is, remains that seemed to represent one discrete individual (not commingled) and that which included adequate skeletal material to assess the selected criteria. This also required each set of remains to have either at least one complete (or broken and refitting) femur.

By adding up the scores assigned to each ailment, a greatly negative score was used to justify assigning a low SES to an individual. For example, if the individual was estimated to have died before skeletal maturity (under age 25-30), and had evidence consistent with osteoarthritis, tooth loss, and periosteal inflammation, the score would be -8.0. One problem was that the few positive values for benign or common issues (tooth loss at an advanced age) or even attaining older adulthood was inadequately differentiated from the far more prevalent negative scores. This did not permit an adult individual with good dental health and a lack of obvious disorders to reach a strongly positive score. However, the apparent success of the rapid scoring system led to the conclusion that a similar, expanded system might have wider applications.

2.1.3 Medieval remains that lack basic demographic information require extra handling

Institutions that have skeletal holdings may not have a database of basic paleodemographic information on each set of remains (White 2011, Giesen *et al.* 2013). In Cambridge, the approximately 16,000 skeletal remains that comprised the Duckworth Collection in 2004 were not identified by age and sex in a database, and thus the author was unable to request access to, for example, 100 individuals representing both males and female, and whose remains were relatively complete. The Duckworth did not have funds to hire an osteologist; the hope was that a 'clever master's student' would collect this information 'someday' (curator Maggie Bellatti, personal communication February 2004).

Published and unpublished reports on several assemblages, which did not always contain comparable data on age and sex, were available (Brash *et al.* 1935; Goodman and Morant 1940; Mahany 1965); and the author was encouraged to examine remains from the same cemetery assemblages as described in the reports. Remains that were commingled or fragmentary were not identified on any list. Two boxes were pulled for every one that contained remains applicable to the tenets of the 2004 project. A database of age, sex and condition of each set of remains (at least) would have resulted in less unusable boxes pulled, and led to reduced handling or unnecessary transport of fragmentary remains, as recommended by Museum of London policies (Redfern and Bekvalac 2013: 90).

Having limited time to gather adequate supportive data for a study is hardly unusual. A gap in the available protocols was noted following the 2004 visit to Cambridge: estimations of age, sex and presumable 'status' in life would not be readily apparent to other postgraduate researchers employed by Rosenbluth and sent off to China. The students required training in how to identify a femur, tibia and humerus; how to measure long-bone lengths; and as non-anthropologists they would be dependent on written records to obtain information on age at death and biological sex from skeletal remains. Finally, it seemed improbable that osteological novices would be able to discern a broad sense of possible socioeconomic status (SES), if unable to diagnose bad teeth, chronic bone conditions and evidence consistent with inadequate nutrition (e.g. indicators of anemia and rickets). The design and testing of a system for assessing SES from large collections of remains became the original doctoral project, begun in York in October 2005.

2.2 Overview of Problems with existing Protocols

The original aim of this project had been to create a 'scoring sheet' in order to accurately and quickly record features on a skeleton that are associated with health and status differences. As the scheme developed, problems with existing methods were recognised and accordingly the project simplified to a Rapid Analysis System (RAS) with the goal to 'triage' under-studied skeletal collections prior to more comprehensive evaluations by experienced osteologists.

In the first instance, to test the accuracy of pre-existing data capture methods, already extant datasets that had been created using existing protocols such as *Standards* (Buikstra and Ubelaker 1994) and *Guidelines* (Brickley and McKinley 2004) were to be compared to results obtained from the initial 'status scoring' method. The first hurdle was the realization that virtually no such list of Buikstra and Ubelaker (1994) metric and non-metric data existed for any collection. Eventually, one such set was located, in a book describing the human remains removed from an abandoned community cemetery in Pittsburgh Pennsylvania (Ubelaker and Jones 2003); this study does not use the paleopathology coding system detailed in Standards (Buikstra and Ubelaker 1994). Accordingly, in December 2005, it was decided to personally 'test' Buikstra and Ubelaker (1994) on a collection curated by Indiana University (see **Section 2.2.1.2** below).

There are 29 separate attachments (blank recording forms) for recording data from skeletal remains in *Standards* (Buikstra and Ubelaker 1994). Not all 29 forms can be used for each skeleton, as three forms are applicable only for nonadults and one is for recording isolated elements from commingled assemblages. Of the forms most likely to be used, one is for recording cranial and postcranial metric data (Attachment 21, ibid); one for nonmetric data that are considered epigenetic traits

(Attachment 22, ibid); six are for dental information; five for recording taphonomy, age and sex estimates, and samples removed for study; one is an inventory for discrete individuals, and seven are for creating visual records of the remains (mature and immature remains) by shading in, on an outline of a skeleton, the elements or portions of elements that comprise one individual in a collection. A total of four forms are for recording pathological assessments including one each for trepanation and cranial modification (head shaping).

The inventory form for complete individuals cited above (Buikstra and Ubelaker 1994: Attachment 1) permits one to checkmark the presence of each element, by type and side (for paired elements: for example, left femur) and to denote whether the element is complete, mostly complete, or only represented by a fragment. The author used this form extensively during work at the Yale Peabody Museum in New Haven CT, between July 2002 and March 2005. The form requires the user to recognise each skeletal element by type and by side, including certain ribs, vertebrae and foot bones, and to be able to judge the level of 'completeness' for each element. With practice, the form took approximately 30 minutes to fill in, after the skeletonised individual had been laid out in anatomical position on the lab table.

There are two attachments that comprise the lengthy paleopathology recording system (Buikstra and Ubelaker 1994: Attachments 25 and 26). This method consists of coding each anomaly so as to identify abnormal bone accumulation or destruction; location (axial or appendicular skeleton); whether it appears to have been active at death, healing or healed; is wide spread or discrete; and so on. The complex coding system will be examined further in **Section 2.2.2.**

2.2.1 Opportunity and Challenges using Current Protocols: Anthropometry

If the full suite of Buikstra and Ubelaker (1994) assessments is taken, an extensive amount of useful information will be recorded. However, based on using three forms, which took 3.5 hours (as a protocol novice: see **2.2.1.2** below) and considering the 30 minutes per inventory form when used at the Yale Peabody, it is estimated that the full set of forms can total up to 5 hours to record, and requires specialist equipment and specialist training. If all metric data are recorded, we will have information that can be mathematically manipulated to determine ancestry, sex, stature, and to an extent, evidence of injury or disease. The full dataset would include the detailed and complex pathology 'coding system'. We would measure the teeth; record non-metric traits; and if Buikstra and Ubelaker (1994) could be followed completely, we would take digital photographs and even retain bone samples for stable isotopes studies, ancient DNA analyses, and histology slides.

These are all important things to record, especially if access to remains is limited due to ethical issues, or if the skeletons examined are part of a very large collection. Visiting scholars will typically analyse remains with a focused, limited inspection in order to address particular questions (for example, Judd's examination of Kerma remains curated by the Duckworth: Judd 2000).

2.2.1.1 Practical problems with collecting data

The techniques to measure the length and diameter of various skeletal elements require experience, are to some extent interpretive, and the results are subject to population and sample bias. Accuracy in taking metric data, and its comparability are also influenced by training. In addition, the paleopathology 'coding' system employed by Buikstra and Ubelaker is time-consuming and requires experience with (at the least) normal and abnormal traits typically observed in the population from which the sample is drawn (Robb 2000; Đjurić *et al.* 2005). The author collected unpublished and indeed absolutely confidential interviews with a small sample of ten postgraduates from America and Europe who were attending the 2007 and 2008 AAPA meetings with respondents asked questions about using standard data collection methods.

The author asked if the respondent had ever used (for example) Buikstra and Ubelaker (1994) to collect data on remains. All said yes. The author asked if they were aware of *why* certain measurements were recorded, specifically medio-lateral (ML) and anterior-posterior (AP) measurements of both the subtrochanteric and mid-shaft regions of the femur. All but one said no; not even two respondents who were PhD candidates were aware of how such data are utilised. A highly platymeric femur is flattened near the neck from front to back, a morphological difference related to activity (Larsen 1997), subsistence pattern (hunting versus farming) and terrain (Ruff 2000: 80-82). Rounder mid-shaft regions are related to a more sedentary lifestyle. The respondents reported problems with determining landmarks, which are the endpoints for obtaining distance. When questioned about the multiple descriptions of the subtrochanteric region, with for example, Steele and Bramblett (1988) describing its location as 3.0 to 6.0cms distal to the lesser trochanter (ibid: 242), four respondents admitted if they were unable to locate a landmark, they 'guessed'. When asked if any had used the pathology 'coding' section supplied with Buikstra and Ubelaker (1994) all said they had not. Any observations of abnormal bone were recorded in the Notes section. Two respondents had been recording data from American Indigenous remains that have subsequently been repatriated.

The author regrets that the vagueness of the anecdotal evidence may lead it to be discounted, but her commitment of secrecy for her respondents is paramount: several had been under the supervision of very well-known anthropologists.

2.2.1.2 Challenges encountered by this project in original format

For an initial project investigating existing protocols, with data collected in January-February 2006, 43 prehistoric Native American skeletons were assessed using forms supplied by *Standards* (Buikstra and Ubelaker 1994). For various reasons, human remains were not available for study in York. The two forms used for all 43 sets of adult remains were Attachment 21, "Cranial and post-cranial metric measurements" and Attachment 22, "Primary non-metric traits recording form" (ibid). For the first six individuals analysed Attachment 20 was also used: "Dental measurements and morphology recording form" (ibid), but was soon abandoned, as the one form took up to 1.5 hours per individual, would be irrelevant without access to specialty dental calipers and training to use them, and mostly because this was an investigation of the so-called short Buikstra and Ubelaker (1994) protocol, rather than an assessment using all potential forms for assessing adult remains.

This task was to collect data using *Standards* (Buikstra and Ubelaker 1994), but also to ascertain the time needed to record such extensive data per individual. At first, using three forms, assessment took 3.5 hours per skeleton, which became just over one hour per individual with practice and using only two forms. Importantly, taking metric dimensions such as the length of a long bone, and the diameters of its epiphyses (which comprise articulating joints) are not techniques bound to one source population, meaning such data can be collected on European remains even if using a protocol created for assessing a specific population (ibid: 69). However, fragmented, abnormal or otherwise incomplete bones should not be measured (ibid: 70).

The assessed collection, Klunk Mound 1 curated in Bloomington Indiana, has been comprehensively examined by King Hunter (unpublished data, Bloomington Campus Indiana University), and has been partially examined by Georg Neumann (1942), Della Collins Cook (1976), Dawnie Steadman, Jane Buikstra and other workers (unpublished data, Bloomington Campus Indiana University). As a result the individuals in this collection have previously been aged and sexed several times; during the 2006 project age and sex were determined "blind" and then compared with results of the other workers. The assessments were in close agreement**.**

Throughout the initial investigation of the 43 Klunk Mound I adult individuals, problems with interpreting how to take the Buikstra and Ubelaker (1994) metrics were encountered. These included: realisation that selecting 'greatest expression of interosseous crest' for the ulna and 'greatest expression of *linea aspera*' for the femur were subjective at best, and with great intra- and inter-observational error at worst; inability to take certain dental measurements without proper training; and the realisation that the nutrient foramen on the tibia can vary widely even between left and right elements of the same individual. It was difficult to consistently take the femoral subtrochanteric anterior-posterior (AP) diameter before the medio-lateral (ML) diameter, which is the order they are requested on Attachment 21 (Buikstra and Ubelaker 1994), especially as visually sighting up and establishing the ML diameter first is most natural and even advised ("Measure from the front—this affords better appreciation of where mesial border begins to swell toward the neck, and the only way to avoid inclusion...of gluteal ridge" Hrdlička 1952: 169). Instead, the side-to-side (ML) diameter is easily taken and recorded, in error, in place of the AP (front-to-back diameter).

2.2.1.3 Cranial and post-cranial measurements: Inconsistencies in current protocol

One disconcerting aspect of most cranial and post-cranial measurements is that the theory behind the taking of one data point versus another is not explained. There may be firm rationale for measuring the diameter of the femur mid-shaft for example but no reasons given as to why (Buikstra and Ubelaker 1994: 83; Bass 2005: 224). Bass (ibid: 225) recommends taking the subtrochanteric mediolateral and anterolateral diameters, stating they are used for a Platymeric Index and providing the formula, but the reader is referred to Brothwell 1963: Table 2 (also found in Brothwell 1981: 89, Table 3) for a "concise discussion of the possible causes of [population] differences" for platymeria (Bass 2005: 225) when a simple explanatory sentence would be adequate. This is actually more damaging than it initially appears, as suggested by respondents in **Section 2.2.1.1.**

In Howells' *Cranial Variation in Man* (1973), he often clearly states the reason for taking a data point. The distance across the foramen magnum is explained thus:

> Foramen magnum length FOL IIb
> *The length from basion to opisthion, as defined.*
>
> Measure with the skull base up, using the inside calipers for simplicity, *not* in order to take an inside measurement.
>
> Notes:
> 1. The main purpose of this measurement is to complete the outline of the skull, otherwise covered by other measurements.
> 2. This differs from M Lange des Foramen magnum, 7, because of the different location of basion.
>
> (Howells 1973: 181)

By providing a clear explanation for taking the length of the foramen magnum, Howells makes it more difficult for a worker to omit this step or collect the data in haste and with a lack of attention. Further, he describes the optimal technique. This distance is not the most informative measure at this time – we are no longer obsessed with cranial capacity among modern humans or ought not to be – but this is an excellent example of rationale, identification, and methodology.

Landmarks, to paraphrase Paul O'Higgins, should never be chosen unless *each one* is backed by a hypothesis; landmark-based data should not merely be an accumulation of distance measurements. As demonstrated using 'geometric morphometric' methods for shape analysis (Zelditch *et al*. 2004), even a 'mesh' of datapoints from a skull does not necessarily provide more information, just more numbers. O'Higgins also questions the utility of placing landmarks on rounded surfaces, such as brow ridges; a continuous curve does not have a readily obvious 'highest point' or most lateral margin.

A proper scientific hypothesis is a statement of supposed fact or a statement of assumption that can be disproved. A hypothesis cannot be proven; it can only survive attempts to disprove it. Each landmark or data capture point requires a hypothesis to justify its choice, a process O'Higgins describes as:

1. Select Landmark (for example, an exuberant muscle enthesopathy, or MSM, which if measurable larger on one individual compared to another can be taken to reflect activity).
2. How might this hypothesis be falsified? (MSMs are not related to activity.)
3. What is the morphological embodiment of the landmark falsified? (Exuberant MSM on everyone; or, large MSM on individuals with evidence of paralysis, spina bifida, etc.)
4. Mensuration (measurement of the MSM).
5. Analysis (comparisons of MSM correlated to lack of activity).
6. Interpretation in terms of morphology (i.e., robust males having large MSMs, individuals with obvious movement impairment having very gracile MSM).
7. Does this falsify the original hypothesis?

(O'Higgins, personal communication 2006)

Landmarks should be simple to locate, easily measured, and most of all, easily repeated. Also, they should have a purpose; using them should tell us something; their choice should be based on hypotheses of physical form, robusticity, or size differences associated with sex. Upon inspection, most measurements suggested in metric-data based protocols fail to meet this test.

Problems with Current Protocols and the Need for a Rapid Assessment System

One valid reason for recording metric and non-metric data on a skeleton is that the data creates a ‘library’ of information about that individual, and possibly the source population if adequate provenienced specimens are available. This goal is not obviously hypothesis driven, but the choice of what to measure must still be based on a gain in comparable data from that individual.

A series of measurements that are illustrative of the confusion and contradiction in current data collection protocol are those taken on the radius: maximum length, and mid-shaft transverse (mediolateral: ML) and sagittal (anterior-posterior: AP) diameters. The mid-shaft data points are based on the metrically derived midpoint of the element, a point exactly in between the ends of the bone (Buikstra and Ubelaker 1994: 80). The use of the metrically obtained radius midpoint differs significantly from the procedure described in an earlier data collection book from which most of the Buikstra and Ubelaker (1994) datapoints are derived: Moore-Jansen and Jantz (1986).

Compare this set of data, the radius maximum length and diameters taken at the midpoint, with measurements taken on the ulna which is the other short bone in the forearm. In this case, a large proximal process known as the olecranon extends beyond the point of articulation with the distal end of the humerus at the elbow joint, a sensitive protuberance widely familiar as the actual ‘elbow’ (White and Folkens 2000). For the ulna, the maximum length is taken, but rather than the metric midpoint of the bone, we are to use the “level of the greatest crest development” (Moore-Jansen and Jantz 1986: 70; Buikstra and Ubelaker 1994: 81) of the interosseous crest to obtain the ML and AP diameters. Further, the physiological length of the bone is taken into account, and is measured by missing out the proximal olecranon process and the small styloid process at distal. We therefore take the physiological length of the bone, the aspect of the element that acts as a lever in the forearm.

The metrical midshaft diameters of the radius as compared to its overall length are used to create a robusticity index for the radius. The total length of this element corresponds with the lever arm (physiological) length of the radius: the maximum length is the true distance between its proximal articulation with the inferior aspect of the capitulum on the distal epiphysis of the humerus, and articulation with the navicular and lunate (carpal bones) in the wrist (Bass 2005: 159). However, it is not the metrically derived midpoint of the complete ulna that is used to calculate its robusticity, nor the metrically derived midpoint of its physiological length. For the ulna, we are to use the diameters located at the widest part (mediolaterally) of the interosseous crest. This creates two disparities.

For the radius we are to ignore any mediolateral exuberance of this same crest, but for the ulna we are to base its mathematical expression *upon it completely* and without explanation. Another issue is the use of the actual metrical midpoint of the radius to locate and describe its robusticity, whereas for the ulna, we must ignore both of the easily reproducible ‘lengths’ that it offers—overall and physiological—and instead incorporate an irregular sheet of bone that separates the front, flexing compartment of forearm muscle from the rear, extending compartment of forearm muscle (Romanes 1976: 56; White and Folkens 2000).

The interosseous crest on any forearm element is variable, as is observable by all researchers who analyse the skeletonised dead. The crest can be so exuberant as to greatly influence the shape index created, so that the index is then based not on the overall round, robust, or even massive gross appearance of the radius or ulna, but on the size of the interosseous crest at the *midpoint* of the radius, and at its *maximum width* for the ulna. Indeed, interpretating the greatest interosseous crest development on the ulna may differ from worker to worker or even for the same worker after a long day; or if the worker is new to the measurement of bones and is somewhat inexperienced. The height of this crest can run along a straight, even path for up to 10mm, all whilst the actual bone shaft narrows as it moves from proximal to distal. One wonders where the maximum crest can be determined when the appearance of its greatest expression remains unvaried for a length that incorporates several shaft sizes.

2.2.2 Opportunities and Challenges of current Protocols: Paleopathology

The paleopathology choices in *Standards* (Buikstra and Ubelaker 1994) require the ability to competently diagnose, or certainly to recognise pathologies such as

Fractures (including the difference between partial, simple, comminuted, spiral); Porotic Hyperostosis; and ‘Arthritis’ (ibid: 115); and terms such as Myositis Ossificans, Sequestrum, and Spicules (ibid). The assessor must determine if a dislocation is a result of Trauma, Congenital, or ‘Cause ambiguous’ (ibid). Even without collecting paleopathology information, metric and non-metric assessments and the inventory sheet (plus dental forms if one has the toolas and training) can take severasl hours per individual.

If due to time constraints and/or training issues students and assistants only record metric and non-metric data, important observations of paleopathology, dental disease and tooth wear, the condition of the remains are missed out or severely curtailed. None of the students interviewed used the paleopathology ‘codes’ **(Section 2.2.1.1)**. In a search of articles published between 2006 and 2010 by the *International Journal of Osteoarchaeology* and the *American Journal of Physical Anthropology*, none appear to specifically include the paleopathology coding system.

The complex Buikstra and Ubelaker (1994) paleopathology assessment codes will not be critiqued, as this is beyond the scope of this project; but also because the pathology assessment is beyond the abilities of early-stage researchers. It takes years to gain experience to recognise specific disease sequelae or to distinguish between an ‘active’ infectious response and one that has recently begun to heal before death. More importantly, the code-based pathology assessment adopted by Buikstra and Ubelaker (1994) was never meant to be used as a global tool, but had been created as a population-specific assessment tool by one researcher for use on one, Native American Midwestern group (Della Cook 2008, personal communication).

Using the Buikstra and Ubelaker (1994) pathology assessment scoring system, the amount of detail required to record the variation of a lesion (a bone defect) can result in a code such as **4.8.1** (Buikstra and Ubelaker 1994, 115) which would signify **4:** “abnormal bone formation”, **8**:“specific structures”, and **1:** “Button osteoma”. The codes cover abnormal bone loss, abnormal shape, abnormal formation; in the skull, the spine, the long bones; fractures; and vertebral pathology, porotic hyperostosis, and arthritis. The last three are especially troublesome because they require a degree of diagnosis to have taken place. Observations should be as bland as possible, record if a problem or abnormality is seen, and its extent. If the bones are to be repatriated forthwith, a novice anthropologist should call in a more experienced worker immediately, or set about to describe the abnormality in notes, as well as take digital photographs if allowed. In discussions and informal interviews with colleagues and with students, it is clear these highly detailed codes are not done. They are ignored.

A search of Google Scholar articles from 2006 to 2012 produced almost 2000 hits citing Buikstra and Ubelaker (1994), including articles on paleodemography, artificial cranial modification, the use of tooth cementum for estimating age at death, and the rise of agriculture in the Americas. And yet the criteria are rarely applied, even by the editors. For example, when Ubelaker was asked why the remains from the Voegtly Cemetery in Pennsylvania (Ubelaker and Jones 2003) were not given the full ‘Buikstra and Ubelaker (1994) treatment’, he protested that the remains were too fragmentary (Douglas Ubelaker April 2006, personal communication). However, there is no authorised, standardised sub-set of paleopathology assessments recommended in such instances. This leaves each researcher to create their *own* subset of the Standards, generally by noting, free hand, diseases and bone anomalies in a ‘Notes’ section, and is thus in the parlance of questionnaire creation an ‘open-ended’ response (Babbitt and Nystrom 1989: 8). This reduces the comparable value of this highly-ascribed method.

2.2.3 A complement or potential alternative to existing protocols

Buikstra and Ubelaker (1994) represents a seminal work, assembled via the experience of almost 20 expert physical anthropologists and was, in its day, the very best of contemporary practice on assessing *Native American remains.* The British or European investigator is advised to refer to British-based *Guidelines* (Brickley and McKinley 2004), assembled by a team of experts from the UK and Europe. Both the American and UK manuals are invaluable for osteologists with some training and in particular Bass (1995 or 2005) provides formulae and (often) the rationale behind their development and their intended outcomes, the latter of which can lead to an increase in care when taking the metric data. Buikstra and Ubelaker (1994) and Brickley and McKinley (2004) also include various recording forms for recording information from commingled remains, incomplete skeletons, cremations, and juveniles from neonate to maturity.

The difficulty lies within the sheer bulk of the data generated. Situations arise in which remains are examined only briefly due to ethical issues, such as remains disturbed during cemetery excavations. If the cemetery is still in use or otherwise still considered consecrated Jewish or Church of England ground, the remains will need to be reburied almost immediately (Lilley *et al.* 1994; English Heritage and Church of England 2005; Webb 2008: 3; Louise Loe personal communication 2008). Skeletons that are part of a very large collection will typically be analysed quickly and with a focused, limited inspection in order to address particular questions. During rapid on-site skeletal analyses of remains disturbed by small-scale building works, Oxford Archaeology staff have preferentially taken dimensions from the femur, if possible, in order to estimate stature. If necessary, other elements (humerus, tibia) will be used. These might be the only metric data recorded (Webb 2008: 8-10). Paleopathology is noted as observed.

Another problem relates to the overt focus on metric data capture employed by Buikstra and Ubelaker (1994) which is only rarely *not* referenced, even in studies based on remains from ancient Egypt (Judd 2002), medieval Sweden (Kjellström 2005), and historic England (Mays *et al*. 2006). In Stirland's (2005) study of the *Mary Rose* skeletons (medieval English remains) she cites Bass (1971) and Brothwell (1981), both of which provide detailed methods for taking metric data. Indeed, Stirland devised her own sets of measurements and indices to best describe asymmetry and robusticity amongst the crew (Stirland 1992). As mentioned, no studies were located using the *Standards* (Buikstra and Ubelaker 1994) paleopathology coding system.

Metrical data do not create a complete picture. For example, when measuring the orbits, one takes the ML measurement, and then perpendicular superior-inferior

(SI) measurements. Inter-orbital distance is also recorded. But height and width do not inform on shape: unrecorded is whether the orbits are round, square, goggle-shaped, or rectangular. Also, since only one orbit is used, even extreme variation between orbits is not assessed. Metrical information on shape must be captured using geometric morphometric techniques, via computer supported equipment such as Inscribe (O'Higgins and Cohn 2000).

One concern raised over the years relates to collecting metric data to estimate age and sex. For example, metrics can be used calculate basic demographic information, but landmarks in the os coxae (hips) are not easily located, with some workers finding the method does not differentiate between sexes (Segebarth-Orban 1980; Seidler 1980; Drew 2013). Formulae must be computed, keyed into a program and used for statistical analyses that must be run in order to determine what can be reckoned by simply assessing the individual. Age and sex can be estimated by gross inspection; or data laboriously recorded to do the same thing (Stewart 1957; Ubelaker 1979). The obvious benefit is that if taken accurately, standardised data collection can potentially be reproduced across collections and between investigators; compared with older and newer data sets; is not subjective.

The metrical midpoint on a long bone shaft can be determined by anyone using a millimeter scale; however, locating subjective landmarks such as the 'greatest expression' of the femoral *linea aspera* might not be readily reproducible. On the proximal femur, determining the greatest width of the subtrochanteric region may include the gluteal ridge (Montagu 1960; Olivier 1969; Steele and Bramblett 1988) or *specifically avoid* the gluteal ridge (Hrdlička 1952; Brothwell 1981; Ruff 1991; Buikstra and Ubelaker 1994). The location of the nutrient foramen on the tibia is unpredictable (Andermann 1976) but variance in how to measure diameters from this landmark is minimal. Guidance and training might not guarantee comparable results if researchers use different techniques (Drew 2013).

Inconsistencies in measuring distances and determining landmarks are a growing concern, albeit one that exercised Howells in 1973, Andermann in 1976, and Jantz *et al*. in 1995. The author is not against recording metric data and indeed finds much value in them; but creating a simple database should take place before remains can be examined for directed projects.

The lack of consistency in taking 'standard measurements' is beginning to attract attention. Researchers are investigating variation in metric data collection, and the ways in which experience, training, and/or interpretation of how to measure the target distance can influence results (Smith and Boaks 2013). New research is focusing on the role of the measuring technique as taught to and utilised by *experienced* workers, and on comprehension of methodology as described in widely disseminated literature. In a study of inter-observer error conducted during the 2013 annual meeting of the American Association of Physical Anthropologists, postgraduate students Ashley Smith and Amelia Boaks collected data on variation of raw long bone measurements using calipers, an osteoboard and three elements: a tibia, clavicle, and femur. Volunteers were asked to measure three diameters, record their findings, and select the methodology used from a short list of landmarks and techniques: Smith and Boaks are thus utilising closed-question format (Babbitt and Nystrom 1989: 8).

2.3 The Project in Development: Revising the Rosenbluth system

The SES scoring system devised for the Rosenbluth project was created for personal use, and thus included technical terms from the field of physical anthropology that may not be understandable to a wider audience. By 2006, the initial modest list of scored features had been expanded to 38 questions that related to 17 categories of disease, disorders or traits. **Table 2.2** is the expanded list of observed traits, with the criteria for each assessed trait. The traits selected for observation are associated with commonly observed diseases, such as osteoarthritis (Jurmain 1999), tuberculosis (Ortner 2003) and syphilis (Powell and Cook 2005), and disorders such as osteomyelitis (Ortner 2003). Examinations of muscle attachment sites and cortical bone mass are related to the author's own interests (Drew 2003, Drew 2009), with the former garnering renewed scrutiny (Alves Cardoso and Henderson 2010, 2012).

Table 2.2 Scoring system for determining SES and/or identifying health issues from human skeletal remains, based on Rosenbluth Project. Listed are the traits and pathologies observed, a 'score', and the criteria used to identify the presence of a trait.

	Observed trait or Pathology	**Score**	**Criteria**
1	Osteoarthritis: Mild in young adult	-1	Joint lipping, eburnation, subchondral erosion
2	Moderate in young adult	-2	As above with severely altered margins
3	Severe in young adult	-3	Joint eroded or fused
4	Severe in mid adulthood	-2	As above
5	Osteoarthritis in older adult	0	As above for Moderate
6	Cribra orbitalia	-2	Spicules or exposed trabecular bone, porous bone in orbital roof
7	Porotic hyperostosis	-2	Thinning of outer bone plate, porosity, thickened cranial vault
8	Fractures well healed: long bones	0	Slight callus, or mild atypical angle or shape to bone shaft
9	Fractures poorly set, poorly healed, or associated with drainage sinuses	-2	Pseudoarthrosis, infectious response, osteomyelitis
**	Fractures associated with defense or abuse ** to be reviewed	-3	Multiple rib fractures in various states of repair, spiral fracture of arm bones (juvenile) or ulna
10	Wounds or cut marks	-1	Sharp defect
**	Traumatic tooth loss in young adult ** to be reviewed	-2	Broken and fragment in socket or associated with mandibular/maxillary fracture
11	Tooth loss in older adult	0	Resorbed socket
12	Alveolar loss in young adult, periodontal disease	-2	Roots of teeth exposed, possibly carious
13	Socket resorbed (tooth lost premortem) in younger adult	-2	Socket filled with woven bone or corpus smooth
14	Entire regions (anterior, posterior, on left or right side of jaw) with teeth lost and alveolar sockets resorbed	-3	As above
15	Caries: up to two, or several small caries	-1	Small defects
16	Caries: extensive	-2	Large defects
17	Extensive wear and chipping in young adult	-1	Loss of enamel and reduced tooth height
18	Wear and chipping in older adult	0	As above
19	Periodontal lesions: infectious cavitations in maxilla or mandibular corpus with or without tooth loss	-2	Rounded drainage canals
20	Periodontal lesions as above in older adult	-1	As above

21	Skeletal infections active at death (ie, periostitis, osteomyelitis) isolated to one bone or joint	-2	Spicules, irregular margins, woven bone at mild or small defects
22	Active infection in two or more joints or elements	-3	As above, larger defects. May include sclerotic remodeled bone and areas of active destruction
23	Systemic infection or isolated severe, i.e., with severe bone destruction	-4	As above
24	Age at death: young adult	-2	Accepted ageing methods
25	Adult	+1	As above
26	older adult	+4	As above
27	Thick cortical bone adult	+2	Cortex compared to medullary canal
28	Thick cortical bone older adult	+4	As above
29	Thin cortical bone young adult	-3	As above
30	Thin cortical bone older adult	-1	As above
31	Strong muscle attachment sites, no notable enthesophytes	+4	As described in literature
32	Moderate attachment sites	+2	As above
33	Rugose sites with enthesophytes	-1	As above
34	Gracile muscle attachment sites	-1	As above
35	Healed disabling injury of one limb	-1	As determined
36	Healed disabling injury/illness of two limbs	-2	As determined
37	Incomplete closure of spinous process in vertebrae, or sacrum involving 3 or more contiguous segments	-4	Gap between laminae

In additional to scoring comparative cortical mass and the appearance of muscle insertion sites, the 2006 protocol expanded choices for describing healed trauma and dental disease. Nested observations were added, such as age-at death assessments that were combined with various pathologies in order to identify combinations that would *not* be considered examples of poor SES (e.g., an *old* individual with osteoporosis and/or osteoarthritis) versus ones that could indicate a life of hard labour (moderate to severe degenerative joint disease in an individual who had died at a *young* age). Finally, the assigned scores were adjusted to exaggerate detriments and health features (**Table 2.3).**

The modified version of the SES system was applied in June 2006 to individuals in the Blackgate Collection, curated in Sheffield under the direction (at that time) of Dr Andrew Chamberlain. The exercise revealed a number of problems, including similarity in scores, and that assessment options were still limited. For the York volunteer testing, the spread between scores was exaggerated further, and additional options for various pathologies were created (see **Section 3.3**).

Table 2.3. Scoring system for determining SES from human skeletal remains. The list is an expanded version of eight disorders or traits assessed for the Rosenbluth Project. The scores were exaggerated from those based on Rosenbluth in order to amplify any actual difference in health issues coupled with age at death.

	Observed trait or disorder	Score
1	Osteoarthritis: Mild before "30"	0
2	Moderate before "30"	-5
3	Severe before "30"	-10
4.	Severe in mid adulthood	-5
5	Osteoarthritis in older adult	0
6	Cribra orbitalia	-2
7	Porotic hyperostosis	-2
8	Fractures well healed	0
9	Fractures poorly set, poorly healed, or associated with drainage sinuses	-10
10	Wounds or cut marks	-1
11	Tooth loss in older adult	0
12	Alveolar loss in young adult	-2
13	Socket resorbed younger adult	-2
14	Large area of tooth loss and alveolar sockets resorbed	-5
15	Caries: up to two, or several small caries	-1
16	Caries: extensive	-2
17	Extensive wear and chipping in young adult	-1
18	Wear and chipping in older adult	0
19	Periodontal lesions: infectious cavitations with or without tooth loss. young adult	-10
20	Periodontal lesions as above in older adult	-5
21	Skeletal infections active at death (i.e., periostitis, osteomyelitis) isolated and small	-1
23	Active infection in two or more joints or elements	-5
24	Systemic infection or isolated severe, i.e. septic arthritis	-10
25	Age at death: Young Adult	-5
26	Adult	+1
27	Older adult	+5
28	Thick cortical bone adult	+5
29	Thick cortical bone older adult—normal bone	+10
30	Thin cortical bone young adult	-10
31	Thin cortical bone older adult	-5
32	Strong muscle attachment sites no enthesophytes	+10
33	Moderate attachment sites	+5
34	Rugose sites with enthesophytes	-1
35	Gracile muscle attachment sites	-5
36	Healed disabling injury of one limb	-5
37	Healed disabling injury/illness of two limbs	-10
38	Incomplete closure of spinous processes in vertebrae, or in sacrum involving three or more contiguous segments	-10

2.3.1 York Test of Concept with Volunteers

Between October 2007 and February 2008, up to 17 York-based volunteers participated in an early version of what would eventually develop into the RAS. At that time, the primary aim of the questionnaire was for assessing SES. Although the author had tested the expanded system at Sheffield University, it needed to be tested on potential end-users. The York trial of the RAS is described in greater detail in **Chapter 3.**

2.3.1.1 Complex Queries, Specialist Jargon, Type of Question

In an attempt to create a socioeconomic status 'score', the observations were by necessity complex. For example, in addition to being asked to identify osteoarthritis or dental caries, and how severe the condition presented, the York volunteers were required to assess age at death.

The type of query seemed to influence scores in the York trial. Beyond dropping complex, 'nested' questions (described in **Section 3.3.2**), the basic simplicity of the question itself impacted a volunteer's ability to answer in agreement with the author. Binary questions (presence / absence; yes / no) were often more successful than graduated queries (mild / moderate / severe). Despite the effort to reduce jargon and supply supportive text, complex queries and numerical 'scores' were confusing to participants (**Section 3.4.2).**

2.3.1.2 Analysing volunteer decisions

The York volunteers were few, and attendance was inconsistent. Accordingly most analyses were based on descriptive statistics such as overall agreement, percentage correct per query and standard deviation among respondents. The true value of the York 2008 test of the protocol was its development into an extended series of 'focus group sessions', a suggested methodology for formulating questionnaires (Babbitt and Nystrom 1989).

2.4 The Thesis Project

The aim of this project is therefore to determine if an accurate and reliable Rapid Analysis System can be created, if such a system can be used by novices, and whether the resultant system creates useful information.

Cambridge is one example of an institution that, as of 2004, lacked organised paleodemographic data for all remains. Small museums with less staff and less funding than Cambridge, such as the Booth Museum of Natural History in Brighton, England curate remains that have not, as of this writing been assessed. Thus, this project has developed to fill a niche in protocol systems available and which aims to be a useful, practical data-gathering system that is generally approachable and useable by a wide range of unpaid volunteers or those already in work as curators.

The author presented this concept in Chicago in 2009 at the annual meeting of the Paleopathology Association (Drew 2009), and at several postgraduate conferences. In Chicago, a museum curator from Arizona expressed interest in the project. The wider workability of this concept is examined in **Section 7.3.6.**

The protocol is essentially a large questionnaire, composed of closed-ended questions (a selection of answers supplied) and geared to the non-expert end user. It is comprised of an inventory segment and a segment for paleopathology assessments. The latter is a series of observations designed to collect information on disorders and diseases. The simplified text is supported by appropriate terminology for two reasons: to avoid creating false and inadequate terminology amongst novices (Lovell 2000); and to permit the student or interested end user to ‘learn’ if desired. In addition, if the pathology checklist is used as a support for systems based on metric evaluation, the correct vocabulary will be easily understood by experienced osteologists.

The guiding principles for creating the system outlined in this thesis are threefold: one, that the protocol will be ‘rapid’ and enable large collections to develop at least a preliminary database; two, that it will accurately capture at least some of the same data that more detailed systems attempt to record; and three, that it will be user-friendly and thus accessible to non-experts.

For such a system to be designed, tested, and if necessary, revised, several issues must be explicitly and critically considered. For one, it must be determined what such a data capture system will involve as far as time, expertise, and equipment. If a system used by novice (or non-) osteologists results in inaccurate findings, assessed skeletons would still require professional evaluation.

Secondly, if the protocol is designed for use by the non-expert, the target audience must be defined. For example, if after testing, it emerges that at least a minimum of osteological training is required, this would limit potential users. However, if after analysing the results of experimental trials it is evident the system does require a certain level of preexisting knowledge, it could still be a viable alternative to typical options available now to museums, which include trying to locate funding for an expert, allowing the remains to wait for a visiting scholar, or to simply de-accession holdings.

Thirdly, the procedure chosen to investigate the efficacy of such a rapid assessment system must be thoroughly interrogated. Ideally, a variety of skeletons would be assessed (various ages, both biological sexes, a range of pathologies) by participants with varying levels of previous experience. Successful and unsuccessful results would need to be analysed to determine if the errors were due to ambiguous instructions, poorly worded queries, a lack of training, or other, unpredicted variables (such as the age of the participant). Finally, once flaws in the protocol are identified, the protocol would need to be appropriately revised; ideally, a new experiment would need to be run, with fresh participants, with the results again evaluated.

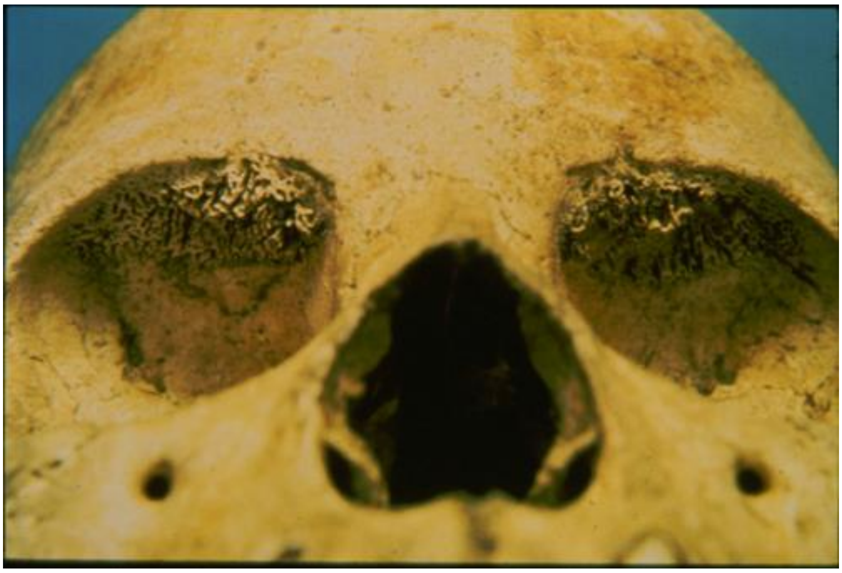


Figure 2.1. An image of cribra orbitalia, or abnormal cortical bone loss and vault expansion within the eye orbits. Cribra orbitalia in indigenous North American child from Florida coast. Note exuberant bone growth. "Santa Catalina de Guale de Santa Maria, No. 41, photograph by Mark C Griffen" (Larsen 1994: 128).

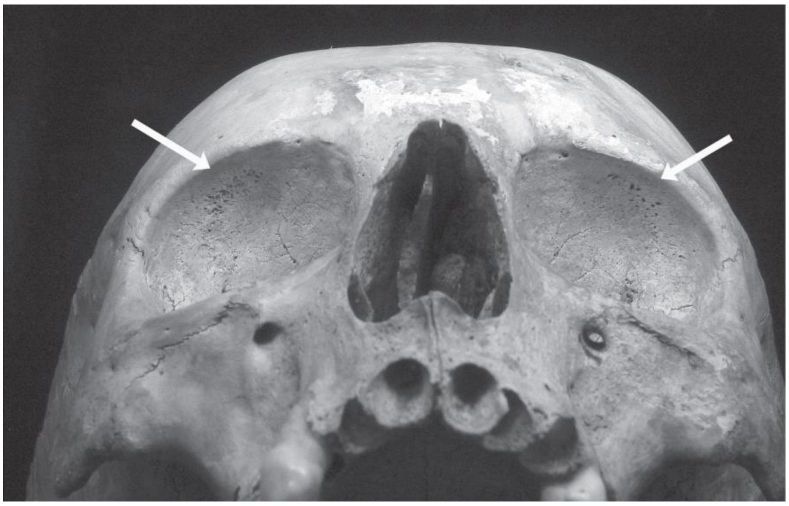


Figure 2.2 The more muted appearance typical of cribra orbitalia observed in medieval European and British individuals. Here it is described as "pitting". (adapted from Chamberlain 2006: 163).

Figure 2.1and **Figure 2.2** both show images of abnormal bone that is presumed to coincide with iron-deficiency anemia in two different populations, Native Americans and individuals from medieval England. Both conditions are termed the same, cribra orbitalia, but the appearances are notably different. The population-based differential expression of the trait could result in the failure to recognise the disorder based on the training and previous experiences of the examiner. For example, if an American-trained researcher, with years of practical experience with

Indigenous American remains were to examine an individual presenting with the modest form of cribra orbitalia shown in **Figure 2.2**, it is entirely possible that the condition could be overlooked. An unbiased, observation-based RAS would provide a mechanism of identifying unusual pitting or bone lose whilst not also prejudging the appearance of the condition in different populations.

Pathology evaluations advocated by museum- and university-based protocols are not completed as suggested, but are relegated to the 'notes' section on the Inventory form, an assertion based on anonymised interviews with postgraduate students (**Section 2.2.1.1**), and the apparent lack in the literature of reports containing this information *as collected using a standard protocol*. However, an observational system can be used in conjunction with a protocol that advocates capturing metric data, and can thus be viewed as an unbiased pathology 'checklist', a benefit for even experienced researchers, so that an important indicator of skeletal health status is not inadvertently omitted.

The use of an observation-based system will allow for an impartial evaluation of remains, without a directed project in mind and without any particular set of attributes being sought. Such an assessment can indeed be carried out by a practiced osteologist; but as discussed, a comprehensive analysis of a set of remains requires time, previous training, and specialist equipment.

Such a system would not record metric data (such as long bone lengths). It is not designed to replace the work of experts and cannot hope to capture the maximum data available from a human skeleton. What the system outlined here does offer is a method by which underfunded, understaffed institutions can address a common, and somewhat valid call for 'Reburial', namely that remains sit in boxes for decades after their removal from the ground, continuing to deteriorate, all while they are not studied, unless they are from a well-known, published collection, such as Towton (Fiorato *et al*. 2007), the *Mary Rose* (Stirland 2005), or Spitalfields (Cox 1995; Thomas 2004). What is offered is a method for creating a database listing the condition of the remains, probable sexes and age cohorts, with an observation-based assessment of abnormal bone loss, bone deposits and trauma. By recording the location and thus pattern of abnormal bone changes, experts can interrogate the results for indicators of common ailments such as osteoporosis, osteoarthritis, and healed fractures, and more notorious ones like tuberculosis.

2.5 Assessment of Human Skeletal Remains suggested in this project: summary

Buikstra and Ubelaker's protocol (1994) advocates taking 79 metric and 26 non-metric data; a minimum of four worksheets on dental information; and a detailed coding of all bone anomalies. While postcranial metrics can shed light on past population-specific activities such as sedentary versus hunter-gatherer lifestyle (Larsen 1997), some diseases (such as treponemal disease) (Bass 2005), and can support estimation of sex using femoral and humeral head dimensions or other robusticity ratios (Bass 2005), these benefits are not clearly spelled out in the Buikstra and Ubelaker (1994) protocol. Further, the description of how to take certain metrics can be difficult to understand, or worse, the region to be measured may be located by subjective means, such as 'widest diameter' of a muscle attachment, or what O'Higgins (2000) refers to as "Type III Landmark", which "can be reliably located to an outline or surface but not at a specific location, e.g. tip of a rounded bump" (O'Higgins 2000: 106). These are landmarks located in variable regions that can be located dependent on the skill of the researcher, and can suffer from both intra- and inter-observer variance (Utermohle and Zegura 1982). The result is that data can be incorrect. Bad data can be worse than no data at all, as it can lead to incorrect assumptions about subsistence methods and disease frequency (Utermohle and Zegura 1982: 308).

In order to justify retention in long-term storage, remains need to be studied. If not, it is difficult to defend their curation. There are reportedly 264 museums in England that hold human skeletal material in quantities that range from small bone fragments to thousands of individuals (White 2011; White 2013). In a survey of the holdings of 157 museums in England that curate human remains, 29 museums (18%) were completely unaware of the condition and quantity of their holdings (White 2011: 99); and 71 museums (45%) were only able to provide an estimate of the number of individuals (White 2013:44). Most of the surveyed museums had databases that were at odds with their physical inventories. The Royal College of

Surgeons and the Natural History Museum together curate up to 64,000 remains (White 2011: 132), with the remaining museums surveyed holding nearly 50,000 remains (ibid: 98). In concluding remarks, White (2011) calls for all English museums with human remains to establish a publicly accessible database of the remains (ibid: 209): this necessitates for each museum to be familiar with their collection. Indeed, according to a report by Arts Council England (2011), any museum that is part of the UK Accredited Scheme should have management policies in place in order to facilitate public access to collections and associated documentation (ibid: 10).

Museums report several reasons for not having accurate documentation of their skeletal remains, including lack of financial resources and appropriately trained staff, and a lack of time to carry out such assessments (Giesen *et al.* 2013: 55). Having the option of utilising existing staff to amass preliminary data via an observation based assessment system would be of great benefit, with staff collecting general information on large holdings to determine viability of remains that may be fragmentary, in poor condition or are otherwise less than optimal. Such remains would ideally be given a more thorough evaluation by an experienced physical anthropologist before being deaccessioned but museum storage space is a precious commodity. It can be argued that it is unethical to retain skeletonised remains that are of limited value to science and are merely deteriorating in a storeroom.

The issues that face collection managers and the researchers who submit requests to examine their collections come down to prioritising one's time, energy, and budget: scientific research requires all three. In the new reality of reduced budgets, a project must be deemed useful to go forward. Collection managers of skeletal human remains are in charge of unique assemblages and have to be sure that the remains are handled carefully and limitedly, for valid research purposes, and therefore efficiently. If granted permission to study a collection, the researcher must be able to assess the skeleton quickly and efficiently. Many institutions now charge bench fees (Chamberlain 2006; Roberts and Mays 2011: 627). Also, even proper handling of a skeleton will inevitably result in slight damage; the act of study exposes the remains to a continuation of their disintegration (Roberts and Mays 2011).

Admittedly, any RAS utilised by novices will also likely result in handling-related damage. However, it can be argued that, if assessed once with diligence, remains handled by museum staff, vetted students and volunteers, and archaeological technicians are less exposed to risk than those repeatedly inspected by visiting scholars trying to ascertain the potential research value of skeletons that lack even minimal information on completeness or bone condition.

This project explores whether an early-stage 'rapid' skeletal assessment system will add benefit to our understanding of skeletal remains, and how it can fit in with the view toward treating the dead in compliance with legislation such as that provided by the Home Office in 2008, which stipulated that human remains were bound by a two-year time limit on study and retention. Although the Home Office had originally promised to 'revisit' this time limit, by 2011 notable scientists had written an open letter to Kenneth Clarke Lord Chancellor and Secretary of State for Justice, regarding the "national significance" of some human remains which would nevertheless fall within the two year limit, no matter how ancient (Pearson *et al.* 2011). It is expensive to exhume, prepare and examine a human skeleton, reportedly costing from "one full day's cost" (about £200 in 2005) of an experienced osteologist "per skeleton" (English Heritage and Church of England 2005: 43) to as much as £1000 per individual (David Connelly, personal communication, 13 February 2014). Thus this project suggests that collecting preliminary demographic information will improve the efficiency of future analyses.

The assessment system as outlined in the project can record bone anomalies, with text and graphic illustrations for support, and offering an unambiguous method for a student or a harried researcher. The checklist does not require the ability to *diagnosis* bone changes, but requests simple observation such as lesion size; whether the bone changes are localized or widespread; and location.

This project ultimately will therefore outline an early-stage option for analysing the skeleton. The aim is to provide a method to capture demographic data and observations of bone variation that can be used by the professional, or by the non-expert. The targeted end-user will be museum curators and museum technicians, archaeological technicians, and early-stage researchers. Images, text support and diagrams will supplement the checklists for various observations on bone anomalies, robusticity of muscle markings, bone cortical thickness, dental health, and the presence and state of pathological features. This method has the potential to be especially useful for very large samples, or for collections that can only be accessed for a limited period of time.

In the following two chapters, the development of the questionnaire is traced, from the York experiment and the resultant vital feedback sessions; to the revision of the protocol, post-York, in order for identified problems to be minimised and if possible eliminated. These chapters are Methodology I and Methodology II.

Chapter 3: Developing a Rapid Assessment System for Non-Experts: Methodology I.

"...[T]he only way to attempt any form of classification or diagnosis of disease in skeletal material is with clear and objective description."

Roberts and Connell (2004: 36), from "Guidance on Recording Paleopathology".

3.1 Developing a Rapid Assessment System for Non-Experts

In Chapter 1, existing protocols in the USA and UK were discussed: most systems focus on metric data capture, or depend on experienced osteologists to accurately record challenging traits and abnormalities. For the most part, only well-funded institutions with comprehensive protocols collect information on paleopathology (Ousley *et al.* 2005: the Smithsonian Institution); or offer free online searchable databases (Redfern and Bekvalac 2013: The Museum of London). In Chapter 2, the shortcomings of existing systems were explored: museums are unfamiliar with their holdings, and lack resources to create an accurate assessment of their collections. In England, most museums do not systematically record data or make it available for researchers (White 2011, 2013; Giesen *et al.* 2013). Researchers do not appear to use any standardised recording protocol to collect data on paleopathology, instead collecting information that pertains to their specific research question and thus not easily comparable with other studies: data that are rarely shared with the host institution (Giesen *et al.* 2013). Finally the genesis and early development of this project was elaborated in Chapter 2.

In this chapter the development of the project will be followed from when the Rosenbluth Project began to be modified, through the first test of the Rapid Assessment System (RAS) at York. In order to define the research imperative, the York trial was mentioned briefly in **Section 2.3.1**, but the process of modifying the Rosenbluth system for use by novices is detailed below.

3.1.1 Author's prior training

Testing the protocol in York required volunteers to assess skeletons using an observation-based protocol, with answers scored as 'correct' if they agree with the author's assessments. In order to justify such a high level of trust in 'correct' responses, a brief synopsis of the author's training is provided.

I. Norwalk Community College (NCC)

1. Archaeological training began in 1994 and included field work, desktop site analysis, and analytical practicals: lithics, paleobotanicals material, faunal remains and shell (marine and lacustrine).
2. Earned an 'Archaeology as Avocation' certificate (1998).

II. Charter Oak State College (COSC)

1. Credits from 1978-1981 combined with coursework at NCC.
2. Associate's Degree (1996).
3. Bachelor's Degree in Science (2000).
    a. For BSc, additional courses were taken at Southern Connecticut State University (SCSU) from 1998-2000.
    b. At SCSU, studied under the direction of skeletal biologist Marie Selvaggio, who had worked with Blumenschine differentiating between canid toothmarks and hominid tool use on Olduvai Gorge faunal remains (Blumenschine and Selvaggio 1988; Selvaggio and Wilder 2001).

III. Yale University

1. Trained with Rika Kaestle on the ethics of DNA research and utilising ancient DNA to map population movements, and Andrew Hill on Human Evolution.
2. Masters advisor was Frank Hole; worked under guidance of Ben Rouse on Caribbean ceramics and relative dating techniques (Rouse 1992; Drew 2009a).
3. For Master's project, evaluated human skeletal material from Puerto Rico that Rouse had brought to Yale Peabody Museum, establishing that the remains were comprised of 14^{th} to 16^{th} century Taíno indigenous individuals, and also prehistoric Saladoid individuals (Drew 2003). Thesis examined by John Verano.

IV. Additional Experience

1. Studied with Clark Spenser Larsen at Ohio State University (May-June 2003) on interpreting human behavior from human remains.
2. July 2002 to March 2005, analysed South American remains curated by the Yale Peabody Museum as part of a cataloguing and documentation scheme (Drew 2005c).
3. September 2004 to August 2005, worked two weeks a month in Miami Florida on fragmented and commingled prehistoric Native American remains found during development of a commercial site in downtown Miami (Drew 2005a, 2005b).
4. Forensic short courses (residential) in laboratory analysis (May 2001), field recovery (October 2001) and post-mortem interval (June 2011).
5. Attended anthropology conferences from 2002 to present, participating in workshops, to maintain skills and remain aware of current research.
6. Visiting scholar under direction of Della Collins Cook at Indiana University, Bloomington, four research trips between 2006 - 2009,
7. Analysed Viking and 19th century Norwegian materials in Oslo under the direction of Per Holck (June 2009-July 2010).
8. September 2010, spent one week at the Mary Rose Trust with Robert Jurmain and Lynn Kilgore, examining spinal pathology amongst the skeletons found in association with the 16th century English warship *Mary Rose.*
9. August 2008, the author attended what became the final two week residential Paleopathology Short Course to be offered at Bradford University, with lectures given by many notable anthropologists.

V. Rosenbluth Project

1. February 2004 examined almost 100 medieval British individuals for the Rosenbluth Project (**Section 2.1**).

VI. *Mary Rose*

1. The author worked periodically with the *Mary Rose* remains from February 2008 to November 2011, and participated in the 2008 television show, *The Ghosts of the* ***Mary Rose****.*

VII. York University (2005 to 2009)

1. Trained with Don Brothwell on identification of atypical pathologies, including brain malignancies, Pulmonary Hypertrophic Osteoarthropathy, smallpox, brucellosis, DISH and leprosy, using Roman and medieval British individuals.

Altogether the author estimates she has examined approximately 1000 fairly complete individuals and up to 800 fragmented and commingled ones.

3.1.1.1 Author tested against post-doctoral human remains researcher

To test the analytical abilities of the author, her results from assessing skeletal remains during two segments of the York 2008 trial were compared with that of a post-doctoral researcher also based at York University, 16HK, who had a similar level of training as the author. The first York segment (see below in **3.1.5**) required observers to examine 10 fairly complete skeletons and rate the age at death, presence of osteoarthritis, healed or healing (that is, ante-mortem) bone fractures, and two widespread measures of 'anemia': cribra orbitalia and porotic hyperostosis, along descriptive scales of 'mild', 'moderate' and 'severe'. The results are shown in **Figure 3.1**.

Researcher 16HK was in agreement with 05RD an average of 74% of the time, with only the assessment for porotic hyperostosis (PO) in rather poor agreement of 50%. When scores for the four traits in high agreement between the two researchers (72 answers) were compared to just PO (15 answers in agreement) and calculated as a chi square statistic, the difference between 05RD and 16HK was not significant at the 0.05 (95% confidence) level: $x^2 = 1.25$ ($p = 0.05$). Interestingly, the apparent difference between the two researchers in assessing PO is explained: 16HK admitted she relied on Buikstra and Ubelaker (1994), a guide to Native American remains, in assessing PO, which presents differently in medieval English individuals (Don Brothwell 2008: personal communication), as does cribra orbitalia (**Figure 2.1** and **Figure 2.2**).

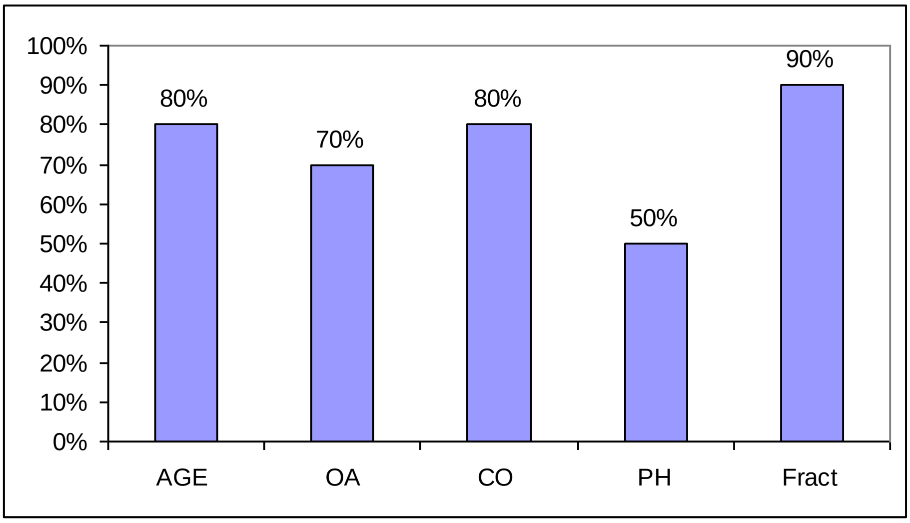


Figure 3.1. Results of 16HK participating in Trial 1; 16HK is another Level 4 volunteer (postgraduate with experience analysing human bone) at a presumed similar level of training as author. Ten skeletons assessed; answers are considered 'correct' if they are in agreement with author. Porotic hyperostosis (PH) most problematic, but 16HK relied on Buikstra and Ubelaker (1994) for diagnostic criteria; *Standards* uses Native Americans as models, and the specimens assessed in Trial 1 are medieval Britons. Age=age at death; OA=osteoarthritis; CO=cribra orbitalia; Fract=healed fracture.

3.1.2 The Goal of a Rapid Scoring System: Adapting Rosenbluth

In the 2004 Rosenbluth Project (**Section 2.1**) was devised to 'rapidly' assess medieval skeletons for estimated stature in life, and 'socioeconomic status'. In order to attempt to ascertain SES from medieval individuals lacking burial documentation beyond 'inside the church' versus 'churchyard', a range of commonly collected parameters was assessed (**Section 2.1.2**). Experience with handling and examining human skeletal remains was necessary in order to recognise these parameters. The author was required to identify non-conforming or redundant skeletal elements; competently measure long bones using an osteometric board; estimate age and sex; and to diagnose diseases and disorders. The disorders included osteoarthritis, 'cribra orbitalia' and 'porotic hyperostosis', diagnoses that remain contentious even among established experts (Rogers and Waldron 1995; Jurmain 1999; Ortner 2003: 370-375). The author realised that the other, truly inexperienced students enlisted by Rosenbluth would find most of the above difficult, and decided to create an SES scoring system for a doctoral project.

The project was begun in October 2005. By 2006, the original list of assessed traits (**Table 2.1**) was expanded (**Table 2.2**). While it was recognised that clear and unambiguous descriptions would need to be used in any system created for use by novices, it was unclear how simple the terms would have to be in order to guide users to select accurate descriptions of skeletal variation. It became obvious that the system needed to be tested on volunteer subjects, with the results analysed. Thus, the possible types of potential end-users were considered.

3.1.3 Rationale for designing RAS for use by novices

Most assessment systems are geared for experienced osteologists; the target user of a Rapid Assessment System is the undergraduate with some training, or the cautious but non-expert museum technician. The system outlined in this project is an observation-based protocol, which will ideally not require the assessor to be able to estimate age and sex, and diagnose specific pathologies, but to select the appearance of skeletal elements from limited options supported by illustrations and descriptive terms. In this one aspect alone it differs from Brickley and McKinley (2004), Buikstra and Ubelaker (1994) and the Smithsonian Institution’s comprehensive system (Ousley *et al.* 2005).

3.1.3.1 Too many skeletons—not enough (experienced) osteoarchaeologists

Existing approaches fail to bridge the gap between the size of un-assessed or under-examined collections, and the number of osteoarchaeologists competent to do the work. For example, the UK arguably contains the largest number of trained osteoarchaeologists per capita; BABAO has approximately 300 members; but there are at minimum close to 50,000 skeletons held in museum collections (Roberts and Cox 2003; White 2011), and more likely close to 135,000 skeletons when Museum of London, Royal College of Surgeons and Natural History Museum are considered (White 2011; Redfern and Bekvalac 2013). Of the nearly 50,000 skeletons estimated to be held in the 157 museums that responded to surveys (White 2011), it is unknown how many individuals have never been examined after the original excavation and storage. In addition, hundreds or even thousands new skeletons are recovered every year, in addition to the approximately 10,000 disarticulated individuals that the London Crossrail project will be disturbing in 2014-2015

(Doyle 2014). This is not counting large holdings of universities such as Bradford, which use their collection of 3000 individuals for teaching, study them actively, and publish their findings frequently (i.e. Fiorato *et al.* 2007, Magilton *et al.* 2008). This is equivalent to up to 450 skeletons per active BABAO osteologist (about one third of members are novices, retired, or non-skeletal biologists), and researchers with the experience to apply existing data capture are limited in both spare time and funding.

3.1.3.2 The Narrow Research Focus of the 'Expert'

The data gathering and writing of a doctoral project necessitates a sharp focus on the skeletal attribute of interest, often to the reluctant exclusion of other aspects that come to light during the course of research. Margaret Judd, in examining the Kerma individuals curated by Cambridge in the Duckworth Labs, had primarily noted the presence or absence of blade wounds on individuals. When some of the same remains she had previously assessed were examined by this author, it was a surprise to discover boxes of examined and yet still comingled remains. Judd had been visiting the Duckworth under time constraints, and had narrowed her focus to the trauma, hardly unusual for a harried researcher trying to assess as many remains as possible from a large collection. "A basic systematic skeletal analysis is required [for Kerma] and is an entire project in itself." (M Judd to R Drew, March 2004, personal correspondence).

As discussed in **Section 2.5**, many museum curators report that their institutions lack the funds, time or training to have their human remains collections analysed, even to the level of being aware of how many individuals are in their holdings (White 2011, 2013; Giesen *et al.* 2013). Most institutions rely on researchers to provide results of their findings, but this is rarely done (Giesen *et al.* 2013: 59, Della Collins Cook 2006, personal communication).

Other researchers have also attested to the brevity of time and funding when making visits to collections (Giesen *et al.* 2013: 59). Limited information on the nature of the collection is available prior to the visit; collections will be stored in site-specific idiosyncratic ways (Redfern and Bekvalac 2013); will typically be lacking some body parts (perhaps the part relevant to one's research project); and may be located far from the researcher's home and thus be difficult to re-visit. One popular storage technique is to store the skull separately from the post-cranial remains, which can be sensible: long bones can be stored in nested trays within an archival box whereas a complete, spheroid skull cannot. Some facilities even store the skulls in separate shelves from the post-crania as the boxes are different sizes and shapes; this can mean storage in a different area or even a different storage room. And once separated from the body the skulls may become 'lost' or certainly difficult and time-consuming to locate during a time-constrained tour through a distant collection.

After personally experiencing pathology 'tunnel vision', and after consulting the literature (Giesen *et al.* 2013) and colleagues of all expertise levels, from fellow doctoral students to Anthropology Department Chairs, it is clear that the simple work of ageing, and sexing and creating a preliminary database of a select set of skeletal attributes observed in a collection cannot be done 'on the side' during a research visit.

3.1.3.3 Does a deskilled assessment system lead to unemployed osteologists?

With the Museum of London reportedly the only institution in the world to have a free online searchable database of over 4500 individuals (Redfern and Bekvalac 2013: 88), and with many of the museums surveyed on the quality and quantity of their human remains holdings unaware of the number, or in error (White 2011), a method of amassing even the most basic information will help the visiting researcher. As one example, a researcher investigating tuberculosis with the criteria of needing prehistoric, fairly complete individuals with vertebral columns and ribs contacted a range of museums reported to curate remains. Many institutions lacked a database (at all), or had one that was not searchable off-site. Finally, even remains that had been identified as fitting the research parameters were, upon physically pulling the boxes, in unusable condition, commingled, or simply 'gone' (Giesen *et al.* 2013: 59).

A rapid assessment system, such as outlined in this project, must not attempt to compete with the various systems and protocols outlined in **Chapter 1** rather, it could be viewed as an efficient, non-invasive recording method, designed to gather a maximum of information in a minimum amount of time. Ideally, it could be used to create a preliminary data base for remains that, for various reasons, cannot be subjected to one of the more time- and resource-consuming protocols.

3.1.4 Potential end-users of this system

It is anticipated that potential users of this system can include museum staff, and vetted, approved interested members of the public such as museum volunteers; archaeological field and lab technicians dealing with large skeletal populations bound by time restraints (i.e., church excavations; large commercial projects disturbing many remains; excavations involving protected indigenous populations); and students attempting to gather data from large collections with a minimum of advice. Other consumers might include early-stage researchers attempting to amass skeletal information on their own and who desire to collect observations that can inform on common skeletal anomalies.

Two of the main justifications for targeting non-professionals, archaeological technicians and enthusiastic undergraduates are that experts are expensive, costing £200 (English Heritage and Church of England 2005: 43) to £1000 (David Connolly, personal communication 13 February 2014) per skeleton; and postgraduate students are engaged in directed projects requiring their time and energy. New osteologists at the beginning of their training would benefit immensely from undertaking assessment projects. The careful undergraduate will:
a. augment previous familiarity with skeletal element recognition
b. gain experience with sex and age estimations, and recognising pathologies
c. discover first hand that skeletal collections vary in bone quality
d. acquire skills that go onto a CV.

University-based curators can address several issues by using an unbiased, observational system. Rather than depending on copies of reports (hopefully) submitted by visiting scholars focusing only on their area of interest and thus based on limited observations, the curators can utilise current students. Many universities offer only one term of human osteology in their undergraduate programmes

(Andrew Chamberlain, personal communication 2009; Mary Lewis personal communication 2009); allowing eager and yet well-vetted undergraduates to assess collections will provide experience and training for the student, and collect data for the curator. The proposed accompanying support documents will include proper terminology, which allows the system to be used as a learning tool.

Project managers and curators will benefit, due to plenty of enthusiastic help with low pay requirements. Importantly, naïve researchers can sometimes note anomalies the experts miss.

3.1.4.1 Augmenting Prior Training

Undergraduates keen to examine actual skeletons will not have the training to diagnose skeletal variation, nor familiarity with relevant texts. This highlights the difference between requiring novice workers to recognise a range of potential pathologies, versus selecting between adequately descriptive terms. In any ‘Assessment System’ it is important that new osteologists with less experience than the authors of the system be competent to fill out the data recording sheets, or such a protocol would fail to meet a primary goal, namely that of cataloging a collection of remains.

At institutions with funding and early-stage osteologists, the problem is dealt with by taking metric and non-metric data, as outlined for example in Buikstra and Ubelaker (1994), typically missing out the pathology coding assessment section. In America, some remains are repatriated and thus no longer available for study, with students taking measurements and then recording, as open-end responses within the Notes section, any compelling pathologies or anomalies that they *happen* to recognise or can *adequately* describe (**Section 2.2.1.1**).

That novice osteologists, often working in under-supervised groups, handle the bulk of such basic analyses speaks to the harried, underfunded environment of most universities and museums. Experts simply don’t have the time; undergraduates and early researchers simply don’t have the experience; and relegating the documentation of anomalies to chance will undermine population studies based on scant information gleaned from materials lost forever. At the very least, the pathology checklist outlined in this project creates a practical list of items to assess, with the Information Booklet (**Appendix 3)** available as support material.

3.1.5 Defining the Users of the Protocol: York

In order for inexperienced workers to use a 'deskilled' system, the language must be clear, the supportive documents adequate, and the resultant data accurate and comparable to other data sets. Therefore, a series of tests of the rapid assessment system, by members of the proposed target audience (students) took place between October 2007 and February 2008 (henceforth termed 'York 2008'). The students selected possessed enthusiasm but lacked professional training.

3.1.5.1 Testing the Drew SES scoring system on student volunteers

The proposed scoring system, in order to be available to the widest possible audience, would need to be based on readily understandable descriptions and thus not require expertise to determine probable causes of bone changes. It would be crucial for the system to provide accurate, repeatable observations in order for the data to be applicable for comparative studies; and would need to be tested to ensure that a range of amateur observers would predictably recognise the same skeletal features.

Ethical concerns regarding the use of students and other York-area residents to examine and handle human skeletal material were minimal. Most of the volunteers were recruited from the student population of the Archaeology Department of York University. During the time this project was based in York (2005-2009), all First Year Undergraduates at the university participated in the course 'Introduction to Human Osteology' which consisted of examining and handling human skeletal remains.

In addition, almost all of the York volunteers had been regular attendees of the Human Osteology & Paleopathology Interest Group, founded by the author in October 2006 and which met weekly with the full support of the Archaeology Department. As participants in what the students themselves referred to as the 'Bone Club', attendees had previously handled human skeletons. Finally, the non-student volunteers had previously handled human skeletal remains, out of personal interest, before participating in this test of the protocol: one from 2002 onward (13AG); and two others (11JE, 12JE) from September 2006 when they had participated in a cemetery excavation in their small North Yorkshire village.

For testing the protocol, the preexisting skill levels of the student volunteers would have to be recorded, in order to investigate which sort of amateur would more accurately adhere to the written directions of the protocol: the true novice, or the student with a term of basic human osteology. Variation in student support during the testing would need to be evaluated, to gauge the impact of student-trainer interaction; it would be preferable for such interaction to have minimal impact, as the protocol must be able to be reproducible in other environments, without the benefit of a hands-on expert to guide selections. Finally, the format of the protocol would need to be tested, to determine the optimal level of impartial, descriptive text; potential benefit of supporting illustrations; and to minimize differing degrees of perception among users of the system by providing clear, unambiguous guidance for collecting accurate data. The target users of the existing protocols, workers experienced with handling and analyzing human skeletal remains, are defined in **Section 1.2.**

3.1.5.2 Guiding the documentation process

With the recognition that the earlier system used for the Rosenbluth Project required the assessor to recognise and diagnose disease and injury, it became apparent that simplified language would have to be used for non-experts. Even so, the system as it existed in 2006 was initially used in the York test. The original terminology was included for two reasons: in order to gauge preexisting knowledge; and to confirm or refute the perceived inappropriateness of the technical terms for use by novices, even when supported by additional descriptive text.

While it was recognised that clear and unambiguous descriptions would need to be used in any system created for use by a ‘lay’ audience, it was unclear how simple the terms would have to be to guide users to select accurate descriptions of skeletal variation. It became obvious that the system needed to be tested on volunteer student subjects, with the results analysed.

3.1.6 Skeletal Collections Used in York Trials

The collections utilised for the York 2008 experiment were the Malmesbury Collection and the Tarbat Collection, both curated by York University. **Table 3.1** shows the remains used in the York study.

Table 3.1. Specimens used for the York 2008 study: Collection, Catalogue number, Age and Sex Estimations

Malmesbury Collection	
Identifier	**Age and Sex Estimation**
Box 1 Burial 1	Older Adult Male
Box 2 Burial 2	Young Adult Male
Box 3 Burial 3	Young Adult
Box 8 Burial 13	Older Adult Male
Box 12 Burial 19	Older Adult Male
Box 19 Burial 27	Adult Male
Box 22 Burial 35	Young Adult Female
Box 26 Burial 43	Adult Female
Box 29 Burial 46	Older Probable Male
Box 32 Burial 49	Adult Male
Box 34 Burial 51	Older Adult Male
Box 36 Burial 53	Older Adult Male
Box 44 Burial 62	Adult Female
Box 47 Burial 66	Older Adult Male
Box 52 Burial 75	Young Adult Male
Box 56 Burial 81	Adult Male
Tarbat Collection	
Identifier	**Age and Sex Estimation**
16	Older Adult
27	Older Adult
Y 10	Young Adult
ST 3179/18	Adult Female

The Malmesbury collection is comprised of approximately 68 discrete individuals and three additional boxes of commingled, isolated bones. Also known by the excavation site name ‘Old Cinema Site’, the collection represents skeletal remains disturbed during commercial development in the vicinity of Malmesbury Abbey. Monasteries were a refuge for the ill and dying, although usually only for palliative care; however, some monasteries provided a higher level of medical attention than others (Gilchrist and Sloane 2004). After examining the many well-healed broken ribs, broken legs, and dislocated shoulders found among this collection, one can reasonably conclude Malmesbury Abbey likely offered a high standard of care. In addition, a substantial number of individuals from this collection show evidence of a heritable congenital skull deformity, premature cranial synostosis (Hope *et al*. 1955; Wilkie 1997), which could be interpreted as further evidence of Malmesbury's adequate palliative services. Individuals drawn from the Malmesbury Collection for the student testing include several older males with multiple rib fractures, healed arm and leg fractures, and moderate to severe hip trauma. Obviously, it can never be known if Eilmer is among this group, but considering it a possibility helped humanize the remains for participants.

Another collection held in York is referred to as the Tarbat Collection, reputed to be individuals from a Scottish monastery site, circa 8th to 9th century. This collection includes several very young juveniles, adult females of various ages, one fragmentary adult male with skeletal evidence consistent with Paget's Disease, a disease whereby the bones turn brittle, fragile and abnormally expanded, and another, more complete individual with probable DISH, a vertebral abnormality (Ortner 2003; Roberts and Manchester 2005). The Tarbat remains examined for 2008 trials consisted of four skulls used for dentition analysis. Despite their apparent antiquity, the remains are mostly in excellent condition.

The twenty individuals selected for analysis reflected a range of ages, both biological sexes and a variety of health and activity-related traits. The condition of the remains also varied, from fragmented and weathered bones, to complete individuals with elements in excellent state of preservation. **Table 3.2** to **Table 3.6** specify which specimens were used in each trial, including collection, specimen identifier, demographic information such as estimated age at death and probable sex, and for protocol tests of paleopathological conditions, the table also notes the disease or trauma. **Table 3.3** and **Table 3.4** both pertain to identification of dental traits and dental disease.

Table 3.2. Trial 1 skeletal materials. All skeletal specimens were drawn frm the Malmesbury Collection.

Specimen	Identification	Demographics
Skeleton 1	Box 1 Burial 1	Older Adult Male
Skeleton 2	Box 22 Burial 35	Young Adult Female
Skeleton 3	Box 52 Burial 75	Young Adult Male

Skeleton 4	Box 26 Burial 43	Adult Female
Skeleton 5	Box 47 Burial 66	Older Adult Male
Skeleton 6	Box 34 Burial 51	Older Adult Male
Skeleton 7	Box 56 Burial 81	Adult Male
Skeleton 8	Box 19 Burial 27	Adult Male
Skeleton 9	Box 44 Burial 62	Adult Female
Skeleton 10	Box 2 Burial 2	Young Adult Male

Table 3.3. Trial 2A skeletal materials. The examination consisted of the skulls from the individuals cited below as Trial 2 was a dental trait and pathology assessment.

Specimen	Identification	Demographics
Skeleton 1	Box 36 Burial 53	Older adult male
Skeleton 2	Box 2 Burial 2	Young adult male
Skeleton 3	Box 22 Burial 35	Young adult female
Skeleton 4	Box 47 Burial 66	Older Adult Male
Skeleton 5	Box 1 Burial 1	Older Adult Male

Table 3.4. Trial 2B. Dental pathology assessment, revised. For each specimen, only the skull was made available for study.

Specimen	Collection	Demographics
Skull 1	Tarbat 16	Older Adult
Skull 2	Tarbat 27	Older Adult
Skull 3	Tarbat Y 10	Young Adult
Skull 4	Tarbat ST 3179/18	Adult Female
Skull 5	Malmesbury Box 3 Burial 3	Young Adult

Table 3.5. Trial 4. This segment tested recognition of Inflammatory and infectious bone conditions. All specimens were from the Malmesbury Collection. The observed skeletal lesions are specified.

Specimen	Identification	Pathology	Demographics
Skeleton 1	Box 2 Burial 2	Widespread active periosteal reaction	Younger Adult Male
Skeleton 2	Box 8 Burial 13	Active inflammatory reaction and possible osteomyelitis; healing periosteal reaction on tibiae	Older Adult Male
Skeleton 3	Box 12 Burial 19	Endosteal trabecular growth	Older Adult Male
Skeleton 4	Box 36 Burial 53	None pertaining to cortical or endosteal reactive bone	Older Adult Male
Skeleton 5	Box 47 Burial 66	Healed periosteal reaction on femora and tibiae	Older Adult Male

Table 3.6. Trial 5. This segment tested volunteer ability to note differences in cortical robusticity. Assessors examined long bones with post-mortem transverse breakage, which permitted observation of the interior aspects of the shafts. Assessors were queried on the comparable cortical bone thickness using an illustration as a guide. Both specimens were from the Malmesbury Collection.

Skeleton	Identification	Demographics
Skeleton 1	Box 29 Burial 46	Older Probable Male
Skeleton 2	Box 32 Burial 49	Adult Male

3.2 Methodology: Creating the trials: Experimental design

The original list of assessed criteria used in the Rosenbluth Project, expanded to accommodate additional pathologies and observations (**Table 2.2**), and tested in 2006 on the Blackgate Collection (**Table 2.3**) was the basis for the observations investigated in 2008. Examined and scored features include age at death and cortical mass (thickness) of long bones, and pathologies such as osteoarthritis, fractures, infectious disease and inflammatory response. In all, over twenty medical conditions or aspects of human skeletal remains were addressed via 40 options. In an attempt to link diseases with estimated age at death, 'nested' combinations similar to those used in Rosenbluth were created. Not all combinations were generated. For example if a query referred to an 'older adult' with a specific pathology and a volunteer determined the skeleton had been of a young person, the pathology assessment aspect of the query would be ignored.

The 40 or so queries from June 2006 were split into different 'Trials'. Five observations were tested in Trial 1, with the remaining observations divided among other Trials. The volunteer sessions were thus assessments of three to six pathologies, with a range of age at death combinations producing up to ten queries, each a variation of age at death plus trait. Segmenting the form created a total of 4 trials (subsequently titled Trial 1, Trial 2, 4 and 5) covering the traits and pathologies from 2006 (**Table 2.3**). A fifth 'trial' (subsequently labeled Trial 3) of an inventory assessment was created. This segment developed during the testing and will be discussed below.

For Trials 1, 2, 4 and 5, questions were binary (presence or absence); graduated (if present, is the condition mild, moderate, or severe) and nested (i.e., if age 50+, *and* with severe osteoarthritis). Adjacent to each query was a blank box for marking a selected choice, and each query also revealed its ‘score’, such as -5 or +6. The answer sheets used by the volunteers during the five segments are shown in **Section 3.3**, as Tables within the corresponding description of each segment.

A lab diary was maintained throughout the trials, which recorded each trial and the participating volunteers, the form being tested; the skeletal specimens observed, feedback from the volunteers, and author observations. Participants were anonymized by assigning and identifier created from their initials and a participant number, with the identifier kept unique even if someone dropped out of the study.

The assessed items from the original system were not presented in a logical arrangement, such as dental assessments adjacent to cranial or vertebral assessments. The earlier format had been examined by several experienced physical anthropologists, none of whom had commented on the awkward arrangement, nor on the inherent need to be able to diagnose pathologies. This is not surprising as, like the author, they are very familiar with human remains, and the diagnostic requirements of the original form would not have presented a challenge to anyone with much experience.

During the protocol testing, student volunteers would arrive at the lab to find the skeletons for the trial already laid out with an identifying label that included the number assigned for the trial, and the original catalogue number, such as “Skeleton 5 (Box 47 Burial 66)”.

Student volunteers examined a subset of remains drawn from the 20 pre-selected individuals, and recorded observations on the assessment sheets. For example in Trial 1, ten skeletons were used for the osteoarthritis and healed fractures segment, and in Trial 2, five skulls were assembled to test the sheet for recording dental traits. In order to assess the robustness of the scoring system, each segment was tested using a series of subjects with a range of skill levels (**Table 3.7**). Success was scored in terms of the percentage of subjects who recorded the same observation as the trainer. The data collected by each volunteer was analysed, and descriptive statistical tests were applied.

3.2.1 Running the trials

Trial 1 was split across three sessions, due to space requirements for ten specimens, and the amount of time required to examine all ten. As discussed in **Chapter 2**, existing protocols can take about an hour for an *experienced* osteologist to collect metric data and record 'non-metric' variation, the latter relating to epigenetic traits that can be used to trace familial relationships. If a pathology assessment component is added, even with non-metric trait assessment being dropped, the length for an assessment can double. The goal of a rapid system is for it to be completed in a similar amount of time as a metric assessment. The volunteers possessed a range of previous experience but would be engaging in a novel task. Therefore, the author estimated that a test of 25% of the protocol could take 15 minutes per skeleton; requesting volunteers to donate up to three hours of their time was not possible. As a consequence of Trial 1 being split across three weeks, some volunteers dropped out and others joined during this period.

Table 3.2 shows the ten skeletons used during Trial 1, with three or four available for assessment each week. The pattern of assessing five or fewer specimens per session was repeated for Trial 2, Trial 2 Revised (Trial 2B), Trial 4 and Trial 5.

In the first run of Trial 2, five skulls with mandibles were assessed for condition of the dental arcade; when the Trial was repeated as 2B, five different skulls were selected for examination. Trial 4 was an assessment of five complete skeletons for the presence or absence, and degree of expression for abnormal bone growth and destruction, and Trial 5 used two skeletons for volunteers to assess cortical bone mass and the appearance and robusticity of muscle attachment sites. Some specimens were used in more than one Trial. An overview of all Trial segments is found in **Table 3.8**.

3.2.1.1 Subjects: Skill Level and Consistency of Participation

Seventeen volunteers (students and non-students) were provided with assessment sheets preprinted with a list of traits or pathologies to observe and were asked to mark their choices in blank boxes adjacent to each query. Two volunteers were former students, and one was the parent of a student. **Table 3.7** lists the skill level and identifier for each subject who participated in the project. The author is Subject 05RD. Subject 16HK, also a Skill Level 4 osteologist, participated in Trial 1 and Trial 2A.

Table 3.7. Volunteers participating in York 2008 study. Volunteers are listed by skill level, their unique identifier, and a description of their level of experience.

Level	Identifier	Description
Skill level 1	07LS, 09TT, 10SR, 11JE, 12 LE, 13AG, 17LR	Candidates who had limited or no experience of handling bone
Skill level 2	01PC,0 2MG, 03AT, 04AJ, 06SC, 08JM	Candidates who have completed the Intro Osteology course, and/or who have attended the weekly ‘Bone Club’ for a year or more
Skill level 3	14S, 15B*	Candidates who have worked as an osteology trainee or assistant. *Did not leave forms.
Skill level 4	05 RD, 16 HK	Candidates who have spent years working with human skeletal remains; have a Masters in skeletal remains; etc. The author has placed herself in Level 4.

Not all volunteers participated in each trial or even in each part of a multi-week trial. **Table 3.8** delineates each section of the trial (Trial 1, Trial 2A etc.) by the date the trial was held, traits assessed in the session, and the volunteers who participated in each session.

Table 3.8. York 2008 test of protocol, listing each segment of the protocol (termed Trials), the date or dates for each segment, the traits assessed and the participants who attended each session.

Trial number	Date	Sheet	Description of trial	Participants
1	Oct 22, Oct 29, Nov 5, Dec 3*	1 original	Assessed age, osteo-arthritis, markers associated with ‘anaemia’ and fractures	01TC, 02MG, 03AT, 04AJ, 05RD, 06SC, 07LS, 08JM, 09TT, 10SR, 11JE, 12LE, 13AG, 16HK*
2A	Nov 12, Dec 3*	2 original	Completeness of dentition (premortem vs postmortem), condition (unworn vs worn), dental pathology	1TC,02MG,03AT, 05RD,06SC, 07LS, 08JM, 09TT, 10SR, 11JE, 12LE, 13AG, 14S, 15B, 16HK*
2 B	Dec 3	2 Revised	As above with additional choices for pathology and options for excellent dentition.	1TC, 2MG, 3AT, 5RD, 6SC, 8JM, 11JE, 12LE, 13AG
3 **	Dec 10	3 original	Age, sex, skeletal inventory sheet	5RD, 6SC, 8JM, 11JE, 12LE

4	Jan 14	4 Rev 2	Infection and inflammation	1TC, 2MG, 3AT, 5RD, 6SC, 7LS, 8JM, 11JE, 12LE, 17LR
5	Feb 6	5 Original	Cortical thickness and MSMs	2MG, 3AT, 5RD. 6SC, 7LS, 8JM, 12LE, 13AG

*16HK examined all 10 skeletons for Trial 1, and all 5 skulls for Trial 2 on Dec 3 2007.
**Not a Trial per se but a discussion regarding inventory form.

Table 3.9 further simplifies the information from **Table 3.8** by listing each participant in the York experiment, their skill level, and the segment(s) that they participated in. Not all volunteers handed in all forms, which was discovered too late to ask the volunteer to redo the segment.

Table 3.9. Participants in Trials 1 to 5.

Subject Number	Subject skill level	Trials participated
01 TC	2	1, 2, 2 revised, 4
02 MG	2	1, 2, 2 rev, 4, 5
03 AT	2	1, 2, 2 rev, 4, 5
04 AJ	2	1 (first 3 skeletons only)
05 RD	4	1, 2, 2 rev, 3, 4, 5
06 SC	2	1, 2, 2 rev, 3, 4**, 5
07 LS	1	1, 2, 4, 5
08 JM	2	1, 2, 2 rev, 3, 4, 5
09 TT	1	1 (Skeletons 7-10), 2
10 SR	1	1 (Skeletons 7-10), 2
11 JE	1	1, 2, 2 rev, 3, 4
12 LE	1	1, 2, 2 rev, 3, 4, 5
13 AG	1	1, 2, 2 rev, 5
14 S	3	2
15 B *	3	2
16 HK	4	1, 2
17 LR	1	4

* data from this subject is not found. **data from this subject for this trial is not found.

3.2.1.2 Monitoring success of volunteers

It was decided to compare resultant volunteer scores with observations made by the author (05RD), with answers in agreement with 05RD considered scored ‘correctly’. This was deemed an adequate monitoring of their findings, based on the author’s prior experience, and the moderate to excellent agreement of her answers with those of another York expert (16HK) (**Figure 3.1)**.

If the average correct scores of the volunteers were initially high, it could be assumed that the assessment protocol was already a useful system. If the scores were low, and problems could be identified and then improved, an increase in successful answers following implementation of improvements could be taken to indicate that the format was becoming more useful. This assumption would be further validated if scores increased in segments not yet assessed, so as to rule out volunteers simply becoming familiar with ‘correct’ answers.

One method of monitoring reliability of successful answers would be to analyse the results using statistical tests that compare answers provided by different groups, such as the Kappa statistic. The Kappa coefficient tests the degree to which two or more respondents have agreement in their answers, and also if a single respondent’s answers agree when asked at different times (Sim and Wright 2005). The Kappa tests whether answers agree by chance or by true (reliable) agreement. However, the sample size of volunteers who completed all segments is too low to be able to apply this test.

Each trial’s average score, and increases, maintenance or decreases in correct scores are discussed below; **Section 3.3.1** examines the different types of queries such as binary, graduated and nested in more detail. Volunteer feedback was recorded throughout the York study; complaints and suggestions from all the participants proved quite useful in gauging the quality of the queries and in determining potentially beneficial alterations.

3.2.1.3 Benefits and challenges of using novices

A benefit to testing the form with novice osteologists was the opportunity to determine the limitations of their general knowledge, by identifying unfamiliar terms, and by determining, through experimentation, the most coherent series of support statements.

It was understood that novices would likely be unfamiliar with technical terms such as cribra orbitalia and porotic hyperostosis, terms used in Trial 1, but it was interesting to gauge the general level of knowledge among the novices; therefore, for Trial 1, jargon from the Rosenbluth Project was retained. It was further decided that, as the revised SES system was ideally created for use by novices who would need to rely on previous knowledge and the supportive descriptive text, no additional verbal support would be given to the subjects throughout Trial 1. Using the assessment system with its existing diagnostic requirements would therefore test the previous knowledge the volunteers already possessed, following one term of a rigorous osteology course taught by a professional bioarchaeologist, and a term of Death and Burial taught by Professor Don Brothwell, a well-known and widely published anthropologist. Further, it would test the ability of novice osteologists to use descriptive text to identify pathologies, such as is required by existing protocols and guidelines.

3.2.1.4 Problems identified during testing

The major purpose of testing and redesigning the rapid scoring system is that the system which is developed is robust; in other words, so that even relatively poorly skilled (e.g. enthusiastic undergraduate students, museum curators, community volunteers, archaeological technicians) will generate comparable data based upon observation not diagnosis.

The assessment sheets proved to have many problems that surfaced only during the testing. Each trial is discussed in detail below. Challenges that were identified during Trial 1 and thus early into the testing phase included confusion due to the use of nested decisions, and the jargon employed by the sheet. Thus, problems generally fell into two categories: requiring volunteers to deal with technical terms and to recognise specific pathologies; and ambiguous or unclear descriptive language.

Related to the first category were issues of linkage between multiple assessments, such as age at death combined with pathologies. If one was assessed incorrectly this had knock-on implications for other scores. The second drawback was less straightforward to solve and involved altering the language and descriptions in each subsequent trial, and engaging in debates and feedback sessions with the participants. The format and wording of the trial sheets needed to undergo revisions so that novice workers could understand what trait they were being asked to examine, could effectively determine the presence (or absence) of this trait, and could then choose between degrees of severity that a pathology presented, successfully choose the ‘correct’ answer, i.e., could choose the same response that an experienced osteologist would choose.

The protocol design was altered during the experiment, based on feedback and results: thus this experiment did not examine a finished product. Finally, this did not test how a rapid assessment system would be employed in a museum or laboratory setting. For ease of collecting data and garnering subject participation, the protocol was split into short segments, and the laying out of remains was performed for the volunteers.

3.3 Specific York trials

3.3.1 Trial 1

In the original design as created for the Rosenbluth project, the scoring system attempted to accomplish two objectives simultaneously: rapidly assess a human skeleton, and by linking weighted scores to each assessed trait, generate a numerical representative for social status.

Trial 1 retained the nested (or dependent) queries and the weighted scores from the revised Rosenbluth system. Thus the students were required to assess age at death, recognise the presence of osteoarthritis and the degree of severity of osteoarthritis (if present), assessments which were presented as a range of combinations of disease plus age at death. This is a nested question. Queries on the presence of cribra orbitalia were graduated (mild, moderate, severe); and porotic hyperostosis was a binary question (presence or absence). Queries related as to whether the remains had evidence of healed fractures were binary, but confusingly described for the inexperienced. Thus, the score sheet requested a diagnosis of pathologies, the ability to determine disease expression, and the experience to differentiate badly healed fractures from non-specific bone infections. In order to assist in making an accurate assessment the sheet included brief supportive descriptions, and also revealed the weighted scores. **Table 3.10** is the Trial 1 answer sheet. In addition to supplying the weighted score, the participant was required to redundantly copy the selected score in the column for ‘Actual Score’, when perhaps simply ticking the chosen box would have been adequate.

Table 3.10. Trial 1 answer sheet used by York volunteers to assess up to 10 skeletons.

TRIAL 1

Skeleton Number ________________Box and burial numbers____________________

	Pathology	Score	Criteria	Actual Score
1a	Age at death:young adult	-6	Ageing methods described in text	
B	adult	+2	as above	
C	older adult	+10	as above	
2a	Osteoathritis: Mild in young adult	-2	Sharpened joint edges, small patch of eburnation OR osteophytes (articular surface or edge)	
B	Moderate in young adult	-3	As above with increased erosion, osteophytes, eburnation	
C	Severe in young adult	-4	Joint eroded or fused; joint destruction; deep grooves on highly polished surface	
D	Mild in adulthood	-3	Sharpened joint edges, small patch of eburnation OR osteophytes (articular surface or edge)	
	Moderate in adulthood	-4	Defined as lipping, eburnation, subchondral erosion at joint	
	Severe in adulthood	-5	Joint eroded or fused; joint destruction; deep grooves on highly polished surface	
	Mild/moderate older ad	-1	Joint changes as for young adult	
E	Severe in older adult	-5	joints fused, or multiple joints highly polished with grooves	
3a	Cribra orbitalia --mild	-6	Slight holes in orbit	
B	Cribra orbitalia--moderate	-8	More holes in orbit, may resemble trabeculae	
C	Cribra orbitalia--severe	-10	Spicules in addition to above	
4	Porotic hyperostosis	-10	Porosity on occipital and/or parietal plates, OR vault thicker than 10 mm frontal or parietal. Beware of widespread cranial periositis as a sclerotic deposit ON surface of skull and brows: may indicate vermin scalp inflammation	
5a	Fractures well healed: long bones	0	Slight callus, or mild atypical angle or shape to bone shaft	
B	Fractures poorly set, poorly healed, or associated with drainage sinuses	-6	Psuedo-arthrosis, infectious response, osteomyelitis, exposed medullary canal	
C	Fractures associated with widespread injury or abuse.	-6	Multiple rib fractures; ulna fracture and/or skull fractures. Humerus fractures.	

Age at death and Sex determinants need to be listed with student delineating their choices. Then the three age cohorts can be columns with various skeletal features and pathologies listed in rows, and choices of “0” and “1” as ABSENT and PRESENT
Sex: skull: glabella, torus, mastoids, occiput, lateral orbits, chin, zyg arches, frontal slope.
Postcrania: pubic symphysis extension, subpubic ramus, ventral arch, obdurator

morphology, pre-auric sulcus, sacrum morphology, humeral and femur heads, humeral epicondylar breadth, overall gracile/robust of elements.
Age: dental eruption, epiphyseal fusion, dental wear, medial clavicle, rib ends, S1/S2, pubic symphysis age changes, auricular striae, auricular and retro-auricular macro-micro porosity and destruction, “lipping”, vertebral osteophytes, OA, OP, trabecular architecture (if exposed).

As in the Rosenbluth study, this initial version of Trial 1 required age assessment to be combined with some pathological assessments but did not offer all potential combinations, such as ‘Mild osteoarthritis in older adult’ and ‘Severe osteoarthritis in Adult’. Combinations of mild, moderate or severe for ‘Young adult’ were available options, but combined assessments of ‘Adult’ or ‘Older Adult’ plus mild or moderate degenerative joint disease was not offered. Indeed, the only options for individuals deemed older than ‘Young adult’ were ‘*Severe* osteoarthritis in Adult’ and ‘*Presence* of osteoarthritis in Older Adults’ were offered. Finally, criteria for determining if the individual had been younger, older or just ‘adult’ were not included.

As anticipated, scores were generally low for the nested query of age plus osteoarthritis, averaging 53% correct for all 10 skeletons. More successful were recognising porotic hyperostosis (82%), a binary question, and fractures (80%). Finally, age at death averaged 69%, and recognising the presence and degree of cribra orbitalia averaged 73%.

Scores varied from week to week, for several reasons: Trial 1 took three sessions to complete, during which some participants dropped out and two new ones joined. Four volunteers participated in Week 1, four in Week 2, and 11 in Week 3. **Figure 3.2** compares all segments of Trial 1.

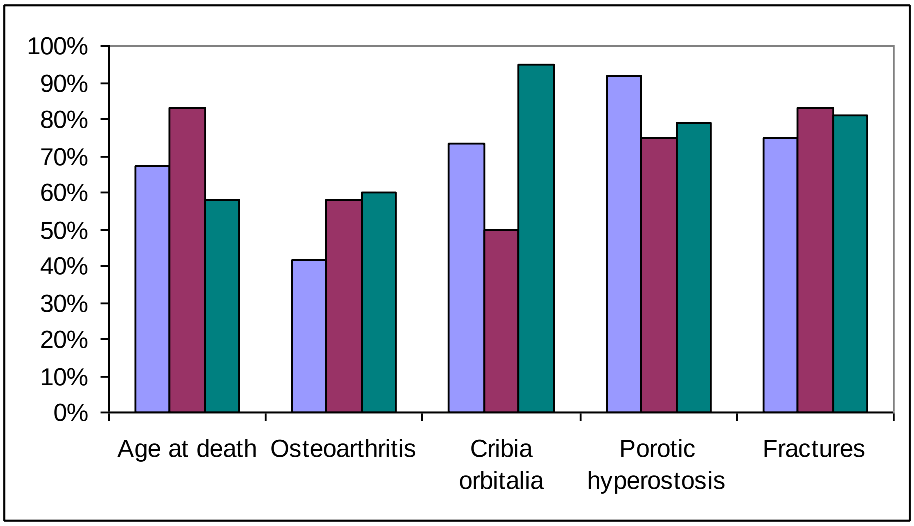


Figure 3.2. Combined results of each section of Trial 1, which took place over three consecutive weeks. Week 1 results are in blue, Week 2 in violet and Week 3 in turquoise. Ten skeleton were assessed, with three assessed in Weeks 1 and 2, and four in Week 3.

Standard deviations for responses to the queries were calculated. **Figure 3.3** illustrates the spread between scores; the standard deviation is low for both fractures (graduated but very familiar to the York students) and porotic hyperostosis (PH), the latter of which was a new concept but was also a binary question regarding presence or absence. In general, the spread of scores around the mean were widest for correctly recognising cribra orbitalia (and its degree of expression), at 22.5%. Interestingly, the scores for combining osteoarthritis with a correct age at death were much closer together, even though the answers were often wrong, with a standard deviation of just under 10%. This suggests the query itself was at fault.

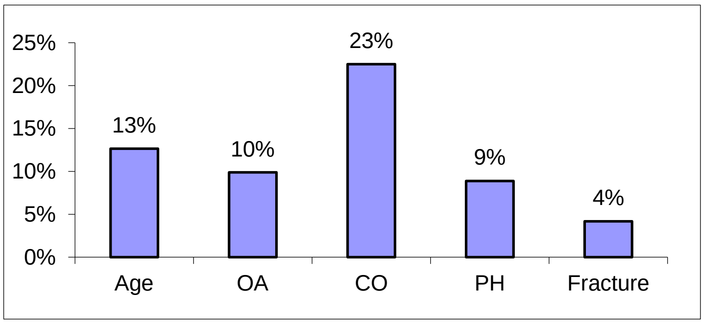


Figure 3.3. Standard deviations: Average scores versus ‘correct’ scores. The abbreviations are osteoarthritis (OA), cribra orbitalia (CO) and porotic hyperostosis (PH); the binary query on PH was more successful than determining presence and degree of CO. There was less spread among scores for osteoarthritis (OA) but the answers were mostly *wrong*.

3.3.2 Trial 2

Trial 2 focused on the dentition, requiring the volunteers to determine if a tooth had been lost before death as compared to after death; if dental caries were mild, moderate or severe; the degree to which the teeth had been heavily worn down during life; and if periodontal disease had been mild or severe. These queries are graduated. One binary query was asked, regarding presence of dental hypoplasia. Except for this query, results for each assessed trait were lower than for Trial 1. Please see **Figure 3.4** for results and **Table 3.11** for the answer sheet used in this session.

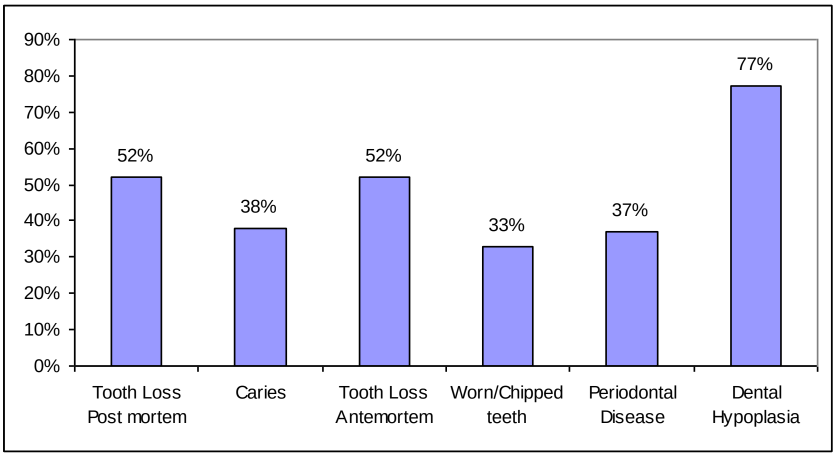


Figure 3.4. Results of first run of the dental assessment segment (Trial 2). Participants observed five skulls to assess traits such as postmortem and antemortem tooth loss; dental caries; loss of enamel, cusps and crown height due to dental wear and tooth damage (‘chipping’), periodontal disease and dental hypoplasia (enamel defects). Fourteen volunteers participated in this segment.

The overall success rate was 48%, including the binary query on presence of dental hypoplasia. Removing this result gives an overall rate of 42%. Accordingly, Trial 2 was retested, with the format changed dramatically. The biggest alteration omitted separate age at death columns, which in themselves had been a change from nested, pathology plus age queries (which had failed to offer all combinations). Due to feedback from volunteers and based on the results, it became apparent that the confusing weighted scores, and the requirement to continually assess age and sex gave the assessor work not integral to a truly objective assessment protocol. Once these were eliminated the system began to move away from an SES assessment and became more of a general assessment protocol.

The influence of ‘correctly’ estimating age at death and identifying the ‘correct’ degree of disease or trait expression (e.g. in agreement with the author) was examined, specifically errors related to choosing adjacent answers, such as Younger Adult compared with Adult; or Mild versus Moderate. When scores were re-calculated ignoring discrepancies between adjacent descriptors, scores improved. **Figure 3.4** and **Figure 3.5** illustrate results from the first round of Trial 2 (dental issues), with the former illustrating the actual scores and the latter offering leniency. **Figure 3.5** shows results from an exercise similar to the eventual awarding of half a point for one-category-off assessments (**Section 5.4.2**). By scoring ‘near misses’ as correct, the scores for Trial 2A improved.

Table 3.11. The answer sheet for Trial 2A, the first version of the dental assessment trial.

TRIAL 2(A)

Skeleton Number _____Box/Burial Numbers _______Time (mins) all skels __

Observation guide
Sex: skull: glabella, torus, mastoids, occiput, lateral orbits, chin, zyg arches, frontal slope. Postcrania: pubic symphysis extension, subpubic ramus, ventral arch, obdurator morphology, pre-auric sulcus, sacrum morphology, humeral and femur heads, humeral epicondylar breadth, overall gracile/robust of elements.

Age: dental eruption, epiphyseal fusion, dental wear, medial clavicle, rib ends, S1/S2, pubic symphysis age changes, auricular striae, auricular and retro-auricular macro-micro porosity and destruction, “lipping”, vertebral osteophytes, OA, OP, trabecular architecture (if exposed).

Please select an age at death category and then choose 0 (absent) or 1 (present) for the feature or pathology. Please use **N/A** when element is missing and cannot be assessed. FOR CARIES, WORN TEETH, MISSING TEETH: MORE THAN ONE PATHOLOGY CAN BE USED.

Scored feature or pathology and degree of severity	Description	Young adult (18-approx 30)	Adult (30 to 45)	Older Adult (50+)	Notes
Tooth Loss—post mortem	**Sockets empty but do not have woven bone filling them in. Some teeth remaining in other sockets.**				
OR	**No teeth. All sockets empty but “clean” and without spongy bone in sockets.**				
Caries	**Mild one or two small defects**				

OR	**Severe** Many smaller caries, or several very large caries; teeth with cusps gone and only roots left in socket.				
Tooth loss	**Mild** One or two sockets filled in, but only partly filled in.				
OR	**Moderate:** Many sockets filled in. Possible abscesses on mandible or maxilla.				
OR	**Severe:** Most or all teeth lost before death, with sockets filled in.				
Wear and Chipped Teeth	**Mild**: Some exposed dentin.				
OR	**Severe**: Most teeth worn to an angle or broken off.				
Periodontal disease	**Moderate:** spongy bone between teeth or in front of/behind teeth.				
OR	**Severe:** large abscesses in body of jaw, exposing teeth roots				
Dental Hypoplasia	**Ridges and furrows on front (anterior) surface of canines or premolars.**				

In a revision of Trial 2, age at death was unlinked from pathology observations and bold outlines were placed around related queries. The changes were so extensive that it was decided to re-test Trial 2 with the volunteers in order to see if the changes made a difference to comprehension of the protocol.

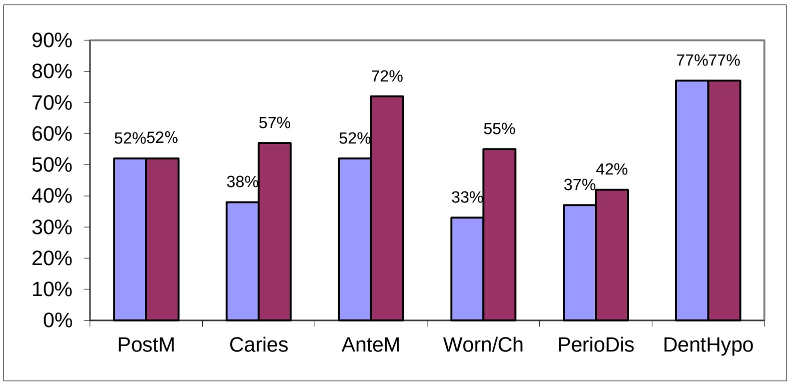


Figure 3.5. Trial 2 with **adjacent** categories accepted as correct, i.e., young adult = adult; adult = older adult; mild = moderate. Original results in blue; thirteen participants. From left to right, x-axis terms are abbreviations for postmortem tooth loss, antemortem tooth loss, worn and chipped teeth, periodontal disease, and dental hypoplasia.

The second test of Trial 2 (**Table 3.12)** removed age at death columns, and added a neglected pathology: the presence of calculus, a hardened deposit that can remain on archaeological teeth (Waldron 2009), and a binary question. Bold outlines were drawn around separate categories to separate them from others, to lessen volunteers either omitting a section or choosing two options in the same category. However, text on estimating sex and age at death was retained.

Table 3.12. The dental assessment was revised and re-tested, with several visual changes (bold text boxes to separate queries) and with the requirement to estimate age at death eliminated. A binary query on presence of dental calculus was added.

TRIAL 2B (Revised Dental Trial)

Skeleton Number _____Box/Burial Numbers ___ mandible present? Y / N
maxilla present? Y / N
Observation guide: <u>Please circle your choice at *</u>
Sex: skull: glabella, torus, mastoids, occiput, lateral orbits, chin, zyg arches, frontal slope. Postcrania: pubic symphysis extension, subpubic ramus, ventral arch, obdurator morphology, pre-auric sulcus, sacrum morphology, humeral and femur heads, humeral epicondylar breadth, overall gracile/robust of elements.

Age: dental eruption, epiphyseal fusion, dental wear, medial clavicle, rib ends, S1/S2, pubic symphysis age changes, auricular striae, auricular and retro-auricular macro-micro porosity and destruction, “lipping”, vertebral osteophytes, OA, OP, trabecular architecture (if exposed). YA=young adult, A=adult, OA=older adult
***AGE: <u>YA (18-25) A (30-45) OA (50+)</u> SEX <u>M (and probably M) F (and probably F) ? (unknown)</u>**

Please mark 1 or checkmark (present) for the feature or pathology if present. Please use **N/A** when element is missing and cannot be assessed. Please choose only **<u>one</u>** degree of pathology per heavily-outlined area.

Feature and degree of severity	Description		Notes
Most or all of teeth in sockets	Healthy teeth in an overall healthy mandible and/or maxilla.		
POST-MORTEM Tooth Loss	**Some sockets** empty but do not have woven bone filling them in; some teeth in place. Sockets not filled in; tooth loss is after death.		
OR	**No teeth.** All sockets empty but “clean” and without spongy bone in sockets. Not lost due to obvious disease		
Caries	**Mild** one or two small defects		
OR	**Moderate:** One or two very large caries with entire tooth hollowed out.		
OR	**Severe** Many smaller caries, or several very large caries; teeth with cusps gone and only roots left in socket.		
Tooth loss	**Mild** One or two sockets filled in, but only partly filled in.		

OR	**Moderate:** Many sockets filled in. Possible **abscesses** on mandible or maxilla.		
OR	**Severe:** Most or all teeth lost before death, with sockets filled in.		
Worn/chipped Teeth	**Mild**: Some exposed dentin.		
OR	**Moderate/Severe**: Most teeth worn to an angle or broken off.		
Calculus	Hardened substance on tooth surfaces; resembles 'cement'		
Periodontal disease	**Mild**: spongy bone around base of some teeth, or on small section of mandible or maxilla		
OR	**Moderate:** more spongy bone between teeth or in front of/behind teeth.		
OR	**Severe:** large abscesses in body of jaw, exposing teeth roots		
Dental Hypoplasia	**Ridges and furrows on front (anterior) surface of canines or premolars.**		

Trial 2A, held on 12 Nov 2007, enjoyed the largest complement of volunteers to attend one trial: 14 volunteers including 16HK (who actually tested 2A on 3 Dec 2007), and thus involving all four skill levels. The revised dental assessment was run on 3 Dec 2007, with eight subjects (**Table 3.8**); all volunteers who participated in Trial 2B also took part in the Trial 2A. **Figure 3.6** shows the results of the revised dental assessment.

Overall, the successful recognition of traits for Trial 2B was 63%. Assessing the degree of severity for caries (38%) and periodontal disease (25%) stayed rather low, but the other assessments reached a combined success rate of 76%. Similarly to Trial 2A, errors occurred when subjects had to decide between adjacent degrees of a trait or pathology, such as between mild or moderate or between moderate and severe. For traits with a binary choice between presence and absence (calculus, dental hypoplasia), as long as the volunteer could identify this trait, the scores were more successfully observed.

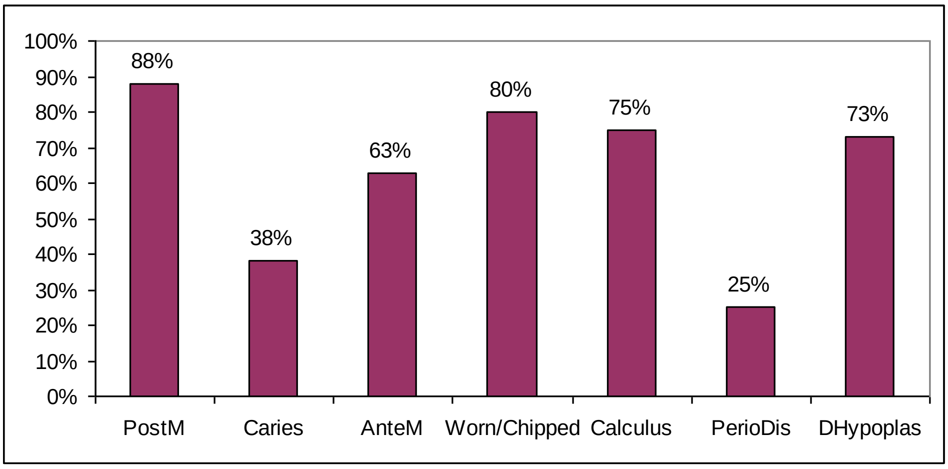


Figure 3.6. Results of revised dental assessment, Trial 2B. Eight volunteers took part in postmortem; antemortem; periodontal disease and dental hypoplasias.

3.3.3 Trial 3

Trial 3 is the designation given to the inventory segment of the York study and which was recognised as a crucial component to an assessment. Whilst working with Trial 2A data, it was noted that volunteer 02 MG had remarked on her answer sheet that Specimen 2 (Box 2, Burial 2) lacked maxillae. Ideally, missing elements should be recorded; but providing a method to record presence and absence of every element would increase complexity in a form designed to be simple.

Thus Trial 3 was not derived from elaboration of the Rosenbluth project, but was created in response to demand for an inventory that allowed participants to record presence or absence of the skeletal elements. The inventory was developed to accommodate that the *lack* of an element, or of a particular feature from an element, did not mean that the individual *had not suffered* from a condition. For example, a missing mandible resulted in failure to assess 50% of the dentition for the presence or absence of dental caries; but this became a default ‘positive’ score for lack of dental caries in the mandible.

Accordingly, an over-all skeletal inventory addressing completeness of the remains, the condition of the bones (weathered, excellent, fragmented), and observing basic age and sex-related markers was created. This aspect of the protocol was not ‘tested’ with volunteers recording observations from specimens.

Instead, a small group of four subjects (a focus group: Babbitt and Nystrom 1989) co-designed this segment, using one skeleton as an example. The only aspects tested were sexually dimorphic characteristics of the skull, such as brow and mastoid robusticity, and mandible dimorphism. This was accomplished by asking the participants to determine the probable sex of several skulls using the selections from the form. As the group was very small, the results were not recorded, but differences in choices were discussed. Trial 3 is shown as **Table 3.13.**

Table 3.13. Trial 3, the Inventory and Age/Sex assessment.

TRIAL 3: Skeletal Inventory

Skeleton Number __________ Box/Burial Nos.__________

Overall impression of remains   Fairly Complete Individual   YES / NO   ____
Bones in Good condition (not degraded?) YES / NO   Skeleton mostly Fragments YES/ NO

Cranial aspects   **Sex/Age: Circle when determined**: Male/Female/Unknown Adult/juvenile

Frontal plate (Forehead):   Sloped to rear of skull OR Vertical ________

Raised **glabella** (lump between eyes) YES / NO / MILD________

Torus (ridge over the orbits) Robust OR Gracile (slight, mild)   _______

Mastoid process (lump of bone behind ear hole) large/medium/small _____

Occipital plate (back of skull: Robust muscle attachments OR Mostly smooth? _______

Mandible present? YES / NO   Is **mandible** complete enough for age/sex/dental assessment? YES / NO

Mandible: gonial angles square, everted, robust, rough OR rounded?. _____

Mental eminence (chin) squared off / wide   OR rounded / gracile ________

Lateral (outer) edges of **orbits** (eyes) rounded/thick/ OR   sharp/thin? _____

Zygomatic arches: robust (thick) OR gracile (thin, fragile) ________

SupraEAM crest (ridge over ear hole) YES / NO / SLIGHT________

Teeth (brief description) Unworn (young person) / Worn (older person) ___________

Post-cranial aspects: **Circle answer if possible, use space if needed**

Elements with well fused epiphyses (ends) ______
OR Unfused to diaphysis (main shaft) _____

Elements (size) large and robust, ____OR gracile? _____
Muscle marks robust ___ OR gracile ___

Os coxae (pelvic bones) male/female aspects: **Pubic symphysis** present YES /Yes Incomplete/ NO

Ramus (strut of bone) below Pubic symphysis thin OR thick _____
Everted YES / NO

Pubic symphysis surface Billowy YES / NO Rounded edges YES / NO
Sharp edges YES / NO

Greater sciatic notch: Deep narrow/ tilted to sacrum _______
OR Wide / shallow symmetrical ____

Pre-auricular sulcus (trench) below auricular (articulation for sacrum on os coxa)
YES / NO ____

Humerus L present YES / NO complete ____
R present YES / NO complete____

Radius L present YES / NO complete _____
R present YES / NO complete____

Ulna L present YES / NO complete ____
R present YES / NO complete____

Femur L present YES / NO complete ____
R present YES / NO complete____

Tibia L present YES / NO complete ____
R present YES / NO complete____

Fibula L present YES / NO complete ___
R present YES / NO complete___

3.3.4 Trial 4

Trial 4 heralded a return to ambiguous results, but it can be interpreted the fault lies more in the complicated and indeed even inaccurate descriptive text, which, in ann attempt to simplify options, conflated descriptions of lesions that are healing with lesions that would have been active at time of death. Trial 4 measured the ability to recognise bone defects due to chronic inflammation and infection. When designing this section, it was difficult to reach what seemed the proper balance of textual information and choices. The answer sheet is shown as **Table 3.14.**

This trial demonstrates clearly that unambiguous language is imperative for the system to be reliably used by novices. Six regions of the skeleton were assessed for abnormal bone loss and deposition, and evidence of active infectious or inflammatory response: cranial vault, ribs, vertebrae, external limb surfaces, internal long bone aspects, and joints. Each region needed internal (if possible) and external inspection; for example internal and external rib surfaces; internal and external skull vault; and so on. Eleven queries were asked. The types of question (binary, graduated) in addition to the clear nature of some queries were influential on whether the feature was correctly assessed.

Table 3.14. Trial 4, assessment for abnormal bone deposit or bone loss.

TRIAL 4

Skeleton Number _____Box/Burial Numbers ______ mandible present? Y / N
maxilla present? Y / N
AGE: YA (18-25) A (30-45) OA (50+) SEX M probably M F probably F ? (unknown)

Please mark 1 or checkmark (present) for the feature or pathology if present. Please use **N/A** when element is missing and cannot be assessed. Please choose only **one** degree of pathology per heavily-outlined area.

Scored feature/ pathology,degree of severity	Description: May be present in Skull and or Long bones. Please note which section you are filling out.	Score 1 or √	Notes
CRANIAL: Ectocranial (outer) vault defects	**Moderate:** in one or two areas, small defects.		
OR	**Severe:** large patches, or many small patches		
Endocranial (inner) Vault defects	**Severe**: Any defect with rounded edges on inner vault surface. Large defect with star-like edges. Not arachnoid scars which are small and on mid-line (sagittal line) in frontal and parietal plates and can appear in clusters.		
VERTEBRAE	Defects, scooped out areas of destruction on anterior surfaces		
VERTEBRAE	Abnormal growth, fusion: with each other or with Sacrum		
RIBs (any number)	**Bone deposits** on insides (inner curves) or bone defects.		
RIBs (any number)	**Bone deposits** on outer sides (outside of curves) or bone defects		
RIBS (any number)	**Fusion between two or more ribs.**		
POSTCRANIAL: Periostitis on long bones, not joints, ribs or vertebrae Reaction/inflammation	**Mild** One limb, tibia for example, with raised new bone on surface. May be remodeled, that is not “woven” new bone with many pores but harder “sclerotic” bone with less pores.		
OR	**Moderate** Widespread on tibia etc with trabecular bone in mid shaft. Trabeculae normal at ends of bones.		

OR	**Severe** Thickened, abnormal and very obvious periosteal reaction with raised new bone, remodeled or not, on many limbs. Medullary canal filled with trabeculae		
Infections Including Osteomyelitis on long bones, not ribs joints or vertebrae	**Healed Mild:** single or small defect or several small defects with smoothed healed edges.		
OR	**Healed Moderate/Severe**: larger defects, more widespread, over several limbs **BUT WITH SMOOTH MARGINS** and **NO** ragged edges, no spicules.		
May ALSO be: May be in different stage of healing elsewhere.	**Active, ongoing Mild:** More holes, may resemble exposed trabeculae at edges (spicules). Irregular, ragged edges. Larger defects		
AND/ OR	**Active Ongoing Severe:** Widespread. Medullary canals may be filled with spongy bone (trabecular bone). Large drainage sinuses		
JOINT INFECTION	**Moderate**: one joint (hip, knee, elbow) with destroyed regions of bone, drainage sinuses, woven and remodeled bone		
OR	**Severe:** two or more joints with above. One joint fused.		

The most successful queries were binary and related to easily comprehended concepts: whether vertebrae or ribs were abnormally fused together; these were answered correctly 75% and 73% respectively. The presence or absence of endocranial defects was mostly avoided; skulls were predominantly intact. The least successful binary queries were about abnormal bone loss on vertebrae, which tend to suffer postmortem damage; and abnormal bone deposits on internal or external rib surfaces. These answers agreed with the author 63%, 60% and 50% of the time respectively. Eight volunteers participated in this trial. Results are illustrated in **Figure 3.7.**

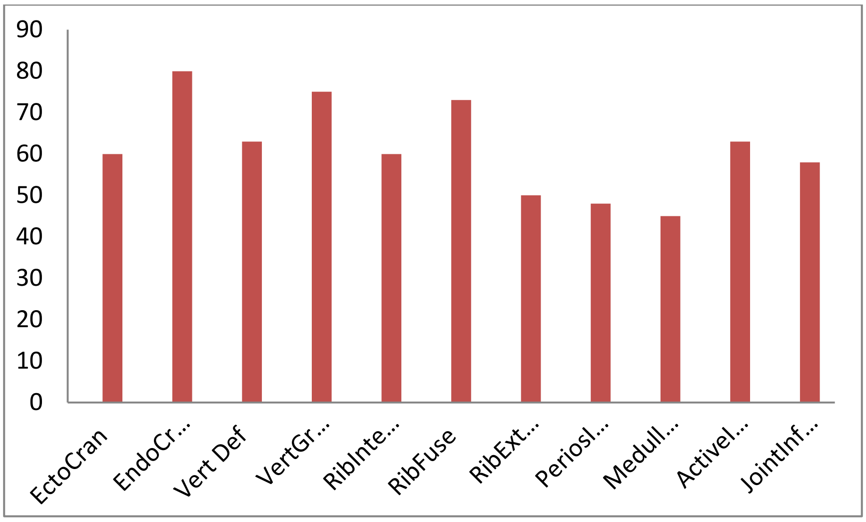


Figure 3.7. This segment assessed inflammatory and infectious response of bone. Eight volunteers participated. The x-axis abbreviations represent ectocranial defects; endocranial defects; vertebral defects (bone loss); fusion between vertebrae; abnormal bone deposits on internal rib surfaces; fusion between two or more ribs; abnormal bone deposits on external rib surfaces; periosteal inflammation; internal abnormal bone in the medullary canal; evidence consistent with active infectious or inflammatory repose; and joint infections or defects.

3.3.5 Trial 5

Instructions for Trial 5 requested the volunteers to assess comparative cortical bone thickness, which is not observable in a complete long bone. The success of some responses may be attributed to the success of the queries: the questions on cortical thickness included a clear illustration; and when bones with mid-shaft breaks were assessed, the success rate was 75%. However, this segment demonstrated clearly that the assessment would benefit from separate treatment of left limbs from right limbs, and separate illustrations for basic differences between naturally thinner upper limbs, and thicker lower limbs. The answer sheet for Trial 5, which includes the simple illustration to aid in identifying cortical mass, is shown in **Table 3.15**.

Trial 5 is a segment created to record bone variation that is of particular interest to the author and the subset of osteologists and bone engineers who study cortical mass. Also recorded were the appearance and robusticity of muscle attachment sites, which vary morphologically between males and females, and also potentially represent the youthful loading and activity history of an individual. One immediate concern expressed by the subjects was the text: it was considered too dense. By supplying as much information as could fit on two pages, the subjects were confused more than enlightened.

Table 3.15. Trial 5 answer sheet, which assessed cortical bone mass (if exposed via a mid-shaft transverse break) and the appearance of muscle attachments on long bones.

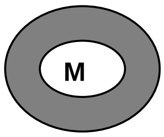
TRIAL 5

Skeleton Number ________Box/Burial Numbers ____ mandible present? Y / N maxilla present? Y / N
AGE: <u>YA (18-25) A (30-45) OA (50+)</u> SEX <u>M probably M F probably F ? (unknown)</u>

Please mark 1 or checkmark (present) for the feature or pathology if present. Please use **N/A** when element is missing and cannot be assessed. Please choose only **<u>one</u>** degree of pathology per heavily-outlined area.

CORTICAL THICKNESS: Bone shaft "walls".
This can only be assessed on a break near the <u>MIDDLE</u> of the bone, because cortex thins out near the ends of long bones. We can observe the mid-shaft only if the bone happens to be broken.
Consider this COMPARED TO THE ACTUAL BONE. For example, a healthy ulna will never be as thick as a femur with "thin" cortical mass. A "thin" ulna may be 2 mm thin on an exposed mid-shaft, but a thin femur might have shaft walls that have a width of 4 mm. The shaded area is the Cortical bone.

The "M" marks the medullary cavity.
Note: this would be a **"thick**" cortex.



Scored feature/ pathology, degree of expression	Description: Some bones may have a combination of features. Please select ONE item from within an outlined area, such as "thin" OR "thick" cortex. Section at bottom is for single bones that are very different from most of the skeleton, such as one femur that is unusually thick or thin, or one humerus having very ragged MSM while the other is more "normal".	**Score 1 or √ if present**	Notes
<u>LONG BONES: UPPER LIMBS.</u> CORTICAL MASS OF EXPOSED MID SHAFTS	**Abnormally thickened**, with a very narrow medullary cavity in comparison to the overall width of the shaft. It is important that only MIDDLE areas are assessed. The ends of bones always have rather thin cortical bone.		
OR	**Thick** bone in comparison to size of shaft.		
OR	**Thin cortical bone** in comparison to rest of shaft.		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers.		

LONG BONES: LOWER LIMBS. CORTICAL MASS	**Abnormally thickened**, with a very narrow medullary cavaity in comparison to the overall width of the shaft.		
OR	**Thick** bone in comparison to size of shaft.		
OR	**Thin cortical bone** in comparison to rest of shaft		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers.		
LONG BONES UPPER LIMBS MUSCLE SITES	**Raised lines, ridges, or humps on long bones that mark the attachment site of large muscles. Present and noticeable?**		
OR	**Large, ragged ridges with scooped out defects near and within muscle site. Can look like pathology!**		
OR	**Almost non-existent. Can be felt with fingers more than seen.**		
LONG BONES LOWER LIMBS MUSCLE SITES	**Raised lines, ridges, or humps present and noticeable?**		
OR	**Large, ragged ridges with scooped out defects near and within muscle site. Can look like pathology**		
OR	**Almost non-existent. Felt with fingers more than seen**		

Seven volunteers participated in this short Trial. Two skeletons, both from the Malmesbury Collection, were observed for this test: Skeleton 1 was Box 29 Burial 46, and Skeleton 2 was Box 32, Burial 49. **Figure 3.8** illustrates the results.

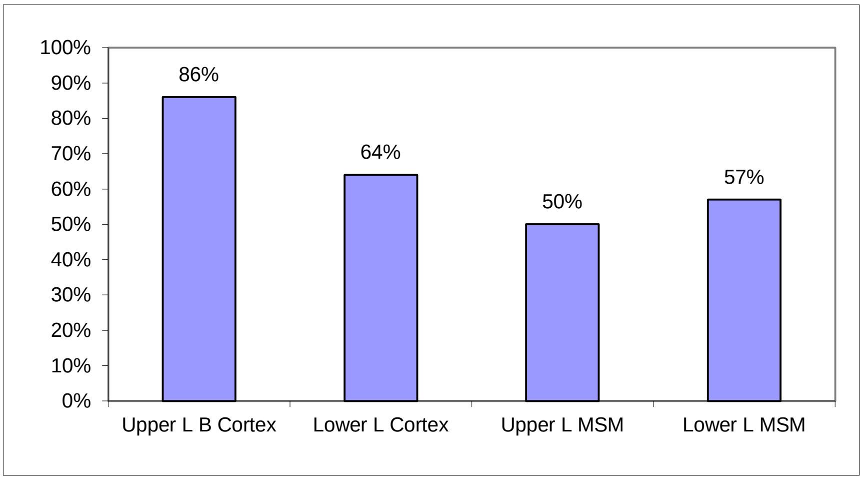


Figure 3.8. Results of Trial 5, cortical mass and musculoskeletal ‘markers’ of activity or ‘stress’ (MSM). The abbreviations on the x-axis from left to right are: upper long bones cortex; lower limb cortex; upper limb MSM, and lower limb MSM.

3.3.6 Positive outcomes of the volunteer trials

The most encouraging outcome of the testing was the possibility, based on comments and results from the novices and the other expert (16HK) that the system was truly ‘rapid’. Once one had become familiarized with the format, and had developed a rhythm to evaluating for a set of traits, the volunteer could move quickly down the sheet, and over each skeleton.

Based on the slight increases in positive scores, especially when queries offered simplified description and were binary, and on the verbal evaluations offered by both novice and expert volunteers, the proposed system seemed to offer a viable complementary or even alternative system to metric data capture and unstructured pathology observations. As this first test involved a form undergoing drastic revision, it was decided to formally re-test the revised protocol on fresh subjects.

Presenting the protocol as a series of segments, the one system could effectively be evaluated more than once, without having to set up a new test and recruit new volunteers. Flaws that were identified by participants (including this author) could be promptly addressed, with revisions incorporated into subsequent segments. Thus, alterations were quickly evaluated by practical application.

It is recognised that constantly altering the format could confound results for several reasons: inadequate sampling, as with each completed segment the remaining traits to test were reduced; and due to open discussions of planned changes, the volunteers were effectively undergoing training. By candidly debating the pros and cons of terminology, wording, and diagnostic requirements, the student subjects increased their familiarity with the assessed pathologies, thus potentially raising their scores due to practice more than from effective changes.

3.3.6.1 Revision process

Increased positive results following alterations to the format were taken to indicate successful dissemination of trait descriptions. Also, agreement in responses between both participating Skill Level 4 researchers (16HK, 5RD) increased confidence in the judgment of the author as the one to whom all scores were compared.

Following the York trial, the author was encouraged that the system could be refined into a user-friendly, observation based skeletal assessment protocol. While the original goal of creating an SES-assessment form had evolved into a conservation tool, the format appeared to have the potential to be configurable for a variety of collection needs. Various data capture requirements could potentially be met: initial database construction; rapid analyses of remains with time limits on access; the inclusion of population-specific markers; and the capture and analysis of status and health markers such as early death coupled with markers of deprivation.

3.4 Challenges during the York study

3.4.1 Consistent Participation

For the York study of the protocol, the 40 queries were divided into four sections, with the first section, termed Trial 1 taking place over three consecutive Monday evenings. Due to limited lab space in which to lay out skeletons and yet allow room for participants to manoeuvre around them, specimens were viewed in small batches on separate nights. The aim had been to maximise the number of skeletons studied for this segment (ten were viewed), but the group of participants suffered attrition by the second session and gained new volunteers in the third, so not all participants saw all ten skeletons. This was avoided in future by limiting each section (Trial) to one evening, with the number of specimens reduced.

However, even though the rest of the Trials were single-evening sessions with all specimens available for each Trial, not all volunteers attended each Trial and indeed only two volunteers (aside from the author) made it to every session of all four Trials (**Table 3.9**). Therefore only two volunteers (02MG, 03AT) took part in all four Trials and examined all 27 specimens, including all ten in Trial 1. Two more volunteers (08JM, 12LE) attended one session of Trial 1, were able to attend all remaining Trials and thus participated in all parts of the protocol even though they did not view every specimen. Consequently, only four participants took part in some portion of all four Trials, viewing at least 21 sets of remains.

One participant (01PC) made it to all sessions of Trial 1, both variants of Trial 2, and Trial 4, missing out only the last segment of the protocol and thus attending six out of the seven segments. Several people came to most sessions. In the event, a maximum of 11 volunteers, plus the other ‘expert’, assessed four skeletons for the third session of Trial 1. Twelve volunteers assessed five dental arcades for the first version of Trial 2; this segment was deemed so problematic due to the requirement to age and sex that Trial 2 was retested; eight participants assessed five dental arcades for Trial 2B. Eight volunteers took part in Trial 4, and seven participants were in Trial 5. With such a small and inconsistent turn-out, most analyses were based on descriptive statistics such as overall agreement, percentage correct per query, and standard deviation among respondents. The ultimate benefit of the York experiment, which utilised volunteers, skeletons and several query formats was the opportunity to test drive the protocol and to determine how best to phrase queries, and to design the form for maximum comprehension.

3.4.2 Complex Queries, Specialist Jargon, 'Too Much Information'

Quickly noticed during the York study was that the admittedly risky plan to use jargon-reduced (but not jargon-free) queries was not at all successful. This had been an experiment with using terminology routinely employed by the other protocols. Even with supportive text available, some crucial terms remained unexplained and thus the relevant traits failed to be recognised by participants. Also, in an attempt to go beyond merely determining disease state (mild, moderate, severe), the age at death was also queried, with both observations being dependent and 'nested'. Whilst a laudable exercise, such nested observations are beyond novices. The York project originally was to create an observation-based system that captured socioeconomic data. This overly ambitious aspect was quickly dropped.

The next feature to be excised was the requirement for volunteers to estimate age at death, even though this was supported by text. Despite unlinking age from any pathology, such estimations are too complex for novices and indeed too complex for a 'rapid' assessment system designed to capture the overall condition of remains stored within a box. As the trials progressed, week by week, the format of the form itself was altered according to suggestions by the volunteers**.** Anomalies and traits queried were outlined within very thick boxes in order to separate them from other queries. When the queries were placed in adjacent boxed areas but with less distinct separation lines, participants occasionally skimmed over an observation.

Jargon and specialist terminology proved very difficult to avoid, even as the weeks passed and feedback from the participants was taken into consideration. Despite descriptive supportive text, 'bone loss' as a result of disease was confused with bone loss due to post-mortem damage, and 'bone deposits' as a reaction to disease or trauma were confused with pronounced muscle markings. On the other hand, expanding support text was also bemoaned as supplying too much information, which participants found overwhelming to read.

3.4.3 Type of question

Binary queries (either/or, yes/no, presence/absence) fared differently from graduated queries (mild, moderate, severe). **Figure 3.2** and **Figure 3.6** illustrate this difference. In **Figure 3.2**, the binary query regarding presence or absence of porotic hyperostosis is more successful than graduated (and complexly nested) questions on cribra orbitalia. In **Figure 3.6**, the binary query regarding calculus (hardened dental plaque) was more successful at 75% volunteer agreement with author than the graduated question on caries: mild, moderate, severe (38%). The differential success rate between subjective, graduated questions and binary questions was only briefly explored in the York study, as was the impact of variation in skeletal remains. The attempt to economize on questions by making each one ‘count for more’ and to pack in more information by ‘nesting’ did not work at all. This aspect was dropped, instigating a re-design: the list of questions was expanded, but broken down as to complexity.

3.4.4 York experiment: conclusion

Despite the importance in ascertaining the reliability and reproducibility of this protocol, inferential testing was not applicable to the York results. This was due to the small population size of volunteers who participated in each segment, and arguably due to the nature of the queries, in which too many variables were presented as options.

Therefore analyses were based on descriptive statistics such as overall agreement, percentage correct per query and standard deviation among respondents. The type of query seemed to influence scores. Beyond dropping complex questions, the basic simplicity of the question itself impacted a volunteer’s ability to answer in agreement with the author. Binary questions (presence / absence; yes / no) were often more successful than graduated queries (mild / moderate / severe).

The true significance of testing the York version of the protocol was the trial’s development into an extended series of ‘focus group sessions’. Thus the York experiment became a collaborative method to test-drive the queries, identifying as many pitfalls as possible and collecting invaluable recommendations. Focus groups are a suggested methodology for constructing reliable and user-friendly questionnaires (Babbitt and Nystrom 1989). Compared to existing skeletal assessment protocols, this project is essentially a tick-box questionnaire.

The suggestions of York volunteers, and the poor results associated with overly-complex questions were considered for the revised protocol. The rationale for protocol changes are discussed in **Chapter 4 Methodology II.**

Chapter 4: Methodology II: Revised Protocol

The first test of the protocol using volunteers provided mixed results: whilst certain kinds of queries seemed more successful than others, accurate information was not consistently recorded. Accordingly, the format of the protocol was examined for complex, ambiguous or specialist language, and it was decided to retest a revised protocol with different volunteers. This chapter provides the rationale for the observations queried in the revised protocol (**Table 4.1**) which was tested over three weeks in Winchester in March 2012. The following two chapters detail the **Results (Chapter 5)** and **Discussion (Chapter 6)** of the Winchester test, with additional revisions to the protocol discussed in the Conclusion. During the first week of the Winchester test (see **Section 5.6.1**), it was recognised volunteers required supplementary support in the form of an Information Booklet, a separate, reusable pamphlet with illustrations of skeletal elements and expanded explanatory text, which was provided for the subsequent two weeks of testing. Due to space considerations, the Information Booklet is found in **Appendix 3**.

4.1 Ideal System: Observations

Two of the most problematic aspects of the York experiment were the small sample size of volunteers, and the extended testing period. Although up to 17 people participated, very few took part in each segment of the experiment, and indeed several volunteers either moved away, or joined mid-trial.

There had been concerns the volunteers would be too familiar with skeletons to represent actual ‘novices’ but instead, presumptions were made regarding volunteer comprehension of specialist language, even with supportive text. It was belatedly realised that the most useful information to collect had not been tested: a simple assessment of the condition of the remains and, ideally, an inventory of probable elements available for study.

4.1.1 Selecting characteristics for observation

Ideally, a rapid assessment system would record presence or absence of basic types of elements (skull; vertebrae; ribs; hips; long bones; podials), record observations by skeletal element, and would choose the option that best describes aspects of its appearance. Bone is limited in its responses to insult, injury and increased activity: it can be added, it can be removed (or a combination of the two), and the overall morphology of the skeletal element can be altered (Ortner 2003; Mann and Hunt 2005; Roberts and Manchester 2005). While particular types of osteological response are not often associated with *one* specific disease (such as leprosy or tuberculosis), certain *patterns* of bone response can simplify the options (Rogers and Waldron 1995). For example, while vertebral bone can be destroyed by non-specific infections, a potential diagnosis of tuberculosis can be considered if several contiguous vertebrae show evidence of anterior destruction, collapse, along with a lack of new bone growth (Aufderheide and Rodriguez-Martin 1998; Ortner 2003). Isolated severe degenerative joint disease in a young individual is likely the result of trauma, whereas symmetrical joint disease in an older individual can be attributed to older age (Jurmain 1999).

Correctly recording the appearance of skeletal elements, whether normal, or having misshapen/abnormal morphology or large areas of abnormal bone can suggest disorders or diseases. Accurately flagged anomalies can alert an experienced osteologist to potential candidates for inclusion in a directed project. Following the York experiment, it was decided that the number of questions could be expanded with little loss of speed. Volunteers seemed to lose time trying to puzzle out the meaning hidden in overly-complex queries and the elaborate text support that was subsequently needed. Simplified questions could be answered more quickly. Also, the more convoluted the questions, the more likely the volunteer would be incorrect.

4.2 Ideal System: Format

In this section, the format for the Winchester 2012 Answer Sheet (**Table 4.1**) will be examined. The foundation for utilising different query types will be explored, as will the relevant literature that provides a rationale for each query.

4.2.1 Questionnaire construction

When using the actual data capture sheets, the novice osteologist, Historical Society volunteer, student, museum curator or commercial archaeological firm technician will not be required to know the theories or research behind each query, nor will they be required to *consciously* observe, recognise and record variables such as age at death estimate, possible biological sex, and bone anomalies such as injury or disease. The protocol is essentially a questionnaire, in closed-question format. An open-ended format allows the respondent to answer in any manner desired using their own words; for example, a section called 'Notes' or 'Additional comments'. A closed-end format supplies a preprinted finite list to choose from, such as true/false, yes/no, multiple choice, checklist, or rating scale (Babbitt and Nystrom 1989: 8).

One key source consulted during the revision process was the *Questionnaire Construction Manual* (Babbitt and Nystrom 1989), commissioned in 1976 by the US Army Research Institute for the Behavioral and Social Sciences and updated between 1986-1989 and for which the authors consult numerous studies. It is described as guide for developing questionnaires and is 'applicable to nonmilitary applications' (Babbitt and Nystrom 1989: i). One must identify the target user, who the results are for and how these results will be used. This is simplified to one consideration: the consequences of a wrong answer. If there are none, the questions are unnecessary; alternatively, if reliable results can save money, energy or streamline an important process, it is imperative to design the form with care (ibid: 20-21).

When creating a questionnaire for general or target audiences, factors to consider include complexity, difficulty and jargon. The task cannot be onerous; participants will lose interest or become fatigued (Babbitt and Nystrom 1989: 166). The questions cannot be biased or use leading language but also must be descriptive (ibid: 115) and avoid jargon of any sort: some specialists have ‘unusual command of their [subject’s] language’ (ibid: 92). Questions that are too confusing will be left blank, which is considered a failure of the questionnaire, not the respondent. Types of queries influence how the results can be analysed. Closed-ended queries are quicker to answer, especially during self-administered tests (ibid: 26) than open ended ones where the respondent is free to write down what they desire. For example, a closed-ended query on postal service might be: ‘Do you find the post office easy to get to? difficult to get to? no difference? (Circle one)’. An open ended query would be ‘What do you think about the post office?’ In the open ended query the respondents are free to write anything. The answers may not be comparable (ibid: 28) and thus difficult to analyse statistically. The format of queries is important: for three or fewer choices, the options can be arranged in a linear fashion but for more than four, a vertical placement is best (ibid: 164). It is more desirable to avoid overlap between options, even at the risk of forcing an inadequate choice than to offer options that are too close in description (ibid: 47, 135). Queries should be phrased in a positive voice as negative may be misinterpreted (ibid: 79); the order of options should be juggled to avoid respondents falling into the habit of repeatedly circling the same (often middle) choice (ibid: 102-103).

One issue is whether to provide information booklets (referred to as Question sheets) in addition to answer sheets: respondents may find it difficult to refer constantly to a separate booklet, but they can be reused (Babbitt and Nystrom 1989: 172). The risk becomes one of supplying too-lengthy an explanation (ibid: 170) versus one of failing to adequately explain the query (ibid: 91-92, 115).

Other sources for questionnaire design are more focused on specific types of questionnaires, such as self-reporting dangerous behaviors, or submitting reliable accounts of crime. The focus in these sorts of retrospective surveys is to encourage accurate recall of events, often by linking them to landmark events in order to help the respondent focus. For example, a paper on public surveys on the incidence of crime is called, "Since the eruption of Mt St Helens, has anyone beaten you up?" (Loftus and Marburder 1983); the landmark event can avoid 'telescoping' of time and elicit a more reliable memory. The format and wording of the queries are key aspects of a questionnaire regardless of the information that is sought (Schwarz and Oyserman 2001). Social workers developing surveys to monitor support systems used by poor mothers with chronically ill children encourage the women to share examples of their daily struggles by acting as 'subordinate ethnographers', with no prior knowledge of the situation and place their clients in the position of 'expert'; echoing the client's verbal expressions by not introducing language (jargon) of their own (Bauman and Adair 1992: 13). In addition to the ethnographic method, the other types of 'qualitative interviews' are described as: 'in-depth, unstructured and unstandardised'; 'in-depth and structured' (such as are used in oral histories: Drew 2002); 'focused interviews' as in those used in marketing drug trial analyses; and 'psychological clinical interviews' (ibid: 10-12). The goal of creating a system to best elicit information from a target audience is essentially the same as described by Babbitt and Nystrom (1989).

Clearly the goals of social welfare programmes are different from a skeletal analysis protocol, but the recommended tools are the same: selecting between open ended and closed ended formats; avoiding jargon or biased language in the questions; keeping the interactions explicable to the respondents.

4.2.2 The Protocol Content

This section examines methodologies (and their underlying research) that are customarily utilised by experienced osteologists to estimate age at death and biological sex, and the most commonly encountered disorders. For ageing, procedures include assessing stage of skeletal maturity or dental development for individuals up to approximately 25-30 years of age, and the consequential wearing down of skeletal elements and teeth in the decades after growth has been completed; to estimate biological sex, sexually dimorphic traits in the skull and pelvic bones are evaluated, along with a range of bone lengths and joint diameters (Krogman 1962; Buikstra and Ubelaker 1994; Brickley and McKinley 2004; Scheuer and Black 2004; Bass 2005, Brooks and 1990; Walker 2005). Every bone in the adult skeleton has been studied for correlation between length, shape, robusticity and biological sex (Bass 2005), including carpals (Mastrangelo *et al.* 2011).

Corresponding options offered on the questionnaire in order to capture observations that indicate age cohort and probable biological sex use parameters such as vertical or oblique forehead; the condition of the teeth; the appearance of ribs and joints; selected femoral dimensions. Accordingly, in the annotated version of the questionnaire (**Table 4.1**), queries cite research that supports the implicit assumptions used by the protocol, namely, that trait X suggests aspect Z; that, for example, a pronounced brow ridge in a robust skull is a male trait. The background is provided to add rigor to presumptions implied by the selected questions. To continue with the present example, literature is cited in order to justify why a brow ridge should be ‘observed’: that a robust brow ridge trends in males. More problematic is eliciting the ‘correct’ observation and leading the novice to determine what constitutes ‘robust’, or even to locate a ‘brow ridge’.

In addition to selecting options that indicate age and sex, the protocol asks end-users to record the overall condition of the remains, for example if skeletal elements seem ‘fairly complete’ and in ‘good condition’, or are fragmented or few in number. This information alone can save time and energy during a research visit. An inventory is also collected: as various sexually dimorphic or age-influenced traits are assessed, the skeletal element or region under inspection is also evaluated for presence (retention) and completeness. This inventorying aspect of the form developed during the York volunteer test of the protocol (see **Chapter 3**). The resultant ‘Inventory’ segment has developed into approximately half of the protocol.

In the second half of the form, which aims to collect observations that are consistent with accepted diagnoses of disease and trauma, respondents examine specific regions and select from several options, including ‘normal’ or ‘not available’ (element or region absent), or a range of expressions for a disease or disorder, such as mild / moderate / severe, with supportive text permitting comprehension or at the least, recognition, of any such manifestation. This is the most ambitious aspect of the protocol. The aim is that the supportive text will be widely understood, that the language employed will not be overly confusing or condescending; and that novices, with the fresh and unbiased gaze of one who is not on a research visit will merely utilise the tools supplied and compare the skeletal remains to the text.

Queries will be designed to facilitate recognition of lesions that are consistent with identified disease processes and which are supported by classic texts and recent literature (Buikstra and Ubelaker 1994; Lovell 1997; Aufderheide and Rodriguez-Martin 1998; Ortner 2003; Brickley and McKinley 2004; Brickley and Ives 2008; Waldron 2009). The observers will be guided to recognise unusual boney deposits or erosions, and to identify typically encountered injuries, disorders and diseases, such as dental disease, osteoarthritis (long bone joints and vertebrae), healed fractures, and inflammatory response or infection of the outer shaft and medullary canal (inner shaft).

Other observations include abnormal bone shaft shape and shaft robusticity, presumed to correlate with activity and nutrition (Brickley and Ives 2008), and controversial interpretations of so-called musculoskeletal stress markers (Isçan and Kennedy 1989; Stirland 1998; Jurmain 1999; Peterson 2002; Stirland 2005; Henderson and Gallant 2006; Knüsel 2007; Alves Cardoso and Henderson 2010, 2012). The system as tested in Winchester 2012 (**Chapter 5**) attempted to elicit recognition of several eccentric bone anomalies such as premature fusion of cranial sutures (termed craniostenosis by Ortner 2003: 460-463), intentional modification of skull shape (Ortner 2003: 164-165), and atypical fusion between the lower spine and the sacrum (Aufderheide and Rodriguez-Martin 1998: 65-66; Tague 2009). The paleopathology queries are annotated in **Table 4.1** with reference to the relevant literature covered briefly below. Comprehensive discussion of ageing and sexing criteria, and of diseases and disorders of bone are beyond the scope of this thesis.

The observations were simplified to checkmark and multiple-choice options on the protocol data collection pages, with a focus on binary or limited option multiple-choice, and an avoidance of unsupported technical jargon. Choices for 'normal' bone, as well as for missing or damaged elements were offered.

4.3 Queries selected for Inventory Segment

The protocol is designed to collect a basic inventory of skeletal elements present, and a general sense of their condition. Accuracy relies on the diligence the worker applies to comparing illustrations and reading instructions. Presence, absence or appearance of an element is not based on theory or past research, but are observations. Therefore questions that relate to condition, such as 'Is the skull complete or shattered' will not be addressed below. Illustrations and descriptions of typical elements are supplied in the Information Booklet (**Appendix 3**).

4.3.1 Estimates of Age at Death

Non-adults are more straightforward to assess for age at death, due to fairly predictable maturation stages in bones and teeth. For neonates, infants and very young non-adults, ageing is based on long bone lengths, the formation and eruption of deciduous and permanent teeth, vertebral fusion and the developmental stage of certain early-forming epiphyses (Scheuer and Black 2004; Lewis 2007). For ease of testing and due to the rarity and fragility of skeletons of young non-adults, adolescent and adult skeletons were used in the Winchester 2012 experiment.

It is most important to determine the age cohort before considering sex to ensure that sexually dimorphic traits that develop after puberty (Krogman 1962: 115) or alter in older years (Krogman 1962; Walker 1995:36) are appropriately evaluated. A gracile skull may be of a young male or an adult female; a moderately robust skull may be an adult male or an older female (Walker 1995: 40). The bulk of skeletal maturity occurs during or shortly after adolescence, with most long bone shafts fusing to their epiphyses between 15-20 years of age (Bass 2005). Once late-fusing bones such as the clavicle and proximal sacrum (age 25-30) have reached maturity and the remains are established as ‘adult’ with skeletal development attained, discerning between ‘adult’ and ‘older adult’ depends on identifying age-related changes in synovial joints (Rogers and Waldron 1995; Jurmain 1999), muscle insertion sites (Alves Cardoso and Henderson 2010, 2012), and several regions in the hips (Phenice 1969; Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Other traits include reduction of bone mass and insufficiency fractures (Mays 1996; Buckley and Ives 2008), dental attrition and tooth loss (Brothwell 1981; Hillson 2000), assessing closure or obliteration of cranial sutures (or not) (Perizonius 1984; Drew 2006); and the ossification of cartilage, especially between ribs and sternum (Isçan *et al.* 1984).

The literature on ageing is vast. Excellent textbooks and countless studies are available: work to quantify age ranges in older adults beyond just ‘50 plus’ is imperative for forensic and population studies. The aim of this section is to justify the traits selected for observation in the protocol by reference to a range of anthropological and clinical sources. People with little or no osteological training are not required to estimate age at death, but to be able to differentiate between bones that have broken after burial due to post-depositional damage, and those that look ‘incomplete’ because an endplate had not yet fused due to skeletal immaturity. Illustrations in the protocol guide should be helpful.

The observations taken using the protocol, which when scored are used to determine the probable age cohort, include:

1. degree of epiphyseal fusion,
2. dental development and tooth wear
3. age-related changes in skull and pelvic bones,

4. age-related changes to articulations such as ‘osteoarthritis’ (a problematic description all on its own), and
5. muscle insertion site (enthesis) development and deterioration. The last two observations will be discussed in paleopathology.

Individual, mature bones are originally comprised of separate parts that form at various intervals during growth (Scheuer and Black 2004). At birth, the main shafts of all of the long bones are present and broadly recognisable, but very few of the epiphyses have developed; only the distal femur is almost always present at birth, although the proximal tibia may also have ossified (Scheuer 2002a; Scheuer and Black 2004). Neonate epiphyses are roughly oval, disproportionately smaller than the diaphyses to which they will eventually fuse, and can best be identified in articulation (Lewis 2007).

The process of fusion, from the initiation of union in which the still-separate epiphysis articulates well with the diaphysis, to complete union can take months to even years, and is ‘more constrained in time’ in long bones and thus more applicable to forensic examinations (Scheuer 2002a: 303). Broad schedules for fusion of the long bones are found in Krogman (1962: 32) and Mays (2010: 58), derived from radiography studies and samples of adolescents who have ended up in dissecting labs (Krogman 1962: 32). Females tend to reach skeletal maturity about two years earlier than males (Krogman 1962: 35; Buikstra and Ubelaker 1994: 42), but schedules are illustrative and a range of extrinsic (environment) and intrinsic (genetic, hormonal) factors can alter the timing: malnutrition and illness for example can delay maturity (Scheuer 2002a; Lewis 2007; Mays 2010). Combinations of fused and unfused bone can be used to narrow the age range for a non-adult. For example, fused elbow regions, fused distal tibiae, but humeral heads and iliac crests still unfused would suggest an age at death range of between 15 years and 22 years. The presence of other epiphyseal sites preserved adequately for inspection would help narrow the range. If dentition is available, erupted third molars (approx. age 18-21) would place the estimate higher (Bass 2005).

Youthful aspects assessed using the protocol include long bones with epiphyses that have not fused, little or no dental wear, and the furrowed, 'billowy' margins of pelvic bones from individuals who died before their mid-twenties. If clavicles are present, a furrowed, wrinkled medial end that indicates an unformed and thus unfused epiphysis is important for establishing an age at death of under 30 (Krogman 1962).

Ideally, the observer using the protocol will be able to tell the difference between an incomplete long bone due to breakage, and an immature long bone in which an epiphysis had yet to fuse. A long bone that has broken postmortem or has suffered unintentional damage during excavation will lack the billowy and yet solid metaphyseal plate of an immature long bone (Krogman 1962: 41). A mature bone with postmortem damage at the joint ends will expose fragile honeycombed bone material; or if the damage extends further up the shaft, will expose the typically hollowed medullary cavity found in normal long bones, in which the element resembles a pipe or tube. In life the medullary canal is filled with blood vessels and marrows, but not bone, unless the individual had an internal bone infection (Ortner 2003: 185)

4.3.1.1 Dentition: Dental Development and Tooth Wear

Teeth are the human tissue most resistant to taphonomic change, surviving for thousands of years (Mays 2010: 280). They are the most abundant human artefact, can be used for sexing and ageing, and can inform on the individual's diet, and health in early childhood. Enamel, once formed, does not regenerate and the erupted tooth can only be damaged *in vivo* by attrition, abrasion (both forms of physical wear), chemical erosion and disease (Buikstra and Ubelaker 1994; Larsen 1997; Hillson 2000). Dental wear is considered an age-related trait (Buikstra and Ubelaker 1994: 47). Teeth alone of all hard tissue can be observed directly without radiography or dissection (White and Folkens 2000: 109).

Enamel is the external covering of a tooth: brittle, hard and nonvascularised (not serviced by vessels), altered only by wear or decay. With no link between enamel and the rest of the body, there is no remodeling, no exchange of minerals, and no replenishment of damaged enamel. Enamel is a fossil when created, being made of up to 97% mineral content with virtually no organic component (Fitzgerald and Rose 2000: 165). Because enamel forms only once at relatively predictable periods during development, it can serve as a record of the health, water and food supply of the individual during the time it was forming. Many studies have been done investigating the location and extent of enamel disruption zones in which the formation was disturbed in some way, by illness, chronic disease or inadequate nutrition (Hillson 2000: 250). These enamel disruptions usually take the form of a furrow or a pit in the enamel, or less commonly as a missing layer of enamel exposing the underlying dentine (ibid: 252). The furrows and pits have been termed dental enamel hypoplasias (Goodman and Rose 1990).

Dentin is the core of a tooth, a calcified connective tissue that is softer than enamel and yet harder than other body tissues (Fitzgerald and Rose 2000: 165). Dentine can survive when enamel has been worn away and still be maintained as an occlusal surface; however once exposed, dentine wears more quickly than enamel. If the tooth is worn away slowly, secondary dentine can form to protect the pulp cavity. A broad method of ageing correlates the wear patterns observed on the occlusal surfaces of molars, with the wearing down of cusps, followed by enamel, with the eventual exposure and abrasion of dentine (Bass 2005: 299; after Brothwell 1981).

Over time, the contact between teeth of the upper and lower jaws with food items or with each other will lead to wearing of the enamel, termed variously as attrition or abrasion (Brothwell 1981: 71; Larsen 1997: 247). The biting and chewing surface of a tooth is called the occlusal surface. The loss, via attrition, abrasion or erosion of enamel on the occlusal surface has been used as a method of determining relative age within a population: heavily worn teeth, with enamel removed and dentine exposed are presumed to be from someone older than an individual with minimal tooth wear.

Brothwell (1981) has created a widely disseminated surface wear chart, which is simplified for this protocol. In the Inventory section, a general query with multiple choices ('select as many as necessary') enquires if teeth are missing, with the empty holes indicating they fell out after death; if the jaws have wide empty spaces, which indicates the tooth or teeth fell out during life with enough time for the hole to be in-filled; if the teeth have caries (cavities, decay: see paleopathology below); if teeth overall are 'unworn (like new)'; 'mild wear (some flattening of cusps but no dentine exposed)' and so on. These are expanded to individual queries in Paleopathology.

These observations may seem straightforward, but even after studying human osteology, several York volunteers struggled to discern much difference between what an experienced osteologist would term an 'unworn' versus a 'heavily worn' tooth (see **Chapter 3**). Therefore in the revised protocol, descriptions and choices were as explicit as possible.

4.3.1.2 Older Adults: Age-Related Changes in Skull and Pelvic Bones

Late-fusing epiphyses such as the medial clavicle and the two most superior sacral elements (S1 and S2) can help determine the age range for a young adult (Scheuer 2002a). Cusp wear and dentine exposure of molars, used in conjunction with fusion of these two regions and the appearance of the pubic symphysis and auricular surfaces in the pelvic bones also support age estimations between age 25 to 35 (Bass 2005: 298-299). But once growth has been completed and all teeth have erupted, it is only the rate and extent of how we deteriorate that can be used to assign age estimates (Saunders 2000; Scheuer 2002a; Lewis 2007). The three stages of skeletal maturity can be broadly described as development, maintenance, and senescence (Scheuer 2002a: 302). Indeed it is suggested that dividing the life span into three intervals, "juvenile or pre-adult, prime adult, and old adult" (Chamberlain 2006: 16) reflects the uncertainty in age at death estimates and allows for broad paleodemographic analyses, such as the Dependency Ratio, which compares the old and young in a society to those in their prime (ibid: 17).

Scholars struggle to agree on what constitutes traits of 'old age'. Candidate traits include extent of cranial vault fusion (Meindl and Lovejoy 1985); dental attrition (Brothwell 1981; Hillson 2000); rib-end morphology (Isçan *et al.* 1984); degree of osteoarthritis (Jurmain 1999; Waldron 2009); and alterations and deterioration of certain pelvic bones, the latter examined and tested for almost one hundred years (Todd 1920, 1921a; Lovejoy *et al.* 1985; Meindl *et al.* 1985; Brooks and Suchey 1990; Đjurić *et al.* 2007). In 1985, an entire issue of the *American Journal of Physical Anthropology* (volume 68, pp 1-106; 281-289) was devoted to a critique of past ageing techniques, with recommendations for new methods. Following the initial burst of enthusiasm, tests and re-evaluations of these new or revised methods began to appear.

Cranial suture methods have been systematically examined and tweaked since the time of Todd (Todd and Lyon 1924, 1925a,b,c); and despite most workers continuing to use them only in support of assessments based on other traits, some have long regarded ageing the individual using cranial suture obliteration as so fraught with inconsistencies as to be avoided (Singers 1953; McKern and Stewart 1957; Powers 1962); or used with caution (Krogman 1962). The cranial vault is formed of seven separate external plates with rounded margins at birth; these enlarge and develop complex, irregular margins in childhood and fuse during adulthood (Scheuer and Black 2004). Fusing earlier than age 7 can lead to developmental issues (Krogman 1962; Ortner 2003).

The more successful methods utilise age-related stages in the pelvic bones, specifically the pubic symphysis (Brooks and Suchey 1990; Đjurić *et al.* 2007) and the auricular surface (Buckberry and Chamberlain 2002), but these observations are imperfect. The suggested age ranges that pubic symphysis studies provide, even on documented remains, are very large in the mid to older phases, with for example the fourth phase (out of six) giving an age range of 26-70 for females and 23-57 in males (Brooks and Suchey 1990: 233, Table 1). The large North American samples studied to obtain Todd's (1920) pubic bone age-related changes are based on the remains of poor blacks and whites born the late 19th and early 20th century, and sample bias is undoubtedly present; in addition, the age was based on external appearance of the deceased (Mays 2010: 66). There are indications that extreme work and/or trauma can prematurely age the individual and thus affect the pubic symphysis and auricular surface (Molleson 1995; Buckberry and Chamberlain

2002: 232; Mays 2010: 67-68), and disease or trauma-related bone changes can obscure the traits used for ageing and sexing. Population and temporal variation as well as an individual's unique set of genetic and lifetime circumstance also affect traits used for ageing (Ubelaker 2000). Finally, techniques for estimating age at death and biological sex have been developed using certain assemblages, but are then applied to individuals from entirely different geographic locations and different time periods, with uncertain results (Ubelaker 2000: 53). Therefore, whilst the auricular surface and pubic symphyseal face and margins are used in the protocol, they are utilised broadly: furrowing (or billowing) and 'transverse organisation', considered youthful features are queried (after Brooks and Suchey 1990; Buckberry and Chamberlain 2002: 233) as are macroporosity of the auricular and pubis, and rim formation and face deterioration on the pubis which are considered traits associated with maturity and older ages.

4.3.2 Determination of Probable Sex

Another area of ongoing research is the basic question of probable sex, sometimes referred to as 'gender', which is incorrect (Walker and Cook 1998). Sex is biological and is reflected, for most of us, genetically by our chromosomes, while gender refers more to societal roles and expectations. For sex determination, any information on the provenience of the remains is helpful, as there are osteological sex characteristics that vary widely depending on the population. As discussed in the section on NAGPRA (**Appendix 1.A**), due to variation in robusticity, the skull of a Native American female can resemble that of a European (white) male (Rhine 1998). Similarly, crania from Balkans males can be inaccurately sexed as female, again in relation to relative morphology, in this case gracility of the skull as compared to other white European males (Đjurić *et al*. 2005).

Assuming the remains are from an identified population, estimates of biological sex are based on characteristics in the skull and in the pelvic bones, diameters of the rounded articular heads of the femur and humerus, overall size and robusticity of long bones, and on the relative size of teeth (Bass 2005). Determining probable sex depends on having comparative materials from other members of the source population (Ubelaker 2000; Đjurić *et al* 2007). Natural human variation within populations and thus between members of the same, contemporaneous group can confound estimations of sex; failing to consider temporal and spatial variation between populations can also lead to errors.

As more cemetery studies are completed using remains that can be identified by age and sex, and potentially corroborated by parish records (Grauer 1995; Saunders and Herring 1995 are edited volumes of studies using historic cemeteries), it is becoming apparent that sex characteristics change during the adult years, even those presumed particularly reliable, such as brow ridge robusticity and the relative size of the mastoid processes (Meindl *et al.* 1985b; Ramsthaler *et al*. 2010). Most worryingly (or to be optimistic, presenting new challenges and opportunities), our traditional age and sex determinations, based on studies of undocumented archaeological remains sexed via tried and true methods of dimorphic assessments, may be more tautological than we care to admit.

4.3.2.1 Sexing Using Cranial Traits

Age-related changes in the skull are due to the development of sexually dimorphic traits after puberty, or even later (Walker 1995). The release of testosterone at puberty and its maintenance afterwards leads to masculinisation (Mays 2010: 43; Walker 1995, 1998). Larger, thicker skulls with pronounced ridges tend to be from males.

In Walker's article in the Grauer collection of cemetery studies (1995), he refers to a scoring system he developed to aid osteologists in sexing crania. Using a series of line drawings, Walker illustrates the differences between male and female skulls, highlighting expansions or difference in the brow, lateral orbit, mastoid process, nuchal crest and the mental eminence (the chin).

Walker based his drawings on his examination of more than 300 skulls of known sex and age at death from several collections, including 18th and 19th century remains from Saint Bride's Church London (Scheuer and Bowman 1995), and remains from the American collections at the Smithsonian Institution and Cleveland Museum of Natural History (Walker 1995: 37). Walker discovered that a more gracile brow (supra-orbital ridge) persisted until age 30 in 29% of males from his sample, and noted that differences between young and older males was highly significant (Walker 1995: 37). Conversely, crania from older females had significant increases in supra-orbital robusticity (ibid: 38). Due to the fragility of pelvic bones, reliance on crania for sexing may result in younger males being sexed as female and older females presumed to be biologically male.

4.3.2.2 Sexing Using Pelvic Traits

Sexually dimorphic traits in the pelvic bones are considered the most reliable for estimating sex (Krogman 1962; Brooks and Suchey 1990; Bass 2005; Lewis 2007; Mays 2010). These traits develop similarly to those in the skull, as a response to hormones. It is claimed the default sex is female and that unless the fetus is exposed to testosterone, it will not develop male characteristics (Lewis 2007); even if lacking ovaries, some female characteristics will develop (Mays 2010: 43). Any number of chromosomal combinations beyond XX and XY will result in altered internal or external sexual organs, or will affect secondary sexual characteristics such as facial hair, breast development and menses (Gilchrist 1999: 57). Testosterone activates skeletal and systemic changes (Lewis 2007) during gestation, which continues with the onset of puberty. Testosterone stimulates bone and muscle growth, leading to more pronounced muscle attachments, and larger bones with wider articulations (Chamberlain 2006: 94). For females, oestrogen triggers pelvic changes related to an increased pelvic inlet, notably by stimulating pubis growth (Mays 2010: 46).

Females also tend to develop a pre-auricular sulcus or trench, an irregular, linear depression (or series of circular depressions) that curves along the inferior margin of the auricular, superior to the greater sciatic notch. This has been associated with ligament pressure during parturition (Cox 2000: 132) but can also be found in male os coxa; it can also trend with pelvic size and morphology (Mays and Cox 2000: 118). However, the trench is decidedly deeper and more pronounced in females (Cox 2000: 132; Bass 2005: 215). Another sex-related trait is found in the acetabulum; the hip socket of a male is larger in order to accommodate the larger femur head (Bass 2005).

The relatively longer pubis in the female pelvis is related to the fundamental difference between males and females: the human female pelvis has evolved to accommodate the gestation and passage of a large-brained infant, whilst still maintaining bipedal locomotion. The pubic bones are thinner and longer in the female, providing greater pelvic diameter than in the male and thus more room for a developing foetus, and a wider pelvic outlet. When compared directly, the male pelvis (including the sacrum) is narrower and has more vertical height and the female os coxae and sacrum is expanded transversely and is shorter (Bass 2005). The subpubic ramus, or the bar of bone that runs from the pubic symphysis to the ischium is thicker, straighter and more marked by muscle attachments in the male than the female (ibid: 208-210); this trait is assessed in the protocol.

4.3.2.3 Sexing Using Metrics

All professional data capture protocols involve measuring the length and several widths (mid-shaft width, proximal and distal articulations) of every major long bone, over 30 linear distances and widths from the skull, and several from pelvic and foot bones (Buikstra and Ubelaker 1994; Bass 2005). These can be difficult for a novice to properly take: many of the landmarks are subjective and not conclusively defined, and thus are not reliably located (Stewart 1954; Steele 1988: 242). Some measurements in the pelvis, such as the ischium-pubis index (Schultz 1930; Washburn 1848, 1949) are considered unreliable to measure even by professionals (Adams and Byrd 2002; Albanese 2003) and indeed failed to determine sex in 25% of remains from the 16th century wartime shipwreck of the *Mary Rose* (Drew 2013).

4.4 Questions selected for Paleopathology

> *"Disease is a part of ecology. It represents the impact of the environment and the body's reaction to it."*
> Simon Hillson (2005: 286)

Paleopathology is the study of disease and injury, as well as genetic and developmental differences. Comprehensive examination and discussions of disease and difference, from the common to the rare, are found in Aufderheide and Rodriguez-Martin's *Cambridge Encyclopedia of Paleopathology* (1998) and Ortner's *Identification of Pathological Conditions in Human Skeletal Remains* (2003). There are other textbooks with descriptions of disease and trauma (Larsen 1997; Roberts and Manchester 2005), but the first two texts are indispensable.

4.4.1 Osteoarthritis

The three most common, and most recognisable pathological conditions in the skeleton are osteoarthritis, dental disease and healed trauma (Lovell 2000: 217; Roberts and Manchester 2005: 133; Waldron 2009: 26). Synovial joints (also called diarthrodial) are fully mobile joints with articulating surfaces covered in hyaline cartilage and contained within a joint capsule. All major joints in the body, such as knees, hips and including hand and foot articulations are synovial joints; as are articulating facets in the vertebral column. Intervertebral discs are less mobile joints and are terms syndesmoses, or amphiarthroses (Larsen 1997; Jurmain 1999; Roberts and Manchester 2005; Waldron 2009 disagrees and reserves syndesmosis for distal ankle). Osteoarthritic changes in the vertebral column are termed osteophytosis and can resemble synovial osteoarthritis (OA) with porosity and bone deposits developing on vertebral bodies (centrae), osteophytes forming on centrae margins, and eburnation and enlargement in facet articulations. Due to the reduced mobility of the spine, exuberant osteophyte formation can fuse vertebrae across the disc space (Jurmain 1999).

'Early osteoarthritis', a sharpening of joint margins, trends with age, as does proliferative osteophyte development which most researchers view as peripheral to the OA process (Jurmain 1999; Waldron). If associated with muscle insertion sites, osteophytes can be conflated with enthesopathies; Jurmain prefers the term peri-articular hypertrophic lesions (Jurmain 1999: 26). Osteophytes develop adjacent to attachment of joint capsule and merge with subchondral bone and are initially capped with hyaline and fibrocartilage, indicating repair response. In advanced OA the hyaline is lost, which is linked to hypervascularisation, which is itself linked to age (ibid: 29). Only severe disease such as eburnation can truly be considered OA (Jurmain 1999; Waldron 2009.

4.4.2 Dental Anomalies and Disease

4.4.2.1 Post-Mortem Tooth Loss

This is not disease, but empty tooth sockets are easy to recognise. After death, the periodontal ligaments dry out and a tooth can be lost from the jaw. When the tooth is lost after death, the alveolar socket is empty and lacks new alveolar bone formation: it leaves a 'pristine socket' (Waldron 2009: 239).

4.4.2.2 Caries

A dental caries is a defect caused by multifactor, multi-bacterial disease that lead to demineralization of the inorganic aspects of a tooth, with subsequent destruction of organics. Caries are infectious, transmissible, and progressive (Langsjoen 1998: 402).

Caries lesions are the most common cause of tooth loss, either by physical destruction (Waldron 2009: 236) or due to the desperate removal of a painful, carious tooth (Hillson 2005: 291). The environmental conditions to promote dental decay include plaque, carbohydrates and acid.

4.4.2.3 Antemortem Tooth Loss

When a tooth is lost before death, remodeling will take place with new bone filling in the socket (Larsen 1997; Roberts and Manchester 2005; Waldron 2009); the socket is described as resorbed. Once the tooth is lost or removed, the alveolar (gum) bone is no longer needed to support the tooth and is also resorbed, with the loss eventually identifiable by a lowered space between remaining teeth. Antemortem tooth loss is caused by periodontal disease, attrition, caries, trauma, scurvy, infectious disease such as syphilis or leprosy, and extraction (Langsjoen 1998; Hillson 2005; Roberts and Manchester 2005).

4.4.2.4 Wear: Attrition, Abrasion

Hillson differentiates between attrition and abrasion. The former is associated with wear facets forming “where teeth meet” (Hillson 2005: 214) either in occlusion (usually during mastication), when upper and lower teeth come together; or in approximal wear, which is a wear facet that develops due to teeth being in contact with adjacent teeth. Abrasion occurs on surfaces that do not contact other teeth (ibid). Using the teeth as ‘tools’ can accelerate wear (ibid: 215). Modern wear is much slower than in the past; but medieval teeth cannot be calibrated amongst members of a population since no known-age, documented samples exist (Hillson 2005: 227). Tooth wear for ageing is based on molar wear (Brothwell 1981: 72; Hillson 2005: 227).

4.4.2.5 Calculus

Calculus is mineralized plaque, and requires an alkaline environmental necessary for this to occur (Waldron 2009: 240). Most researchers consider it adequate to record ‘presence’ or ‘absence’.

4.4.2.6 Periodontal Disease

The periodontium is comprised of several tissues that surround and support teeth, including the periodontal membrane which supports a tooth in its socket; the alveolar bone; and the gingiva or ‘gums’ (Langsjoen 1998: 396-397). Gingivitis is inflammation of the gingiva, caused by excessive bacteria-laden plaque that exploits space beside a tooth, packs the area with bacteria and creates a pocket or sulcus beside the tooth. Within the sulcus, increased exposure to bacteria causes inflammation and destruction of alveolar bone. This results in pitting, new bone growth and bone loss around roots (Langsjoen 1998; Waldron 2009). A plaque pocket can cause a cyst (larger than 3mm) or granuloma (under 3mm), both fluid-filled lesions and thus smooth-walled. Periapical defects are infection of the dental pulp; the abscess has a roughened wall due to new bone and a drainage canal (Waldron 2009 242-243). Involvement of alveolar bone distinguishes periodontal disease from various degrees of gingivitis (Hillson 2005: 305).

4.4.2.7 Dental Hypoplasia

Dental hyposplasias are disturbances in the formation of enamel (Goodman and Rose 1996; Hillson 2000; Waldron 2009). During dental development, crown formation begins at the tip and progresses down the body of the tooth; roots continue to grow after the tooth erupts. Any interruption of the process of enamel formation cannot be corrected at a future time: enamel forms once. Permanent incisors and canines are typically used in assessing enamel defects, of which the furrow type is most common (Hillson 2005: 170). Permanent tooth crown surfaces begin to form from about a year after birth until approximately age six (Hillson 2005: 172-173). Because these teeth are forming simultaneously, defects will be similar across crowns forming at the same time and if not, the enamel interruption is localised (ibid: 171). Age and dental disease will erase hypoplasias; using the naked eye to assess is less than ideal, due to the shiny surface obscuring very small defects (ibid). However, the largest defects will be visible; and if the dentition is at least recorded as being present, a researcher investigating dental anomalies may be persuaded to examine the remains.

4.4.3 Trauma

4.4.3.1 Fracture

A fracture is a traumatic overload of bone leading to failure; or any injury that perforates or otherwise disrupts the periosteum (described in **4.4.5.1**). Bone failure can be acute, repetitive, or related to a severe underlying condition that has weakened the bone (Lovell 1997; Ortner 2003). It is a ‘complete or partial break in the continuity of bone’ (Roberts 1991: 226 as quoted in Jurmain 1999: 185). Greenstick (bowing) fractures are incomplete bone shaft stress fractures in children and may only be noticed in the archaeological record if the bone did not have time to completely remodel (Lovell 1997; Ortner 2003). Perimortem fractures may not be easily discernible in archaeological bone due to taphonomic changes. Healing fractures are easily recognised (ibid).

Complications of fracture healing depend on the severity of the injury, exposure to infectious pathogens, misalignment or overlap of bone ends, and inadequate healing. The latter can be due to premature use of the damaged area, intrusion of soft tissue between the bone ends (non-union), or poor nutrition (Lovell 1997; Ortner 2003; Roberts and Manchester 2005; Waldron 2009). Subsequent developments due to improper alignment of joint components include OA or fusion of adjacent joints. Nerve damage can lead to paralysis, and interruption of blood supply can result in necrosis (tissue death). Finally, traumatic soft tissue damage to muscle can trigger bone growth within the muscle (Ortner 2003). Abnormally angulated or shortened elements, or those with extensive excess bone related to infectious response or ossified soft tissue should be recognisable (Lovell 1997; Roberts and Manchester 2005; Waldron 2009).

4.4.3.2 Osteochondritis Dissecans

Osteochondritis dissecans (OD) is usually a rounded, shallow lytic (bone loss) defect on the convex surface of a joint. This includes curvate distal condyles, spherical femoral heads, or the rounded articulation at the distal humerus, but OD can occur within the concave hip socket (Ortner 2003), or indeed in almost any joint (Stirland 2005). Consequent to trauma, blood supply to articular cartilage is impaired leading to necrosis of cartilage and at times subchondral bone. The defect can remain as a rounded depression (Ortner 2003) and the dislodged fragment might persist as a ‘joint mouse’ (Aufderheide and Rodriguez-Martin 1998: 82-83).The most common location is the distal femur (knee); causative trauma may have been ‘shearing, side impact or rotational forces’ (Stirland 2005: 112).

4.4.3.3 Orthopaedic Injury

An injury in young adolescence, such as fall or wound and which fractures the femoral neck, or even simply interrupted its blood supply can instigate necrosis (Aufderheide and Rodriguez-Martin 1998; Ortner 2003; Scheuer and Black 2004). Aseptic (not related to infection) necrosis typically develops consequent to fracture to the femoral neck, especially if epiphyseal blood vessels are severed; and can follow traumatic dislocation of the hip (Ortner 2003).

4.4.4 Metabolic Bone Disease

Bone is a dynamic and living tissue that responds to injury, disease and activity throughout life (Krogman 1962; Aufderheide and Rodriguez-Martin 1998; Ortner 2003; Brickley and Ives 2008). Growth is termed modeling and occurs when bone matrix is laid down on cartilage templates, or forms within connective tissue. Remodeling is associated with renewal, repair (such as in fracture healing), and response to biomechanical loading (Ortner 2003: 15-16).

Metabolic bone disease is any chronic condition that disrupts the regular processes of bone formation (modeling) and bone maintenance (remodeling) or repair (Brickley and Ives 2008: 2). In a very simplified description, bone material is first produced as an unmineralised, mostly collagen new bone often called ‘woven bone’ but which is better described as ‘fibre bone’ (Ortner 2003: 19). This bone is created very quickly during growth, or following a fracture, but is inadequate for structural support (Brickley and Ives 2008: 23). Fibre bone is mineralised and then replaced by mature bone called lamellar bone. During life, bone is regularly resorbed by bone-removing cells and then replaced by freshly deposited new bone, which is mineralised and replaced: these processes remove microfractures and other minute defects, and maintain the integrity of the skeleton. These processes of removal and deposition must stay in balance (Ortner 2003; Brickley and Ives 2008).

4.4.4.1 Rickets, Osteomalacia

Vitamin D deficiency will lead to rickets in growing, unmineralised bones and osteomalacia in bones that are adding material to existing surfaces, or that are undergoing remodelling (Brickley and Ives 2008). Rickets can cause long bone shaft curvature and is a disease of early childhood when growth is most rampant.

The very act of walking or crawling can result in long bones becoming bent under the loading, with the development of upper-limb deformities as a child crawls on inadequately mineralized limbs, and lower-limb deformation in the child that can walk; the latter are more typical (Brickley and Ives 2008: 92). In addition, the accumulation of unmineralised osteoid at the ends of diaphysis, where growth occurs will result in flaring at the shaft end and an increase in cartilage formation.

4.4.4.2 Osteomalacia, Osteopenia, Osteoporosis

Bone remodeling continues throughout life, although new bone deposition is reduced as the individual ages (Ortner 2003; Brickley and Ives 2008). Due to more rapid bone renewal (also termed ‘turnover’) within trabecular bone, bone loss occurs primarily in the trabecularised joint regions of long bones and in flat bones. The loss of this supportive material can lead to vertebral collapse, and fractures of the femoral neck due to the mechanical loads and gravity-related stresses placed upon these areas (Ortner 2003: 411).

4.4.4.3 Anaemia

Haemoglobin permits red blood cells (RBC) to transport oxygen throughout the body. A deficiency in iron, which is the oxygen-binding component of haemoglobin, reduces the ability of RBC to carry out their primary function.

One response to inadequate oxygenation is to increase RBC production, which takes place in the flat, red-marrow containing bones of the skull, ribs, pelvis and vertebrae, and the ends of long bones. Haematopoietic expansion of the marrow cavities to accommodate the increased production can stress the bones, especially in very young non-adults, where the marrow cavities are already filled with red marrow to accommodate rapid growth (Larsen 1997: 32). The thickening of trabeculae and expansion of RBC-producing regions is termed porotic hyperostosis (Larsen 1997; Ortner 2003). This term applies to both the bony expansion in the orbits, known as cribra orbitalia, and the thickening of the cranial vault.

The appearance of porotic hyperostosis varies widely between populations. **Figure 2.2** shows cribra orbitalia in an indigenous American, and **Figure 2.1** shows the far more modest expression observed in medieval British individuals. Similar differences are observed between indigenous American and medieval Europeans in cranial vault porotic hyperostosis. More recently, researchers express great reservation in linking proliferative bone changes in the orbits and on external cranial vault surfaces to anaemia; similar changes can occur with infection, cancer and other metabolic diseases such as Vitamin C deficiency (scurvy) (Ortner 2003: 370) and indeed anaemia and scurvy are considered co-morbidities (Brickley and Ives 2008: 47).

4.4.5 Infections

Communicable and environmentally-dependent diseases might be present throughout a local population, afflicting the wealthy as much as the poor (malaria; tuberculosis, treponemal disease), but access to resources influences severity and morbidity (Waldron 2009). “Infectious disease is a generalised term used to describe the invasion of a foreign microorganism and the subsequent pathology caused by the host’s response…or the actual damage caused by the organism itself” (Raisor 1993: 94).

Infectious agents can be viral, fungal, or bacterial; *Staphylococcus aureus* is the most common (Ortner 2003). Once infection is introduced into the body, it creates an inflammatory response with increased blood circulation; the blood and other fluids can stimulate bone production if the periosteum and its osteogenic layer are disturbed; or cause bone loss if pressure from the fluids interrupts blood supply (Mays1999: 123). The appearance of the new bone relates to the stage of inflammation: fibre (disorganised) bone will appear like random short strands or grains. It can appear like wet sand due to the porosity. The appearance of infectious bone lesions and the state of the repair process (if any) informs on the manner in which the infectious agent is attacking the bone. If rapid lytic (destructive) activity is ongoing the interior of the lesion will appear porous from continual reactive bone formation, and margins will be ragged and undefined; if the defects are from an acute but healing infection, the interior of the defect will be more dense (sclerotic) and the margins appear well-defined (Ortner 2003). A slow and moderately progressing infection will appear somewhat in between, with defined margins rimmed by small amounts of new compact bone, but the interior still largely an open, ragged hole. Infectious disease requires a large population.

4.4.5.1 Periosteal Reaction

The periosteum is a dense, fibrous membrane that surrounds all bone surfaces except synovial joints. The internal surface is lined with bone-forming cells. Chronic periostitis, better termed periosteal reaction, instigates abnormal bone growth due to disturbances in the periosteum caused for example by trauma or infection (Ortner 2003; Lewis 2007).

Periosteal reaction in response to infection, trauma, and some metabolic conditions is not considered a disease (Ortner 2003; Brickley and Ives 2008); if due to infection, it can also be termed periosteal inflammation (Ortner 2003: 206). The new bone can appear as fibre bone, plaques, or spicules, and can be remodelled into layers of undulating, irregular bone after healing (Ortner 2003; Mays 2010). These layers may be symmetrical (Ortner 2003).

Lung disorders can lead to periosteal deposition of fibre bone on long bones, which increases on par with the duration and severity of a chronic disorder (Burstein *et al*. 1997; Ved and Haller 2002; Murphy *et al*. 2008). This is termed Pulmonary Hypertrophic Osteoarthropathy (or Osteopathy), or PHO and is also known as hypertrophic pulmonary osteoarthrophy or Pierre Marie Bamberger Syndrome. It presents as symmetrical thickening of the periosteum which can extend into the synovium, and is secondary to chronic heart or lung conditions. PHO is associated with lung cancer, tuberculosis and cystic fibrosis.

4.4.5.2 Osteomyelitis

Osteomyelitis is caused by opportunistic bacteria that invade the marrow space of bones. This is usually a chronic condition that instigates bone and tissue destruction, repair, and the discharge of necrotic tissue and pus. Macroscopically this can appear as diffuse periosteal destruction, new bone formation, and large perforating erosions of subchondral bone (Aufderheide and Rodriguez-Martin 1998; Mays 1998: 123-127; Ortner 2003: 180-183; Waldron 2009). Chronic osteomyelitis can be recognised by expanded shafts, highly irregular bone deposits, drainage canals, and, if endosteal pressure from accumulated bacteria has sufficiently restricted blood supply, necrotic bone. The endosteal bacteria moves throughout the medullary canal causing lytic destruction but also instigating internal bone growth in order to restrict the spread of infection (Ortner 2003: 185).

4.4.5.3 Tuberculosis

Tuberculosis (TB) is an airborne disease transmitted by infected humans or animals that can also be contracted from eating food products of an infected animal (Waldron 2009: 92). TB commonly affects vertebrae and ribs as the infection spreads outward from the lungs (Aufderheide and Rodriguez-Martin 1998, Ortner 2003). Only a few vertebrae might be involved but the bone destruction is not accompanied by repair and the severe destruction can cause affected vertebrae to collapse. The resultant spine deformity, an angular kyphosis is pathognomic of vertebral involvement and is called Potts Disease. Less than 10% of TB sufferers show skeletal evidence of the disease (Aufderheide and Rodriguez-Martin 1998; Santos and Roberts 2001; Ortner 2003; Waldron 2009: 91 claims 2%), but lesions are observed in individuals with pulmonary TB (Santos and Roberts 2001). TB can instigate proliferative new bone on visceral (inner) rib surfaces and on long bone shafts, as well as on scapulae, clavicles and the sternum (Santos and Roberts 2001; Matos and Santos 2006).

4.4.5.4 Syphilis (Venereal and Non-Venereal)

Treponemal infections can be venereal and non-venereal, with the latter found in tropical and arid regions (yaws and bejel respectively). A fourth treponeme, pinta, affects soft tissue only and will not be considered in relation to skeletal lesions (Ortner 2003). Diagnostic features include symmetrical involvement of limbs; severe periosteal and cortical destruction; endosteal bone growth resulting in medullary obstruction; hypervascularisation; gummata; expanded bone shafts; and joint destruction with erosive arthropathies. Large irregular destructive lesions on the skull, termed caries sicca are considered diagnostic (Ortner 2003; Powell and Cook 2005).

Trabecular bone is normally associated with the epiphyses and metaphyses of long bones, but is found within the mid-shafts of bones affected with treponemal disease and is a pathognomic feature (Powell and Cook 2005).

4.4.6 Obscure, rare, specialist or controversial

4.4.6.1 Cranial Modification

Beginning almost immediately after birth, the soft thin skull of an infant can be shaped using bands tied around the skull, flat boards tied to the front of the skull, rear or both, with the end result a cranial shape that is identified with the population that practices the technique (Rouse 1992; Aufderheide and Rodriguez-Martin 1998; Ortner 2003). The use of cultural modification is more closely identified with indigenous Caribbean (Rouse 1992), North and South American populations, but is not unknown among prehistoric and medieval Europeans, the Near East, Australia, and African populations (Roberts and Manchester 2005: 86-87).

4.4.6.2 Premature Cranial Synostosis

Estimating possible age at death using cranial suture closure patterns has been investigated for as long as the skull has been examined. However, premature fusion of cranial sutures will result in that area of the cranial vault ceasing to expand, with other regions continuing to grow (Ortner 2003) which will alter the shape of the skull. Aufderheide and Rodriguez-Martin (1998) describe premature fusion as a "normal process that occurs at an abnormally early age" (ibid: 52). Craniostenosis is relatively benign if occurring after age 7, when maximum brain volume has been attained (Ortner 2003). With early fusion along the sagittal (midline) suture, the skull may be elongated due to continued expansion at the occipital (Aufderheide and Rodriguez-Martin 1998; Ortner 2003). It has been observed that crania with evidence of premature suture fusion have misaligned mastoid processes.

4.4.6.3 Lumbosacral Transitional Vertebrae

'Lumbosacral transitional vertebrae' (LSTV) is assimilation of the lowest lumbar vertebra and the sacrum, termed a sacralised lumbar vertebra; or a first sacral vertebra that has failed to fuse to the other sacral vertebrae and thus remains mobile, and which is termed a lumbarised sacrum. Such vertebrae are described as having 'transitioned' to the adjacent vertebral type (Abitbol 1987; Aufderheide and Rodriguez-Martin 1998: 65-66; Barnes 2008). A sacralised fifth lumbar vertebra presents as a sacrum with six segments. The anomaly is presumed to be congenital (Barnes 2008; Tague 2009).

4.4.6.4 Schmorl's nodes

Schmorl's nodes are ubiquitous depressions on the superior or inferior vertebral bodies that are of uncertain paleopathological significance. Indeed some researchers have long been aware of their dubious importance (Jurmain 1999: 163-5), and yet investigators continue to record them and report their prevalence. Schmorl's nodes are frequently observed both archaeologically and clinically. Recent conference papers deride the anomaly as worthy of study, but at the same time request additional data on their ubiquity and thus in this spirit the anomaly is recorded in this protocol.

4.4.7 Conclusion

The text of the protocol is found in **Table 4.1**. The theoretical foundation for queries on sexing, ageing and paleopathology is based on the sources cited above in

Sections 4.3 and **4.4**. For questions related to physical counts of elements (how many carpals; how many phalanges), or for selecting the condition of remains (fairly complete, in fragments) no theories have been provided.

4.5 The Protocol as Tested in Winchester 2012

Table 2.1 provides the text of protocol as it was tested in 2012, over a three-week period. Details of the Winchester experiment, including Materials (skeletons, volunteers, laboratory space, osteometric boards), Methodology (recruiting volunteers, selecting skeletal specimens, supplying and scoring the protocol) and the Results are in **Chapter 5.**

The actual 2012 Answer Sheet with supportive illustrations and full explanatory text (the slightly modified version: see **Chapter 5**) can be found in **Appendix 2.** During the March 2012 test of the protocol, seven queries on Inventory (presence of element; condition) were added to the Inventory segment; one elaboration on a vertebral anomaly was added to the Paleopathology segment. All final queries, including the eight added in after the first week of testing are included below. All versions of the Answer Sheet (Week One version, and subsequent versions) are in soft-copy on the CD.

The Information Booklet (**Appendix 3)** was created after the first week by reducing some of the more elaborate supportive text from the Answer Sheet, which streamlined the form. The Booklet follows the course of the Answer Sheet, query by query, supplying illustrations for almost every skeletal element and region assessed. The web sources for all illustrations used in the Answer Sheet and Information Booklet are in **Appendix 6.**

Table 4.1. The Rapid Assessment System as tested in Winchester in 2012 with 37 volunteers. Participants were directed to circle correct answers or tick-box the correct observation. The minimum adequate supportive text is supplied with each query, but participants were each provided with an Information Booklet (**Appendix 7**), which provides additional text and illustrations.

INVENTORY SEGMENT

Are remains already in a marked box? **Yes / No**

Are elements stored in separate bags such as Left Leg and Right Arm?

Yes Some bags No

Overall impression of remains: Fairly Complete Individual

Yes / Partial / No

Bones in **Good condition** (not broken, outer surfaces not flaking away?)

Yes/ No

I. Skull

1. a. Skull complete? Yes / No*

***IF NO → Broken into a few large pieces?** OR **Shattered?**

b. Juvenile and unfused?

2. Frontal plate (Forehead): **Sloped somewhat back to rear of skull** OR **Vertical OR Moderate** OR **N/A**

3. Raised **glabella** (lump between eyes) **Yes / No / Mild** or **N/A**

4. **Supra-orbital ridge** (ridge over the eyes) **Robust** (large, pronounced) OR **Gracile** (slight, mild) OR **Moderate** or **N/A**

5. Occipital plate (back of skull): **Robust muscle attachments**, protruding beak of bone OR **Mostly smooth** OR **Moderate** OR **N/A**

6. Zygomatic arches (cheek bones; protruding arches on sides of facial area) **Robust (thick)** OR **Gracile** (thin, fragile) OR **Moderate** OR **both N/A**

7. Lateral (outer) edges of **orbits** (eyes): **Rounded/thick** OR **Sharp/ thin/** OR **moderate** OR **Both N/A**

8. Mastoid process (lump of bone behind ear hole) **Wide and large**
OR **Small and narrow** OR **Moderate** OR **Both N/A**

9. **SupraEAM crest** (ridge over ear and mastoid process) **YES / NO /**
SLIGHT OR **Both N/A**

10. Maxilla (upper jaw and half of nasal cavity)
Left side: **Complete / Partial N/A**
Right side: Complete / Partial N/A

11. Nasal area: **Complete / Partial** OR **N/A**

12. Was skull artificially modified in life? (best noted on complete or fairly complete skulls)

a. Extreme **horizontal flattening** at front, rear, conical shape to skull)
Yes / No

b. Extreme **vertical flattening** at sides or top of skull? **Yes / No**

13. Premature suture fusion:(unusual bulges or flattened or inverted areas near squiggly suture lines) Note: premature fusion may also cause skull to appear asymmetrical.

Yes [see below] / No

→ **Only if YES, choose: Sagittal** (midline superior suture) OR **Lamdoidal** (Upside down V-shaped twin sutures at back of skull) OR **Several areas**.

14. Are **mastoid processes** (bony lumps behind ear holes) **Misaligned** and uneven when viewed from bottom of skull? **Yes / No** OR **N/A**
(Query based on author's observation on crania with premature suture fusion).

II. Mandible (lower jaw) + Teeth in both jaws

1. Is Mandible present? **Yes** OR **No**
→ If Yes: **Complete and unbroken** OR **Several large sections**
OR **Mostly small pieces**

2. a. Mandible: **Overall: Robust** (heavy, thick) OR **Gracile** (delicate, thin)

b. Is mandible **edentulous** (toothless)? **Yes** or **No**

3. Mental eminence (chin) **Squared off** (wide) OR **Rounded** perhaps pointed

OR **Moderate** OR **N/A**

4. **Condyles** (rear knobs of bone; where mandible connects to skull**) present?**

Yes / No / Partial OR **N/A**

5. Gonial Angles (rear lower angle of jaw: Jaw line): **Robust** (square, flaring outward, with ridges) OR **Rounded** (curved, thin) OR **Moderate** OR **N/A**

6. Teeth in general (both upper and lower jaws): Choose as many as necessary. **Unworn** (like new) / **Mild Wear** (some flattening of cusps, but no dentin exposted) /**Moderate** (more cusps flattened, some dentin exposed) / **Very worn or chipped** (grey or brownish dentine completely exposed) / **Teeth lost during life** with socket filled in by bone (healed over: no socket) **Teeth Missing (likely post-mortem)** with empty sockets.

III. Post-cranial bones: (all bones below the skull) **Circle best answer possible.**

1. Long bones (arms and legs). Three arm bones and three leg bones per side.
All 12 present and look complete [**please refer to sketch**] OR
All 12 probably present but one or more broken into large sections OR
Can't be sure if 12 present, Most broken or Fragmented, many small sections OR
No long bones and/or very few fragments.

Note: if long bones missing or too fragmented to assess, please skip to Section IV.

2. Overall size of larger long bones (femur, humerus, tibia) **if probably adult**
Large, heavy, and "robust", with pronounced bumps and ridges (muscle attachment sites), OR
Smallish, thin, smooth and "gracile" (few muscle attachments are noticeable) OR
Moderate.

3. Joint areas: found at the ends of long bones, where one bone joins (articulates) with another
Look Complete OR
Fairly complete, some edges broken OR

One or two missing entirely (broken off) OR
Most joint areas missing.

4. Patella. **Both** present **One** present **N/A**

IV Clavicle (collar bone) and Scapula (shoulder blade), and Ribs

1. Clavicle: Is the **Medial** end (the flaring, cone-shaped end) **Immature and unfused** (example: wrinkly, with ridges) OR **Mature** (flat, rounded, ragged) OR **N/A**

2. Left and Right clavicles present? **Yes Both** **One** **N/A**

3. Left and Right scapulae present? **Yes:** both in good/fair condition
One in good condition **Both Fragments** **Both N/A**

4. Ribs

a. Costal ends (toward front, not toward spine/vertebrae**)** **Flattish/wrinkly** appearance **(**youthful) **Yes / No** [if No see below] OR **N/A**

b. → If No: **Cup-shaped** or **V-**Shaped with s**mooth/round scalloped** edges**?**
Yes / No [if NO see below]
→ If No: **Deeply excavated with ragged/thin/uneven** edges? **YES**

c. Condition of Ribs: **Complete** / **Large sections** / **Fragments**/ **N/A**

V. Vertebrae:

1. Are there any vertebrae? Yes No

2. Do the vertebrae appear to be complete or mostly complete? Yes / No

How many vertebrae in total? OR **N/A** due to fragments C ___ T ___ L ___

VI. Wrist, Ankle, Hands, Feet, Fingers and Toes (Carpals, Tarsals, Metacarpals, Metatarsals, Phalanges)

1.Carpals (small, squarish and irregular) ___ (8 each hand, 16 in total)

2.Metacarpals (short tubular bones, with rounded heads and squared bases)
___ (5 each hand, 10 in total)

3. Phalanges: (fingers tend to be flatter, toes narrower at mid-shaft)
___ (14 each hand, 28 in total)

4. Tarsals (larger, some like triangular cubes. This includes the heel)
___ (7 each foot, 14 in total)

5. Metatarsals (short tubular bones, with narrower heads and squared bases)
___ (5 each foot, 10 in total)

6. Phalanges: (narrow at mid-shaft) ____ (14 each foot, 28 in total)

VII. Os coxae (pelvic or hip bones)

1. Are **pelvic bones: Complete**? **Fairly complete**? **Shattered?**

2. Pubic symphysis (oval front region) [see sketch**]** present?
Yes / Yes but partly broken No, N/A: pubic symphysis broken off.

3. R and L symphyses present? **Yes / NO: R present** OR **L present**

4. a.Pubic symphysis surface **Billowy (**wrinkly; furrowed)? **Yes / No /**
Slightly OR **Flat** surface **Yes / No**

b. If flattish, are there irregular '**ragged' holes or bony growths? Yes / No**

c. Pubic symphysis edges: Is **front (ventral) edge** flattened? **Yes / No**

d. Sharp/distinct rims (edges) Both **Yes /** Both **No** OR **Only one edge**
(front or back) with sharp rim

e. Ragged irregular edges Both **Yes / B**oth **No** / OR **Only one edge**
(front or back) ragged

5. Sub-pubic Ramus: strut of bone branching off below oval **Pubic symphysis:**
Thick, vertical? at ~45 degrees, descends directly from oval pubis face OR
Thin, flaring, curved away from pubis?, with small neck between pubis and downward arc of ramus

Rear of pelvic bones.

6. Greater sciatic notch (deep curve at back of each hip):
a. Deep, narrow, perhaps tilted back to rough and raised articulation for sacrum OR
Wide, shallow, symmetrical OR **Intermediate** OR **NA**

b. If both hips present: **Do Left and Right** sciatic **notches match**? **Yes / No**

7. Outer side of pelvic bones**: hip sockets.** Are the **rims: Round/oval** with firm edges OR **Irregular,** 'bumpy' rough OR **Very uneven**

8 . Auricular Surface (ear-shaped region near back of pelvic bones**) Billowy**, solid, with gently rounded wrinkles? **Yes / Yes some / No N/A**

OR **Rough, irregular**, ragged appearance, 1mm holes, tiny sharp peaks**?**

Yes / Yes some No N/A OR **Intermediate?**

9. Pre-auricular sulcus (a trench, a groove) below auricular surface

Yes wide, pronounced OR **Yes mild** OR **No N/A**

10. Is the **sacrum** present? **Yes / Yes** but broken **/ Yes** but fragments **/ No**

11. Are all the **sacral segments fused into one bone? Yes No**

12. If fused onto one bone, is there a **gap** or opening between **S1 and S2?**

Yes / No Yes fused, but fusion line still visible.

LONG BONE LENGTH: THE FEMUR.

Length (mm) L femur: MAX Total Length _____mm or N/A

Diameter (width) of Head _____mm or N/A

R femur: MAX Total length: _____mm or N/A

Diameter of Head _____mm or N/A

PALEOPATHOLOGY SEGMENT

This section is not numbered, as all queries are clearly separated by strongly outlined boxes (**Appendix 2**). The queries request a checkmark if the trait or condition is Present, and N/A if not observable.

Dentition

Postmortem Tooth Loss: Some sockets empty, no woven bone filling them in, some teeth in place

OR No teeth. All sockets empty but 'clean' and without spongy bone.

Caries (tooth decay). Mild. One or two small yellowish marks or small holes on sides or tops of teeth

OR Moderate. One or two very large caries,

OR Severe. Many large caries more than three teeth hollowed out.

Tooth Lost during life. Mild: One, two, even three sockets filled in with bone.

Moderate.Severe: most or all teeth lost before death, with sockets filled in.

Worn/chipped teeth. Mild: some dentin exposed through enamel

Moderate/Severe: most teeth worn flat, or to angle, or broken off.

Calculus: hardened substance on teeth; resembles 'cement'. Can be at base of teeth or 'gum line'.

Periodontal disease. Mild or moderate: small amounts of raised, porous (spongy) bone around the base of some teeth.

Severe: Large holes in body of jaw, exposing tooth roots.

Dental Hypoplasia. Ridges or furrows on front surfaces of canines or premolars (not front teeth)

Skull: abnormal bone deposits and bone loss

Inside orbits on roof or at sides: unremarkable

OR: **slight holes** on roof or internal sides of orbit

OR: **more holes**, may resemble spikes of bone

May include deposited bone accumulated on inner surface of orbits; may resemble wet sand.

Outer skull (not including face). Unremarkable.

Or: thick brownish **deposits** on skull. In patches small holes close together, may cover large areas of skull surface

and/or small roundish **bumps**

and/or **small** patches of **bone loss** on outer skull: perhaps 15-20mm diameter
and/or **large** patches of **bone loss**: can be quite extensive with irregular edges.

Skull vault thickness only if skull is in fragments. If not broken please skip next two boxes.
Vault fragments: unremarkable, average thickness is well **under 10mm**
OR: skull vault fragments **thicker than 10mm**

<u>Long Bones: Joint areas</u> Appearance on most or all of bone joints, including hip sockets

Healthy: Joint edges generally smooth, no bony lumps (osteophytes), no holes or shininess.
OR: Most joints overall: **sharpened edges**, small patches of shininess (eburnation), small round bony lumps (osteophytes) on joint surfaces or around egdes.
OR: Several joints **extremely abnormal**.
Local injury or disease in **ONE joint**? Only if Yes please complete section, otherwise skip next two boxes.
Upper Limbs (arms)
Lower Limbs (legs)

<u>Vertebrae: spinal column</u> Appearance of the vertebral body (centra) on top, bottom, sides and contact facets.

Cervical (neck) vertebrae: saddle shaped bodies and oblique contact plates (facets) **look smooth** or otherwise remarkable.
OR: Some saddle shaped bodies **look porous**, ‘moth eaten’, contact facets enlarged, with foamy appearance
OR: As above but **more extreme**. Facets may be shiny (eburnated)
OR: Bodies may be **fused together**.

Thoracic (chest, rib) vertebrae: Heart shaped/roundish bodies and vertical contact **facets smooth**. No bony growths (osteophytes) on edges of vertebral bodies.
OR: A **few osteophytes** (rounded bony growths) on two or three bodies. Contact facets widened and flattened, rib articulations may be deepened and enlarged.
OR: Same as above, but contact facets enlarged with foamy appearance; maybe with regions of **eburnation** (shininess). Increased osteophytes.

OR: **Osteophytes severe**. Several vertebral bodies may be fused together. Eburnaton or porostisy (holes due nto bone loss) at articulatjions. Bodies may be abnormally flattened compared to other T verts.

Lumbar: oval/kidney shaped bodies ith curved contact facets **smooth**. Sides of bodies are relatively vertical.
OR: A **few osteophytes** (rounded or spiky) on one or two bodies. Facets widened and porous. Sides of vertebral bodies may be concave.
OR: **Osteophytes on most** lumbar bodies. Vertebrae may be fused. Eburnation and or porosity at articulations.

If **vertebrae are fused** together, is there a smooth sheet of bone down the front of the vertebrae? It has been described as resembling melted candle wax. Skip if not applicable

Fractures: healed injuries

Single Fracture long bones: **well healed:** slight greyish ring of raised porous bone around shaft (callus) or mild angle or bend to one bone shaft or small bulge on bone.
OR: **Badly angled or overlapping** bone. May be associated with one small round edged hole.
OR: Badly angled or overlapping, **with round-edged holes**; unusual bony lumps, patches of raised bone that may be quite extensive.

Multiple fractures long bones. **Well healed:** slight greyish ring of raised porous bone around shaft (callus) or mild angle or bend to one bone shafts (is this rickets?)

Single fracture ribs: **well healed**: slight raised ring of greyish bone, or mild atypical angle or bulge on rib shaft.
OR: **Poorly healed** / poorly set: associated with roundish-edged holes, patches of rasied bone and/or moth-eaten bone with holes.

Multiple fractures ribs. **well healed:** slight raised ring of greyish bone, or mild atypical angle or bulge on rib shaft.
OR: **Poorly healed** / poorly set: associated with roundish-edged holes, patches of rasied bone and/or moth-eaten bone with holes.

<u>Cortical thickness</u>: Bone shaft 'walls'. (with supportive illustration and text)

Upper limbs (arms): cortical bone exposed mid-shaft: **Normal** bone in comparison to size of shaft
OR: **Abnormally thickened**, with very narrow medullary cavity in comparison with overall width of shaft
OR: **Thin** cortical bone in comparison to rest of shaft
OR: **Abnormally thin bone**, almost as thins as a piece of paper: 1mm or less in thickness

Lower limbs (legs): cortical bone exposed mid-shaft: **Normal** bone in comparison to size of shaft
OR: **Abnormally thickened**, with very narrow medullary cavity in comparison with overall width of shaft
OR: **Thin** cortical bone in comparison to rest of shaft
OR: **Abnormally thin bone**, almost as thins as a piece of paper: 1mm or less in thickness

Trabecular (spongy) bone in **any mid-shafts?**

<u>Muscle Attachment Sites</u>

Long Bones Upper limbs (arms): Raised lines, ridges or humps present and **noticeable**
OR: Large **ragged ridges** with scooped out defects near and within muscle sites.
OR: Almost **non-existent.** Can be felt with fingers more than seen; or very mild.

Long Bones Lower limbs (legs): Raised lines, ridges or humps present and **noticeable**
OR: **Large ragged ridges**, scooped out defects near and within muscle sites.
OR: **Almost non-existent**. Can be felt with fingers more than seen; or are very mild.

<u>Miscellaneous traits or pathologies</u>

Endocranial (inner) skull vault **defects**. Can only be seen on broken or partial skull. Bone loss seen on inside curves of skull vault: any defect with ragged or rounded edges on inner vault surface.

Vertebrae possible infectious disease: Scooped out areas of **destruction** on vertebral body.

Lumbar vertebra fused to sacrum. Abnormal growth, fusion. May be partial: one side of L5 fused to sacrum, or on both sides.

Vertebrae “Schmorl’s nodes”: irregular smooth sided **depressions** on top and/or bottom surface of a few centrae (vertebral bodies)

Ribs (any number). Bone **deposits on inside** (inner curves). New abnormally placed bone on top of the surface. May look brown, or like wet sand. may also look lumpy.
Ribs (any number) Bone **deposits on outer sides** (outside of curve).
Ribs. Fusion between two or more ribs. **Bridge of bone** between ribs.

Long bones: Abnormal bone (inflammation, infection)
Mild: One long bone, tibia for example, with **raised new bone** on surface. May be in raised rows, looking mostly dense but with some small holes. May look ‘lumpy’.
OR: **Moderate / Severe: Widespread** on tibia, other long bones. Thickened abnormal deposits may be extensive. May be arranged in linear manner in raised smooth rows.

Lone bone shaft chronic conditions that involve outside and inside of bones. May have spread to joints.
Healed (two options) and **On-going** (third option). may select one from healed and on-going

Long bones and related joints: **Mild: dense, lumpy bone** with one or very few small defects (holes) with smoothed edges. One or two bones only
OR: Healed **moderate/severe: larger defects, more widespread** over several limbs, but with smooth margins and no ragged edges, no spicules (spikey bone) inside of defects.

Active, on-going: Holes trimmed with spikey bone, **ragged irregular edges**. Defects can be quite large. Patches of spikey bone on shafts, often surrounded by raised rim of rough bone.

Orthopaedic injuries or bone/joint abnormalities

Humerus head: odd shaped, small rounded **defects,** head **flattened**, head partly missing
Femur head: odd shaped, small rounded **defects**, head **flattened**, head partly missing

Joint defects: in lower humerus or femur, anywhere on radius, ulna, tibia:

Mild: Small defects on inside joint surfaces, bone chips missing (1-2mm), tiny bone fragments added, small edges missing off joints. One or two surfaces.
OR: **Moderate/severe: Small defects, widespread** over many joints, or very **large sections (3mm+)** missing from two or more joints.

Sacrum: odd shape. Rather **straight** or **very curved** (even bent or folded). Too **long** (6 segments) or **too short** (less than five segments).

Rickets mild: Long bones with **curved shafts,** especially lower limbs. Some bowing, but matched between left and right
OR: **Moderate/severe: More widespread**, on upper as well as lower limbs, **marked curves.**
Rickets: possible indication: **ribs with extreme curvature**
Rickets: possible indication: **Scapula: blade curved noticeably**

4.6 Methodology II Conclusion

Subsequent to expanding and redesigning the protocol, a new test of the system using volunteers was held in Winchester during March 2012. The following two chapters, **Chapter 5** (Results) and **Chapter 6** (Discussion) detail the Winchester experiment. The Conclusion (**Chapter 7**) will discuss the 2012 test and make suggestions regarding this project.

Chapter 5: Assessment Protocol Tested in Winchester

Photograph 5.1: Student volunteer Week 1 (session 1B) (R Drew photo).

This chapter details the Results from the second test of the RAS. The Methodology employed in the three week Winchester 2012 trial is explained, and the overall Results are examined. Specific results for each weekly segment, each of the four groups of volunteers and each skeletal specimen are also included. **Chapter 6** will follow on from this chapter with a detailed examination of the findings, and with a Discussion.

5.1 *Winchester Trials*

When organising the Winchester test of the protocol, one goal was to minimise the issues that were revealed during the York experiment. The form was redesigned, and a special effort was made to increase volunteer participation.

Setting up the Winchester test required obtaining access to resources such as skeletons **Table 5.1**) and lab space, and recruiting volunteers (**Table 5.2**) (Materials). The testing methodology for the revised protocol needed to be determined, and dates selected for volunteer sessions that would be amenable to the maximum number of participants (Methods). Each aspect is addressed below.

5.2 Materials

5.2.1 Volunteers for Win RAS trials

In order to improve the analysis of a new trial, it was recognised that the number of skeletons assessed would need to be somewhat similar to the number assessed in York; and that more than 15 participants were required. Access to specimens would be straightforward as University of Winchester curates dozens of skeletal remains. The second condition could also be easily met due to two circumstances: the Winchester area has several active clubs for amateur archaeologists who participate in community archaeology projects such as the Winchester Archaeology Rescue Group (WARG), and New Forest History and Archaeology Group (New Forest); and first year undergraduates were keen to participate in the study.

To avoid inadvertently causing emotional upset among the volunteers, every effort was made to ensure they were aware that human remains would be handled. A statement briefly outlining the project and requesting volunteer help, applicable for both types of participants, students and adult members of archaeological groups, was composed. The methodology was described as requiring volunteers to view and handle human skeletons whilst recording observations on a form in a simple ‘check mark’ style. No experience was necessary and indeed those without experience would be important for the study, but any volunteers would need to be prepared to see and handle skeletal remains. Department staff then forwarded the statement to several area historical societies, and it was circulated on the department email listserve. Two of the three archaeological groups that were contacted agreed to send out emails to their members, and also advertised the study in their newsletters.

5.2.1.1 Recruiting Adult and Student Volunteers

Every effort was made to ensure volunteers were fully cognizant they would be observing and indeed handling human skeletal remains.

The following is the text of the first email sent out:

Would you like a chance to handle human skeletal remains this coming March, and to ALSO help further scientific investigation?

Hello, my name is Rose Drew and I am a PhD Candidate at University of Winchester. For my dissertation project, I am investigating preliminary assessment techniques for cataloguing human skeletal remains. I am looking for volunteers who can commit to attending trials of my assessment protocol, which will be held weekly for 3 weeks. The time commitment is a few hours each session, and I will reimburse volunteers for their time at £2 per session and a £5 bonus for everyone who completes all three sessions.

The system I am working on is a basic system for observation of human skeletons, as in a museum or lab setting. Human remains will be handled, so you have to be okay with that. Ideally, everyone who participates will enjoy a chance to study remains, will learn something about the human skeleton, and AFTER all the sessions are done, I will be delighted to answer a few questions you have about remains.

I am testing several types of volunteers: students, both with and without experience of examining skeletons; field archaeologists; museum curators who may or may not work with remains but who nevertheless are familiar with handling fragile and unique artefacts; and finally, human bone specialists, who will be used as "controls" and thus verify my own assessments. (Anthea, Katie, I mean you.)

The dates for assessing remains are Weds March 14, 21, 28 for students, and Tues and or Thurs (based upon volunteer availability) of those same weeks for non-students. The remains will be drawn from the Winchester collection of skeletons found during recent field work, and the volunteer trials will take place in Medecroft in the teaching labs.

Thank you in advance!!!

Rose Drew

I can be reached by cel and by email at:

Over forty potential volunteers responded to the call for volunteers. Adult (WARG and New Forest) volunteers who asked for additional information received the following reply:

Dear Volunteer,

Thank you for responding to my request for participants.

My project deals with how human remains are initially assessed at the lab or museum level. Some remains from less-than-famous sites might sit in storage for years; or are considered sensitive and must be reburied quickly. As you may know, rules are currently in place requiring ALL archaeologically obtained skeletons to be reburied within 2 years! So, a preliminary system, administered by existing museum staff or inexperienced but careful novices may at least help identify remains that could prove useful for scientific and cultural studies.

The sessions will aim to be around 2 hrs. We will be looking at human skeletons, using a check list questionnaire. The participant circles the best answer or checks a box, and thus captured observations on the remains in a non-judgemental way that aims to not require expertise with remains.

We have a wide range of experience. Some participants have actually washed and catalogued these remains before, whilst others have never actually seen a human skeleton up close, ever.

On Tuesdays, we cannot get in before 11 am, and on Thursdays we need to be out of the lab for a 3 pm class. Therefore the optimal time to run the sessions is from noon to 2.30 pm (including a break). I have a few volunteers coming in at bang on 11.30 on Tuesdays, and one or two that need to come a bit late on Tuesdays. So on Tuesdays I will be in the lab from 11-ish to after 3 pm.

Rose Drew

Students who enquired further received this reply:

Dear Volunteers,

Thank you for responding to my request for participants.
My project deals with how human remains are initially assessed at the lab or museum level. Some remains from less-than-famous sites might sit in storage for years; or are considered sensitive and must be reburied quickly. As you may know, rules are currently in place requiring ALL archaeologically obtained skeletons to be reburied within 2 years! So, a preliminary system, administered by existing museum staff or inexperienced but careful novices may at least help identify remains that could prove useful for scientific and cultural studies.

The sessions will aim to be in the 2 hr range, and consist of examining skeletons already laid out while marking off checklists or circling the "best choice" answers. Because of the enthusiastic student response, I will run 2 sessions on each of the Wednesdays: 11 to 1 pm, and 2 to 4 pm. Please let me know your preference, but also please tell me if you cannot be in one particular session. I will take your availability into account.

Due to the size of the lab and the required number of specimens to examine, it will take at least 2 weeks to fully assess all the skeletons chosen for the study. I am pretty sure we will need all three sessions. If there is time, the third session will test the ability of the non-expert to lay out remains from scratch. Again, thank you for volunteering. If you have changed your mind, or now have a friend or two who may want to take part, please let me know.

Thanks
Rose
(mobile number provided)

As the list of potential volunteers became more definite and the selected testing dates drew near, a third email was sent out to the WARG and New Forest volunteers who had replied with great enthusiasm, and seemed most likely to participate. This email provided additional details such as the testing location and the exact times for sessions.

Assessment Protocol Tested in Winchester

Thank you for answering my request for volunteers. I am delighted at the response.

Here is a link to the campus map.
http://www.winchester.ac.uk/contactusandmaps...

We will meet in the Medecroft Building, No 19 on the map, in Room 21 in the basement. I will have signs up to help.

Parking!
However, I have been mistaken about parking. If you MUST have a spot, please email me or phone me immediately (phone number provided) with the date and time you will need it, and a spot will be set aside. The South Park n Ride drops you off at the Hospital and then it is a 5-7 min walk downhill to the Medecroft Building. Please accept my sincere apologies; I am new to the Winchester campus.

The project.
As you may know, the current rules with the Home Office are for remains recently disturbed by excavation, development, etc to be reburied in 2 years, unless they are of 'significant study value'. Or, in museums, some remains have been in boxes for years, with no one able to be hired to give them a preliminary once-over.

My project is testing a data sheet that can hopefully be used by non-experts, such as yourselves, or by really busy professionals such as me who may not want to forget to look at something important. I am endeavouring to avoid 'jargon' and technical language, and aim to have the checklist be as user-friendly as possible.

We have a wide range of experience. Some participants have actually washed and catalogued these remains before, whilst others have never actually seen a human skeleton up close, ever.

Sessions
Tuesdays or Thursdays, March 13 or 15; March 20 or 22; March 27 or 29. Noon to 2.30 with some room for flexibility.

The sessions will aim to be around 2 hrs. Please allow that long to inspect all five skeletons. We will be using a check list questionnaire. The participant circles the best answer or checks a box, and thus captures observations on the remains in a non-judgemental way that does not require expertise with remains.

On Tuesdays, I will be setting up after 11 am and plan to stay until at least 3 pm. On Thursdays, we need to be out of the lab for a 3 pm class, and thus cannot work past 2.30 pm. Therefore the optimal time to run the sessions is from noon to 2.30 pm (including a break).

Thank you again for volunteering. Hope to see you all next week,

Rose Drew

5.2.1.2 The Participants

It was recognised that volunteers would be donating their time. In York, the sessions were about an hour; most volunteers lived locally and were part of an osteology group. Even so, attendance was inconsistent. In Winchester small stipends were offered as an enticement.

Altogether, 37 volunteers took part in at least one session **(Table 5.2).** Of these, 14 were first-year undergraduates from the Department of Archaeology, and most of the other 23 were (older) adult members of New Forest or WARG. Two WARG members were also undergraduate students but for this study were classified as WARG members. The affiliation for several people was unclear and they were considered to be Interested Members of the Public (IMP). The adult volunteers were late middle age or older, retired or semi-retired, with flexible schedules and were available for daytime sessions.

5.2.2 Skeletons

The study remains were drawn from the St Mary Magdalen Hospital, Winchester. This assemblage is curated by University of Winchester and is associated with a late Saxon/ Norman leprosy hospital and cemetery (Roffey 2012; Roffey and Tucker 2012; Taylor *et al*. 2013). The specimens chosen for the study are listed in **Table 5.1**. The skeletons selected for testing needed to be sturdy enough to withstand handling by members of the public with limited or no experience of remains, and were by necessity not overly fragile. Staff discussions identified eight skeletons that had been previously analysed by the project’s physical anthropologist and were not overly delicate. In case volunteers quickly assessed these specimens, additional suitable remains were identified.

The St Mary Magdalen skeletons have extraordinary retention of elements, and are well-preserved. Despite the individuals having suffered from *Mycobacterium leprae* (Hansen’s Disease: leprosy), a disease that often leads to nerve damage (Ortner 2003: 264), subsequent physical damage to fingers and toes and the loss of digits (Ortner 2003: 267-268), the recovery of small hand and foot bones is remarkable. Many specimens are stored with multiple sesamoid bones from feet and even hands, and podials are stored in separate labelled bags (R hand, L foot). Few bones have post-mortem damage, most individuals have all skeletal elements, and many skulls are complete. Each box was clearly marked with the assigned skeleton number, and skeletal elements were in labelled bags per limb. For example, 'Right Arm' held all long bones of the arm including humerus, ulna and radius.

A range of age cohorts and specimens from both biological sexes were chosen as specimens. (Determining biological sex is not always straight forward nor is phenotypic 'sex' binary; but considering chromosomal variation such as Turner's Syndrome (Saenger 1996) and hermaphroditism are beyond the present discussion.) The eventual sample was comprised of five probable males, two probable females and an adolescent probably male; in addition to the adolescent, five were adult or older adult and two were younger adult. (**Table 5.1**) The author aged and sexed all skeletons used in this study, and completed a protocol form on each. These assessments are found in the **CD Appendix Item 4, Qs to Versions 1 and 2**.

Table 5.1. Skeletal specimens used in Winchester 2012 Study. The eight specimens are listed by catalogue number, and provided estimates of age at death and probable sex as determined by the author; age and sex estimates are also in agreement with previous studies (Roffey and Tucker 2012).

Skeleton ID	Age Cohort	Probable Sex	Burial location
SK01	oA	M	Chapel
SK02	A	M	S cemetery
SK07	oA	M	N cemetery
SK09	A	M	N cemetery
SK15	yA	M	N cemetery
SK17	yA	F	N cemetery
SK20	A	F	N cemetery
SK21	Adol	M?	N cemetery

Adol = Adolescent (age 10 to 18-20), **yA** = Young Adult (approximately 18-20 to 30), **A** = Adult (28-30 to approximately 45-50), **oA** = Older Adult (45+), **F** = Female, **M** = Male. See text for ageing and sexing criteria.

Age cohorts were delineated as Adolescent (age 10 to 18-20), young adult (approximately 18-20 to 30), adult (28-30 to approximately 45-50), and older adult (skeletal maturity with pubis and auricular deterioration consistent with age 45+). Traits associated with skeletal maturity and subsequent deterioration are described in **Section 4.3.1.** Sexual dimorphism is most securely observed in the pelvic bones (Krogman 1962; Brooks and Suchey 1990) but cranial traits were considered, as were long bone and joint robusticity. Supplemental traits include scapula height, clavicle length, and sternum length especially as compared to the manubrium. These traits are discussed in **4.3.2**. Diagnosis of disease and trauma followed criteria as described in **4.4.**

5.2.3 Lab Space and Equipment

In addition to specimens, lab space for the study needed to be located. The space would need to be available for the each of the study days; have adequate space to safely lay out 3 to 5 skeletons in anatomical position; and provide enough room for participants to maneuver between tables. Ideally, a room with four 1 m x 2 m tables would permit one skeleton per table, so that volunteers could observe and handle elements easily. The space would need to be within the Department to minimise transport of fragile human remains.

Lab space in the Archaeology Department was reserved for three consecutive days a week, for three consecutive weeks in March 2012. The lab consisted of three large tables, 2 m x 3 m, which permitted two sets of remains per table for a maximum of six skeletons available at one time. However, this arrangement would make picking up elements from the side of a skeleton away from table edge awkward. This will be addressed further in methods **(5.4.4**).

Additional equipment available in the Department included five osteometric boards for volunteers to use in measuring the maximum length of a femur as well as the maximum femur head diameter. The latter is most commonly measured using sliding calipers, but this was presumed to be a specialist tool that would require training. It was interesting to see if the rough metrics obtained by placing the head between the end board and sliding board of the osteometric board would adequately record femoral head diameter. Having volunteers measure the femoral lengths with measuring tape was considered, as an osteometric board is also 'specialist equipment'; but this was dismissed. Osteometric boards (also called 'osteoboards') can be fashioned from graph paper and solid end pieces and it was interesting to see if the novices could take accurate measurements with proper osteoboards, which were on hand whereas calipers were not. This has been the author's experience over the past 14 years: osteoboards are often available, whilst calipers are rarely.

The volunteer testing was arranged for Wednesdays for students, and either Tuesdays or Thursdays for adult volunteers. All times for lab availability would need to include set-up, specifically laying out skeletons, forms and pens, and osteoboards; and break down, the latter most importantly consisting of re-bagging or re-wrapping all skeletal elements and returning all remains safely to the appropriate boxes.

5.3 Methods: Testing and Analysis

5.3.1 The Protocol

The method for testing the protocol consisted of supplying one paper form per skeleton to each volunteer, who used the form to select from a set range of answers whilst observing the skeleton. The protocol had been expanded from the 40 query version used in York (**Table 2.3**) to around 100 queries (**Table 4.1**). The expanded protocol was 14 pages including integrated supplemental text; the rationale behind each query is discussed in **Chapter 4**.

The protocol was roughly divided between inventory and age/sex assessments, and paleopathology, the latter an expanded version of the format used in York 2008. On the first page, general conditions regarding the overall condition of the skeleton were asked. Below this, the respondent was asked to record the sex and age of individual if such information had been provided clearly on the outside of an archive box. At the top of every page were spaces for Volunteer Name, Date, 'Skel/Box/Burial'.

5.3.2 Scoring and Analysis

Another aspect to the Methodology was to determine how much of the form to provide for each session. The version of the protocol to be supplied (full form of 14 pages, or partial form) would be based on various interdependent factors such as availability of confirmed participants per each session, availability of the lab room, and number of skeletal specimens to be used in the study. Skeletons were laid out in anatomical position before each session, even though providing this level of help does not mimic a 'real world' situation, in which potential end-users will visit under-funded museums to create preliminary databases of under-studied remains. However, laying out the skeletons in advance saved set up time, and maximised data collected in a minimal amount of time. The final format will provide end-users with an illustrated guide to laying out a human skeleton.

After each session, the forms were scored, using the author's results as the 'correct' answers. Answers that matched those of the author were 'correct', and scored as 1.0 point; 'incorrect' answers or unanswered queries were scored 0. Because most morphological traits that are used to estimate sex and age at death are both graduated (mild, moderate, strong/robust) and are to an extent subjective for ambiguous traits, answers that were off by one degree were scored as 0.5. For example, assessing a brow ridge (torus or supraorbital ridge) as 'gracile' when the author had selected 'moderate' was awarded 0.5 points. The 16 binary questions were either correct or incorrect and scored as 1.0 or 0.0. The scores were totaled, for each volunteer as well as each query.

Resultant scores were statistically analysed. The total number of correct answers for each query was based on the total volunteers to participate; the total score for each volunteer (per form) was based on the number of queries per form. Each form contained around 100 queries (though this increased during the three week experiment). In Week 1 there were 103 queries when counts of each type of podial and vertebra were considered individual questions; this dropped to 96 when individual podial types were considered as a total of 'hand' or 'foot' bones, and vertebral types were combined.

The analysis includes descriptive statistics on the success of each query; the successful assessment of each skeleton; and the success of each volunteer, both per form and overall. Twenty queries were identified as 'important', with results examined at the level of total participant success, as well as by group level (students versus older adult amateur archaeologists). Results are shown graphically as charts with subsections related to the three separate weeks of testing. Complete results (in the form of Excel spreadsheets) are on an accompanying CD.

Inferential statistical tests such as chi-square analysis, ANOVA, and t-test were to be applied to the data to test for between-group and within-group differences in scores from the volunteers. Results for the 20 Important Queries, as observed by multiple volunteers were compared, query by query, to measure within- and between-group variation. Statistical testing would ideally identify trends in the data capture, such as the relative success of questions types, such as binary (yes/no) versus graduated (mild/moderate/robust); and the success of descriptive terminology such as robust, gracile, abnormal bone accumulation, abnormal bone loss.

Identifying which queries were most successful, which were least successful and if there are significant differences between types of questions or target volunteers is important for ascertaining if the protocol can be successfully used by naïve workers to collect data from human skeletons.

5.3.3 Arranging Sessions and Access to Campus Lab

A range of complex, interdependent variables influenced the number of sessions and the days and dates that they could be held. Several options to minimise volunteer drop-out and thus maximise consistency of the data were considered; it was decided to test the protocol across a series of days, on contiguous weeks, with the number of participant sessions determined due to volunteer feedback. It was presumed that most volunteers would be able complete a full form in about 30-40 minutes. This estimate was based on the York trials, during which a volunteer could complete five partial forms in 20 to 40 minutes; each partial form represented 20% of the protocol.

Due to the initial response from 19 Winchester undergraduates, two separate, consecutive sessions were run on student volunteer days, with attendance limited to 10 students per Wednesday session. Similarly, local archaeological societies expressed a high level of interest with 25 respondents. These participants were divided into single sessions on Tuesdays or Thursdays with 12 or 13 participants in each session. Most archaeological society volunteers were older adults, but two were also Winchester students. **Table 5.2** lists all volunteers by Identifier; affiliation (WARG, NF, IMP, Students); and whether they self-identified as having any prior experience handling human skeletal remains.

Table 5.2. Volunteers for 2012 Winchester Trial of Protocol.. The table lists participants by their identifier, (VOL ID#), and specifies Affiliation (IMP, WARG, NF, UoW), Student or non-Student status, and any Prior Experience.

Vol ID#	Affiliation	S or NS	Exp Y/N	Type of exp
01JR	IMP	NS	N	
02IC	NF	NS	N	
03RC	NF	NS	N	
04AH	WARG	NS	N	
05GL	WARG	NS	N	
06PH	WARG	NS	N	
07RH	WARG	NS	N	
08MH	WARG	NS	N	
09CS	WARG	NS	N	
10SH	WARG	NS	N	
11JR	WARG	S	N	
12EJ	WARG	NS	N	
13MW	WARG	NS	N	
14YS	UoW	S	N	
15BD	UoW	S	Y	washed bones
16WH	UoW	S	N	
17CB	UoW	S	N	

18AK	UoW	S	N	
19KM	UoW	S	N	
20ND	UoW	S	Y	washed bones
21TR	UoW	S	Y	washed bones
22ZE	UoW	S	Y	washed bones
23MS	UoW	S	N	
24AF	UoW	S	Y	"experienced"
25SH	UoW	S	N	
26AY	UoW	S	Y	washed bones
27PF	UoW	S	Y	washed bones
28AP	NF	NS	N	
29MY	IMP	NS	N	
30JY	IMP	NS	Y	Dentist
31CW	IMP	NS	N	
32BB	WARG	NS	N	
33AB	NF	NS	Y	Bournemouth
34OM	WARG	S	N	
35JD	WARG	NS	N	
36DH	WARG	NS	N	
37IN	WARG	NS	N	

Vol ID# = Volunteer identifier; **S** and **NS** = Student, non-Student; **Exp** = experience; **IMP** = Interested member of the public; **NF** = New Forest Historical and Archaeological Group; **WARG** = Winchester Archaeological Rescue Group; **UoW =** University of Winchester students; **N** = None; **Y** = Yes.

5.3.4 Partial Form or Full form

In the York study, splitting the protocol into separate segments resulted in partial data when volunteers could not attend every session. It was estimated that the full protocol, now expanded to include the inventory section would likely take 30 to 40 minutes per volunteer.

Based on the number of interested volunteers, it was possible that each session could have 10 or more participants. Ideally, ten skeletons would be assessed by each volunteer over the course of the study. If participants were to spend 30 minutes (or more) per skeleton, only three to a maximum of four skeletons would be assessed per volunteer per session, with volunteers spending 30 to 40 minutes handling each skeleton. This would require room for volunteers to manoeuvre in order to examine the skeletons, leading the author to briefly contemplate one specimen per large lab table. The number of skeletons viewed each session could be increased, but would require changing over the remains. Partial forms would risk incomplete data if volunteers could only attend one session.

Four testing models were considered, particularly as related to student participants since their workload was expected to grow as the term progressed, increasing risk of participant dropout. Options included half the protocol tested each session on ten skeletons, requiring multiple sessions; full protocol tested on fewer specimens, either as a one-off session or multiple sessions for all ten specimens; or one single very long session with ten specimens observed.

1. Testing half the protocol on the full set (10) of specimens.
Assuming two student sessions with about ten students in each session, each volunteer could complete half of a form, taking approximately15 minutes per form, one partial form for each skeleton per session. This would entail laying five speciments out at first, repacking these and laying out five more whilst volunteers take a break; estimated session length would be three hours.

Whilst all 10 specimens would be viewed, there were problems with this option. One negative aspect to running half the sheet over all 10 specimens each session was that this required students to (hopefully) come back after a break to examine the second set of remains. Secondly, having each student session view all ten skeletons would require setting out then repacking specimens repeatedly, which would take time, and subject remains to multiple repackagings. Thirdly, with only half of each form completed, a volunteer could not recheck previous work during the following week's session, which would not mirror a real-world situation. Four, splitting the sheet over 2 weeks would risk volunteer attrition. Lastly, at approximately three hours, the session would be very long.

One benefit would be that the second half of the form would be novel, thus any discussions during the week about queries from the first half would not influence the second half. One option would be to return the first half to each student in the second week to make the entire protocol available when applying the second half to the same 10 skeletons.

2. Testing the full protocol each week on fewer (5) specimens.

Assuming two student sessions with 10 volunteers, the full protocol would be provided to each volunteer with a new form for each specimen. Five specimens would be available for assessing. On the following Wednesday, the second set of five specimens could be assessed. This option would remove the need to pack up and exchange specimens repeatedly, and reduce the length of a break whilst exchanging specimens. Assuming two consecutive Wednesdays for student sessions, all participants would have the opportunity to assess all ten specimens.

This option had two negative and four positive aspects. Students would be able to discuss their interpretation of the queries between sessions. Also, there would be the risk of attrition, as students who could only come once would assess less than 10 specimens. However, benefits included full assessments carried out with no partial forms; all ten skeletons assessed by (hopefully) the entire cohort of students; avoidance of over-handling the remains; and this option would mimic a real-world scenario in which a museum technician or volunteer examines one skeleton at a time, using the data capture form in its entirety. Each session would be less than three hours.

3. Using half the protocol on a partial sample, and continuing to meet until all ten skeletons have been assessed by most students.

This would simply stretch the trials out for too long. One benefit would be shorter sessions but extending data collection trials would risk losing student (and non-student) volunteers to attrition.

4. Full protocol on the full set of 10 specimens, with one group per week.

This would be similar to the first option in that the first set of specimens would need to be packed up and put away, and then the second set lain out. This option would require the same group of ten students to participate for both sessions on one single Wednesday, which would be a very long day of five to six hours.

The positive aspects included avoiding attrition from one week to the next; no multiple unpacking and repacking of the remains (though this would occur once). This option would permit access to the full protocol by all participants with no need to hand back part of the form, replicating a real world situation. On the other hand, the lengthy time commitment could result in people decling to participate at all. During the break whilst the specimens were switched over, some could leave. Finally, that this method would take up to six hours was not realistic in terms of student volunteers, nor realistic as a real-world scenario. The volunteers would be fatigued and perhaps prone to mistakes after even 3 hours.

5.3.5 Selected Method for Testing: Full form, half sample

In all previous possibilities, volunteer attrition was a risk, either due to a 6 hour session or as a result of splitting the 10 specimens between sessions. In every option, less than 10 specimens would be available for study at the same time due to the small size of lab and the large size of each volunteer group. The second option was chosen, with five skeletons at a time assessed using the full data capture sheet, requiring volunteers to attend at least two sessions in order to assess all ten. This would risk not all skeletons assessed by all students, an outcome possible in every option; but at least the protocol would not be left half-finished from one week to the next, which was essentially what happened in York by using partial forms.

The lab room was reserved for three weeks; each week was denoted as a ‘Session’, with the first week Session 1, the second week Session 2, and the third week Session 3. The suffix A, B, C or D was added to the session number to denote the specific group of attendees meeting for that week. For example, Session 1A is one group of adult volunteers that met on Tuesday 13 March (Week One); Session 1D is a second, separate group of adult volunteers that also met in Week One. Session 3B is the first student session of the day on Wednesday March 28 and was comprised of the same Group B students to meet in the first session each week. **Table 5.3** lists the 2012 sessions held in the Department of Archaeology and the type of volunteer (student, adult) that attended each session. Sessions 1 and 2 were designed to accommodate five specimens each session for a total of 10 skeletons; Session 3 was reserved for participants to finish up any forms if needed and to potentially test whether novices could lay out a skeleton using only a guide sheet. Up to 43 participants were expected; if ten skeletons were observed by all expected guests, the trial could produce up to 430 forms.

Table 5.3. Sessions for Winchester 2012 Trial of Protocol. Sessions were scheduled for three contiguous weeks, with the 37 volunteers assigned to two categories: WARG/NF/IMP 'adult' participants and University of Winchester undergraduate 'student' participants. In addition, members in the two categories were assigned to specific sessions: Sessions A and D for 'adult' participants, and Sessions B and C for the students. Session 1 ran for one week and consisted of four sessions, two for students and two for adult volunteers. Sessions 2 and 3 were held during the following two weeks.

Session 1

Date and Time	Scheduled Attendees
A. Tuesday March 13, 12.00 pm - 2.30 pm	NF, WARG, IMP
B. Wednesday March 14, 11.00 am – 1.00 pm	Students
C. Wednesday March 14, 2.00 pm - 4.00 pm	Students
D. Thursday Mar 15, 12.00 pm-2.30 pm	NF, WARG, IMP

Session 2

Date and Time	Scheduled Attendees
A. Tuesday March 13, 12.00 pm - 2.30 pm	NF, WARG, IMP
B. Wednesday March 14, 11.00 am – 1.00 pm	Students
C. Wednesday March 14, 2.00 pm - 4.00 pm	Students
D. Thursday Mar 15, 12.00 pm-2.30 pm	NF, WARG, IMP

Session 3

Date and Time	Scheduled Attendees
A. Tuesday March 13, 12.00 pm - 2.30 pm	NF, WARG, IMP
B. Wednesday March 14, 11.00 am – 1.00 pm	Students
C. Wednesday March 14, 2.00 pm - 4.00 pm	Students
D. Thursday Mar 15, 12.00 pm-2.30 pm	NF, WARG, IMP

Photograph 5.2: Week 1. WARG and New Forest volunteers. Bagged remains had been laid out in anatomical position and were in process of being removed from bags and displayed when most participants arrived. Participants hesitated to remove all remains from the bags and lay them out completely.

5.4 Results

Over three weeks, 37 volunteers handed in 95 forms, with one skeleton assessed per form. Of the forms collected, 91 were anlaysed; not all were completed, with abandonment primarily occurring in the second half of the protocol, partway through the Paleopathology segment. The multiple choice questions on condition and completeness of each skeletal, placed at the top of each form and thus not counted as part of the protocol, consistently enjoyed the most success. On 91 forms, 81 (89.0%) recorded these options correctly.

Most scheduled participants attended as planned, with two new volunteers joining for one session (35JD) or two (19KM). Over the three weeks, 23 members of WARG and New Forest attended and filled in 56 forms, and 14 undergraduate students from the Department of Archaeology took part, completing 35 forms. Although attendance dropped off as the sessions progressed, 13 adults and 9 students attended every session (**Table 5.4**). Student and adult volunteers arrived for sessions each week as previously scheduled. Session 1A, the Tuesday session during Week 1 scheduled for adult members of local archaeological societies, suffered from a few glitches related to printing off the forms. This remained a feature of every week and indeed of many sessions, but was a relatively benign misfortune.

Previous to the arrival of participants, the lab room was prepared by placing bubble wrap on each table, readying pens and forms, and laying out the skeletons in anatomical position. Photographs of participants were taken with permission, and volunteer comments, complaints and suggestions chronicled. Except for the first two Week 1 sessions (1A, 1B) the author also participated, timing herself for each form, which took 20-35 minutes (minus interruptions) per form per skeleton. Recorded timings for the author are Skeleton 7 = 35 minutes, Skeleton 9 = 30 minutes, Skeleton 17 = 20 minutes, Skeleton 20 = 20 minutes, Skeleton 21 = 35 minutes. Due to monitoring participants in early sessions, for example ensuring remains were handled gently, times for Skeletons 1, 2 and 15 were not recorded.

Table 5.4. All participants for the three weeks of the Winchester 2012 test This table lists all participants by their Volunteer ID, specifies the skeleton or skeletons each volunteers observed each week, and associated scores. Scores are listed as raw numbers of queries correct or partially correct, with the actual number of queries per week in (brackets). For example, Week 1 forms had 96 queries. Participants who attended every week are in **bold.**

VOL#	Week 1 Skeleton	Week1 Score (96)	Week 2 Skeleton	Week 2 Score (103)	Week 3 Skeleton	Week 3 Score (104)
01JR	SK 01	48.5				
02IC	**SK 21**	**61.5**	**SK 02**	**78.5**	**SK 17**	**73.5**
03RC	**SK 15**	**43.5**	**SK 02**	**69.0**	**SK 17**	**49.0**
04AH	**SK 01**	**47.0**	**SK 15**	**59.5**	**SK 09**	**46.5**
05GL	SK 01	55			SK 07	60.5
06PH	**SK 21**	**36.0**	**SK 15**	**78.5**	**SK 09**	**80.0**
07RH	**SK 02**	**71.5**	**SK 17**	**77.0**	**SK 07**	**77.0**
08MH	**SK 02**	**75.0**	**SK 17**	**74.0**	**SK 07**	**84.0**
09CS	**SK 15**	**68.0**	**SK 02**	**85.5**	**SK 07**	**88.0**
			SK 17	**82.5**	**SK 09**	**89.5**
10SH	SK 21	68.5				
11JR	**SK 15**	**62.0**	**SK 02**	**65.0**	**SK 17**	**55.5**
12EJ	**SK 21**	**71.0**	**SK 15**	**85.0**	**SK 09**	**78.0**
13MW	SK 01	59.5				
14YS	**SK 21**	**72.0**	**SK 15**	**71.0**	**SK 07**	**69.0**
15BD	**SK 21**	**75.0**	**SK 17**	**64.5**	**SK 07**	**68.5**
16WH	SK 02	48.5	SK 15	77.5		
17CB	**SK 02**	**71.5**	**SK 17**	**67.0**	**SK 07**	**75.5**

Assessment Protocol Tested in Winchester

18AK	SK 20	71.0				
19KM	SK 20	63.5	SK 17	65		
20ND	**SK 20**	**42.5**	**SK 15**	**77.5**	**SK 07**	**66.0**
21TR	**SK 20**	**31.0**	**SK 17**	**69.5**	**SK 09**	**72.0**
22ZE	SK 20	33.0				
23MS	**SK 02**	**71.5**	**SK 17**	**74.0**	**SK 07**	**65.5**
24AF	**SK 21**	**45.0**	**SK 17**	**65.5**	**SK 07**	**50.5**
25SH	**SK 02**	**69.5**	**SK 17**	**74.5**	**SK 07**	**72.0**
26AY	**SK 21**	**73.5**	**SK 17**	**74.5**	**SK 07**	**72.5**
					SK 09	**69.5**
27PF			SK 15	74.5		
28AP	**SK 21**	**81.5**	**SK 17**	**74.5**	**SK 09**	**67.5**
29MY	**SK 20**	**56.5**	**SK 02**	**80.5**	**SK 07**	**61.5**
30JY	**SK 21**	**72.0**	**SK 02**	**78.0**	**SK 07**	**60.0**
31CW	**SK 01**	**78.0**	**SK 15**	**90.5**	**SK 07**	**71.0**
32BB	SK 01	64.5	SK 17	68.5		
33AB	SK 20	66.5				
	SK 21	61.0				
34OM	SK 01	63.0	SK 02	82.5		
35JD			SK 02	73.0		
36DH			SK 02	83.0	SK 09	71.0
37IN			SK 15	65.5		

Vol# = Volunteer identifier; **SK** = Skeleton

In addition to circling or check-marking choices, volunteers were asked to record Skeleton Number, their initials, and the date in pre-printed areas at the top of each page. On the first page, they were to circle appropriate statements regarding the condition of the remains ('Fairly Good' or 'In Fragments'), and whether elements were stored in labeled bags such as 'Right Arm' or 'Left Leg'; in addition, volunteers were asked whether they considered themselves to have 'No Experience', 'Some Experience' or 'A Lot of Experience' with handling and/or analysing human skeletal remains.

Photograph 5.3: Week 1. WARG and New Forest Volunteers often worked in teams but generally recorded individual observations.

Photograph 5.4 and 5.5: Week 1. Student sessions.

Very few volunteers managed to complete more than one form per two hour session. This was surprising and led to an immediate alteration to the trial methodology. With only three sessions scheduled per group, and only one form finished by most volunteers within a session, the maximum number of skeletons for participants to observe was revised from ten to three.

Some volunteers set themselves the task of viewing more than one skeleton during each session. 33AB managed to complete two forms in session 1D, partly due to his desire to help the study, and partly since this was the only session he could attend. Conversely, although 09CS could only complete one form in 1A, he succeeded in observing two skeletons for each of the last two sessions for a total of five. Finally, several students managed to complete two forms in the final student session 3C. However, only one extra form from one student was usable for reasons explained below.

Once the author had assessed each specimen, volunteer forms were scored, with a point awarded for a ‘correct’ answer (i.e. in agreement with author), a half-point given for answers off by one subjective degree as was done in York. The rationale for awarding half points is explained in **Methods 5.4.2**

Two well-intentioned features from Week One were quickly discarded: a scale and an image of a human skeleton. Originally, a 27cm scale was placed on one side of page 6, adjacent to a request for measurements of Femur Length and Head (**CD Item 2, Answer Sheet** March 13 2012). The aim was to ensure end-users working without any tools at least had some sort of scale to hand. This was succinctly dismissed by 02IC: “Delete scale. Issue ruler.” (**Appendix 5 Volunteer Comments**). The image of the skeleton was inadequate for novices. Other volunteer comments were equally useful. Throughout the three week experiment, language was continually sought to describe pubic symphyseal margins without being too detailed or too vague. Comments from volunteer 25SH written directly on the form were very helpful in this regard (see **Section 7.3.5**).

The number of questions increased from Week One to Week Two (Section **5.5.2.2**.). Not including bone counts for each type of hand and foot bone, or each type of vertebra, maximum scores increased from 96 (week 1) to 104 (week 3) due to observations added in the inventory section for recording presence of scapulae, clavicles and patellae, and additional observations on the hip girdle. ‘Questions for Protocol Version 1 and Version 2’ in the accompanying CD (**CD Appendix Item 4)** provides comparative lists of the questions.

5.4.1 Overall results

All results for each week are stored on a CD supplied with this thesis, which is a supplemental and expanded Appendix. The protocol form as given to volunteers in each week, plus the separate information booklet that was created and supplied to each participant is also included in soft copy.

The most obvious queries were the most successful, with 81 of the 91 forms correctly selecting all three options on overall condition of the remains. A shattered skull was identified correctly 87.5 times (96.2%), the presence and condition of long bones, and presence of mandibles and sacra were successfully observed 81 to 86 times on the 91 forms for a success rate ranging between 89-95%. **Table 5.6**, summarises results for the 'Twenty Important Queries' and identifies the successes (and failures) on these basic and yet essential observations. If all weeks are combined, 172 Inventory queries were asked, of which 123.0 were correct for an overall 71.5% correctly recognised; 131 Paleopathology queries were asked, of which 81.4 were correct for an overall 62.1% correctly recognised by the volunteers.

For Week 1, combining *all* scores from the 34 forms, the overall success rate averaged 61.1 (out of 96 questions or 63.6%). For Week 2, the average rate for 31forms (30 participants) climbed to 74.4 (out of 103 questions: 72.2%). For Week 3, the 26 forms (24 participants) averaged 69.0 (out of 104 questions: 66.3%). Respectively all raw scores per week are included as Excel spread sheets on the **CD Appendix** as **Item 5. Sheets 1, 2** and **3**. Considered as a whole, roughly two-thirds of the queries were answered in agreement with the author: 204.5 correct answers out of 303 questions, or 67.5%.

It is instructive to examine these results by query (Inventory versus Paleopathology); by type of participant (older adult amateur archaeologist versus undergraduate); and by skeleton. In addition, results are examined below by week, in Sections **5.5.1, 5.5.2**, and **5.5.3**.

Many participants increased their scores week on week, with the exception of results in Week 3 for reasons addressed in **Chapter 6**. A careful few managed to overcome the difficulties associated with the specimens in Week 3 and did increase their scores. Some participants experienced a significant increase in scores, such as 06PH, who scored 36.0 for Week 1 (Session 1A) and 78.5 in Session 2A; his score maintained this level for Session 3A with a score of 80 (104 queries). Comparative scores are found in **Table 5.4.** Specific traits and bone anomalies that were missed by more than 70% of the volunteers are examined in section **Chapter 6**.

5.4.2 Volunteer Scores by Query Type

Considering the scores by query, the maximum score for correctly answered queries is equal to the number of forms completed in each week. For Week One, with 34 forms analysed, the maximum score for correct queries is thus 34 and the average was 21.6 correct (of 34), or 63.6% as stated above. The range was 9.5 to 32.5, SD = 5.52.

Broken down by general type of query, the average score for the 'Inventory' segment in Week One was 22.8 correct out of 34 (67.1%), range 9.5 to 32.5, SD = 6.06; the average score for the 'Paleopathology' segment was 20.1 (59.2%), range 11.5 to 29.5, SD = 4.39. The relative success for each actual query varied greatly, from the almost unanimous recognition of skull condition (31.5 out of 34 or 92.6%), presence of a mandible (also 31.5), and completeness of long bones (32.5 or 95.6%), all Inventory queries, to the low success at determining morphology of the sub-pubic ramus, presence of a pre-auricular sulcus, or the ability to measure a femur head (respectively, 14 out of 34 or 41.2%, 9.5 times or 27.9%, and 11 times or 32.4%). The last three queries are also 'Inventory' but in reality collect data that indicates biological sex. All results for Week 1 are shown in **Sheet 1** in Excel: **Week One All Answers** on **Item 5, CD Appendix**. Each of the four meetings is also examined in detail below in S**ection 5.5.1**

In Week Two, 31 forms were collected, thus the maximum correct score per query is 31. Overall, respondents averaged 22.4 correct answers out of 31, or 72.2%, with a range of 5 to 31, SD= 5.53.

By type of query, Inventory traits were identified an average of 21.9 of 31 opportunities (70.7%), range 5 to 31, SD= 6.02; and Paleopathology queries 23.0 times (74.2%), range 4 to 28, SD = 4.80. All results for Week 2 are found in **Sheet**

2 in Excel, **Week Two All Answers o**n **Item 5, CD Appendix.** The CD lists all answers for Sessions 2A-2D. Each meeting is detailed below in **section 5.5.2**

For Week Three, with 26 forms analysed and the maximum correct responses also 26, overall queries were answered correctly an average of 17.2 times (66.3%). The range was 4 to 26, SD= 6.22.

The Inventory segment queires were answered correctly an average of 19.8 times out of 26 (76.1%) with a range of 5 to 26 and SD= 5.40. The paleopathology assessments averaged 13.8 correct answers on 26 forms (53.4%), with a range of 4 to 22, and SD= 5.58. **Sheet 3** in Excel, **Week Three All Answers** is found in **Item 5, CDAppendix.** Each of the four meetings in Week Three is detailed in **section 5.5.3.**

In addition, the scores are examined by type of query and category of volunteer. The Inventory segments (**section 6.3**) were more successfully comprehended by the volunteers than were the Paleopathology segments (**section 6.4).** The raw results are on the **CD** in Excel spreadsheets. **Sheet 7 Inventory Only** from **Item 5 on the CD Appendix** lists all Inventory queries for the 91 forms, with associated volunteer scores. **Sheet 8 Paleopathology Only** lists all Paleopathology queries for the 91 forms, with associated volunteer scores. **Sheet 9** divides the Inventory responses by type of volunteer, and **Sheet 10** compares answers to the Twenty Important Queries between types of volunteers (**sections 5.6.3.** and **6.5).**

5.4.3 Skeletal Specimens

The results for each skeleton are summarised below in **Table 5.5**. All answers for all skeletons are also organised into Excel tables, one for each skeleton per week: Skeleton 2, for example has two tables since this specimen was observed by volunteers in Week One and Week Two. **Sheet 11** in Excel, in **Item 5** on the **CD Appendix** shows all answers by Skeleton. The spread sheet illustrates the relative success participants had with assessing each skeleton, and the success of queries per skeleton based upon the number of volunteers. In general, scores per skeleton improved from Week One to Week Two; in general Inventory segments were more successfully answered than Paleopathology segments in Weeks One and Three, and Inventory scores improved steadily from week to week. The skeletons with ambiguous traits were more difficult for some volunteers to score: this may relate to how the questions were asked (see **6.7.1**) but also suggests that extremes were easier for novices to identify. The potential interplay between specimen variability and problems with comprehending the form are discussed further in **sections 6.2.2.**and **6.7.4.**

Table 5.5. The eight skeletons assessed by volunteers in 2012. This is a summary of the skeletons assessed during the Winchester 2012 trial. Skeletons 2 and 15 were available in Weeks One and Two, and Skeleton 17 was observed in Weeks Two and Three. Therefore these specimens are each listed twice. Results are separated into Weeks One, Two and Three. Each summary includes catalogue number; estimation of probable biological sex and age at death cohort; the weekly number of observers; average participant score both as raw number and percentage of queries; and separate results for both Inventory and Paleopathology segments.

Specimen	Age and Sex Estimate	Number of Volunteers	Average score (raw and percent of total queries)	Inventory (raw score and percent of volunteers)	Paleopathology (raw score and percent of volunteers)
			WEEK ONE		
Skeleton 01	Older Adult Male	7	59.4 out of 96 queries. 61.8%	4.93 out of 7. 70.4%	3.58 out of 7: 51.1%
Skeleton 02	Adult Male	6	67.9 out of 96. 70.8%	4.09 out of 6. 68.2%	4.43 out of 6. 73.8%
Skeleton 15	Young Adult Male	3	57.8 out of 96. 70.2%	1.83 out of 3. 61.0%	1.78 out of 3. 59.3%
Skeleton 20	Adult Female	8	54.4 out of 96. 56.6%	5.27 out of 8. 65.9%	3.62 out of 8. 45.3%
Skeleton 21	Adol-escent, probably male	10	64.6 out of 96. 67.3%	6.75 out of 10. 67.5%	6.71 out of 10. 67.1%
			WEEK TWO		
Skeleton 02	Adult Male	9	77.2 out of 103 queries. 75.0%	6.55 out of 9. 72.8%	7.01 out of 9. 77.9%
Skeleton 15	Young Adult Male	9	75.5 out of 103. 73.3%	6.51 out of 9. 72.3%	6.72 out of 9. 74.7%

Skeleton 17	Young Adult Female	13	72.0 out of 103. 69.9%	8.90 out of 13. 68.5%	9.28 out of 13. 71.4%
			WEEK THREE		
Skeleton 07	Older Adult Male	15	69.4 out of 104 queries. 66.8%	11.28 out of 15. 75.2%	8.28 out of 15. 55.2%
Skeleton 09	Adult Male	8	71.8 out of 104. 69.0%	6.30 out of 8. 78.8%	4.45 out of 8. 55.6%
Skeleton 17	Young Adult Female	3	59.3 out of 104. 57.0%	2.22 out of 3. 74.0%	1.02 out of 3. 34.0%

5.4.4 Results by Session per each week

The results are broken into smaller charts for each specific meeting within each week (e.g. Session 1A, 2B, 3C) and are listed separately in sections **5.5.1, 5.5.2** and **5.5.3**. One aim of breaking the overall results into sections is due to the size of the data pool: altogether, 91 forms were scored for 96 – 104 queries. The number of participants and forms varied from week to week, and the actual specimens that were observed also varied from week to week and at times between meetimgs. By breaking results down by week, individual meeting, and form segment (Inventory, Paleopathology) trends can be more readily observed and can help to identify successful or weak areas in the methodology.

5.4.5 Twenty Important Queries

For ease of comparing results between and within groups, and to test if the protocol accurately picks up the most important information from a human skeleton, a small sub-set of twenty questions were identified from the overall list of approximately 100 questions (plus counts of types of podials and vertebrae). These queries are shown in **Table 5.6**. The 20 queries were selected based on the information each would provide on the completeness of a human skeleton (skull complete versus shattered; long bones present; joints complete; pubic bones present; vertebrae present), criteria that can determine if a specimen is appropriate for analysis by a visiting scholar. For example, a researcher interested in moderate to severe DISH in older females would prefer to study specimens which probably retain most vertebrae; as well as elements typically used for ageing and sexing. Result for the 20 Important queries are in **Table 5.6.**

Table 5.6. Twenty Important Queries. Twenty important queries are identified from the full list of 96-104 questions. The queries are listed by full descriptor, abbreviation commonly found on figures and tables of the results, the number of correct answers out of the total of 91 forms, query type and location on the protocol. 'Query type' describes the category of information obtained by correctly answering the query. Inventory refers to presence, absence and condition of a specific element or type of elements (i.e., vertebrae for type; skull for specific). Sexing and Ageing traits, based on accepted criteria are associated with biological sex or indicate skeletal maturity or skeletal degeneration. The rationale for each trait is discussed in Chapter 4.

Query	Abbreviation	Correct	Query Type	Location
Skull Complete?	Sk Compl?	87.5	Inventory	Inventory
Morphology of Torus	Torus	57	Sexing	Inventory
Morphology of Lateral Orbits	Lat Orbs	62.5	Sexing	Inventory
Mandible Present?	MandPres	81	Inventory	Inventory
Mandible Robust or Gracile?	MandRvG	61.5	Sexing	Inventory
Teeth General	TeethGnrl	73	Ageing	Inventory
Long Bones Present?	LB Pres	86.5	Inventory	Inventory
Long Bones Robust or Gracile?	LB RvG	72.5	Sexing	Inventory
Joints Present?	Joints	83	Inventory	Inventory
Medial Clavicle Morphology	ClavFusd	44	Ageing	Inventory
Vertebrae Present?	VertPres	81	Inventory	Inventory
Pubic bones Present?	PubePres	73.5	Inventory	Inventory
Pubic Symphysis billowed?	SympBil	63.5	Ageing	Inventory
Symphyseal margins sharp?	SympShrp	37	Ageing	Inventory
Sacrum Present?	Sacr Pres	86	Inventory	Inventory
Max Length L Femur	L Fem L	72	Sexing	Inventory

Max Diameter Femur Head	L Fem Hd	43	Sexing	Inventory
Ante-mortem Tooth Loss	AMTL	63	Ageing	Paleopathology
Degree enamel wear or chipping	Wear/Chp	71.5	Ageing	Paleopathology
Long Bone shafts Abnormal?	LB OutrShft	34.5	Paleopathology	Paleopathology

5.5 Results By Week

5.5.1 Week 1 Session 1, sections A, B, C, D (13, 14, 15 March 2012)

5.5.1.1 Materials

Five skeletal specimens were identified for use in Week 1, with the presumption that all five would be observed by most participants in each of the four volunteer meetimgs. The selected specimens were Skeletons 1, 2, 15, 20, 21 (**Table 5.1**). Dr Katie Tucker, who has examined the St Mary Magdalen collection extensively (Roffey and Tucker 2012) provided additional background on each specimen which gave context beyond the gross visual analyses performed by author.

Skeleton 1: Adult Older Male, coffined, possibly 17th century. The individual is edentulous, has mild osteoarthritis (OA) in several joints as well as one small localised lesion (round: cyst) active at time of death.

Skeleton 2: Adult Male, leprosy confirmed by molecular studies (Taylor *et al.* 2013), nasal destruction. Moderate to severe caries and dental wear, healed greenstick fracture on right femur resulting in anterior bowing. Mild periosteal reaction on both femora, mild osteochondritis Dissecans (OD). Premature fusion of the lambdoidal sutures, an obscure pathology.

Skeleton 15: Young Adult Male, tall, gracile. Tuberculosis and leprosy; skull shattered. Mild dental wear. Mild periosteal reaction on both tibiae, active at death.

Calvarium adequately intact to permit observation that sagittal suture fused prematurely.

Skeleton 20: Adult Female with slight evidence of leprosy, and one tiny patch of eburnation on pisiform. Female traits in pelvic bones. Mild OA at joints, and moderate to severe OA on thoracic and lumbar vertebral facets. Some loss of teeth pre-mortem. Some OD on joints, curved sacrum.

Skeleton 21: Adolescent, with a wide range of fusion patterns. Both humerii with fused proximal and distal epiphyses, but femur distal unfused (head fused recently); neither tibial epiphyses fused on one, with only distal epiphysis fused on other tibia. S1 not fused to S2. Excellent mix of mature and immature aspects.

5.5.1.2 Methods

The first version of the form was used for all participants in Week One (See **CD Appendix, Qs for Protocol Version One)**. Version One offered 103 questions, including requests for actual counts for each type of vertebra, and actual counts of each type of foot or hand bone (e.g. phalanges, metacarpals and metatarsals, carpals and tarsals). Simple explanations of each basic type were supplied, but each form advised participants that a simple count from each bag (50 hand bones; 45 foot bones etc) was sufficient. Most importantly, the form states, "Assessing individual hand and foot bones are beyond the scope of this general form. …If hand and foot bones are bagged separately, please count the individual bones and record the number…..Unless bones are sided (major error with jargon: see **Volunteer comments, Appendix 5**) simply give total counts….Don't worry if you can't separate tarsals from carpals."

Most comments written directly on the form relate to these two sections (vertebrae and podials), such as "A sketch or something might help to identify?" (19KM). This section was surprisingly successful, which will be discussed in **Chapter 6**. For tallying scores, individual counts of vertebrae and podials were scored as one query: as total successes, total failures, or given half a score for mixed results. Therefore, the 103 questions are scored as 96 questions.

Viewed as 96 questions, the first section of the form is comprised of 53 queries mostly related to inventory ("all long bones present") or ageing and sexing traits ("Frontal plate: Sloped to rear, or Vertical, or Moderate"). Four queries relate to unusual traits such as cranial modification (head shaping) or premature cranial suture synostosis with mixed results: for these queries the options were Yes or No. A general assessment of dentition was requested, and the maximum length of both femora and maximum diameter of femoral heads was asked.

The second and most ambitious section, the 43 paleopathology assessments, followed the York 2008 practice of offering heavily outlined sections for different traits or regions of the skeleton, and offered three columns for recording observations: "NONE or N/A", "Present on Bones", "Notes". Not all respondents recorded a checkmark in one of the three boxes, an omission marked as incorrect. Lower scores were associated with blanks, with one or more participants in each session simply leaving the last 20-25 questions blank.

5.5.1.3 SESSION 1A, Tuesday 13 March, WARG and New Forest.

This first meeting was attended by semi-retired or retired adult members of Winchester Archaeological Rescue Group (WARG) and New Forest Historical and Archaeological Group (New Forest), although one Winchester student from the History Department, also a WARG member, took part in this session and was assessed as a WARG participant. All five skeletons were laid out in preparation. Thirteen volunteers participated: 01JR, 02IC, 03RC, 04AH, 05GL, 06PH, 07RH, 08MH, 09CS, 10SH, 11JR, 12EJ, 13MW. Each completed one form on one skeleton, although Volunteers 01JR through 06PH abandoned the form partly through the pathology assessment.

Success rates ranged from a low of 36.0 in agreement with the author (06PH observing Skeleton 21) to 71.5 (07RH observing Skeleton 2). The standard deviation between participants was 12.23. The average score across the 13 participants was 58.9, or 61.4% of 96 questions. Incomplete forms had the lowest scores in the session (36.0, 43.5, 46.5, 48.5, 55.0), with only one exception (02IC at 61.5 correct answers).

Photograph 5.6: Week 1. WARG and New Forest volunteers.

Table 5.7 illustrates the success of individual participants. The scores are based on 96 questions, but with scores rendered as a percentage of 96, the averages remain quite similar. **Figure 5.1** illustrates the similarity. In discussions of participant performance, or the relative success of a query, results will be converted from the actual score to a percentage of correct answers based on the numbers of questions, but the actual scores will predominately be used throughout the text. Figures illustrating results will always be created using scores, not percentages.

Table 5.7. Participant scores for Session 1A.. The participant scores are based on 96 queries. The raw scores are compared to each score as a percentage of possible correct answers.

ID#	Score (of 96)	% of 96
01JR	48.5	50.5%
02IC	61.5	64.1%
03RC	43.5	45.3%
04AH	47.0	49.0%
05GL	55.0	57.3%
06PH	36.0	37.5%
07RH	71.5	74.5%
08MH	75.0	78.1%
09CS	68.0	70.8%

10SH	68.5	71.3%
11JR	62.0	64.6%
12EJ	71.0	73.9%
13MW	59.5	62.0%
Average	**58.9**	**61.4%**

ID# = Participant. **Score (of 96)** = raw score, **% of 96** = raw score as a percentage of possible correct answers.

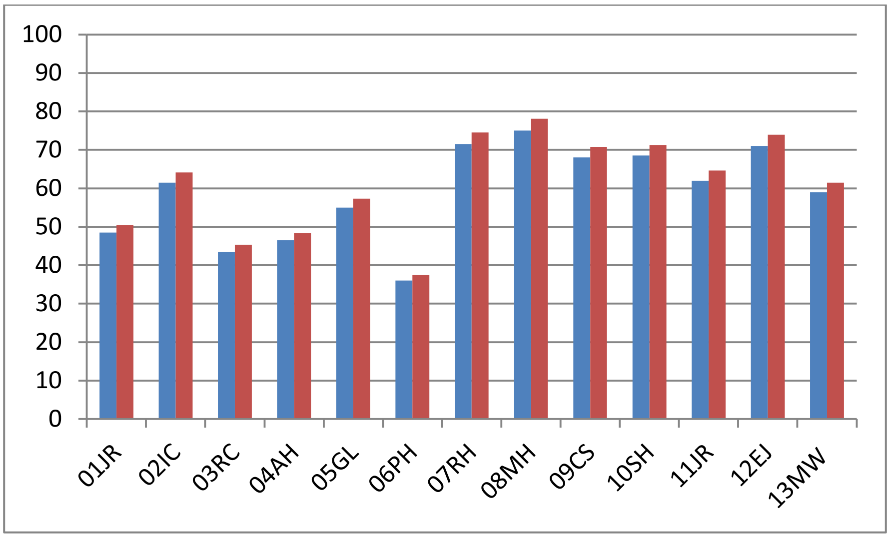


Figure 5.1. Session 1A. Scores for participants in Session 1A, showing both actual scores in blue, and percentages correct (in red) based on 96 queries. The x-axis lists Session 1A participants by their identifier, and the Y-axis depicts their relative success with the protocol based on 96 queries.

Figure 5.3 depicts the overall results for the thirteen participants in Session 1A. **Figure 5.2** and **Figure 5.3** illustrate the overall success of each type of query. The maximum possible number of correct answers to any query was 13, the size of the group. Overall, participants recognised traits and bone anomalies an average of 7.98 queries out of 13 (61.4%). 'Inventory' questions (**Figure 5.2)** averaged 8.83 correct responses (67.9%) and were more successful than 'Paleopathology' assessments (**Figure 5.3)** which were correct an average of 6.93 times out of 13 (53.3%). Problem areas included identifying the pre-auricular sulcus (a sexing trait) in Inventory, and simply choosing an answer in the Paleopathology segment.

The traits and disorders queried are abbreviated in all tables that illustrate results for participants (sections **5.5.1, 5.5.2**, and **5.5.3**). **Table 5.8** supplies full descriptor of each query and abbreviations typically used; queries are separated by type, and are listed in order of appearance in the protocol.

Femur length and femoral head diameter was measured with surprising accuracy, especially the length: for example, 01JR, 04AH, 05GL and 13MW matched the author to the millimetre on femoral length and 07RH, 08MH and 12EJ were within 2 to 4mm of actual length. Femoral head diameters were mixed, with some volunteers matching the author's findings to the millimetre whilst others seemed to have incorporated the width of the entire proximal region into the 'head' diameter, recording measurements of 70 to 110mm for heads actually 45 to 50mm in width. To be marked 'correct' the length needed to be within 10mm of author's findings, and the femoral head within 5mm.

Table 5.8 Full descriptor for Protocol queries. This table provides the descriptor for each query and the abbreviation most commonly used in **Section 5.5.** Inventory queries in left-hand columns, paleopathology queries in right-hand columns; observations separated by body regions.

Region	**Typical Abbrev-iation**	**Full query**	**Region**	**Typical Abbrev-iation**	**Full query**
	Inventory			**Paleopathology**	
Skull	Compl?	Skull completeness	**Dentition**	Healthy	Most teeth Healthy
	Frntl	Frontal plate shape		PMTL	Post-mortem tooth loss
	Glab	Glabella expression		Caries	Carious lesions
	Torus	Torus expression		AMTL	Post-mortem tooth loss
	Occip	Occipital plate expression		Wear/Chip	Cusps and enamel worn or chipped
	Zygs	Zygomatic arch robusticity		Calculus	Hardened plaque
	LatOrbs	Lateral orbit shape		Periodont	Periodontal disease

Assessment Protocol Tested in Winchester

	Mastoid	Mastoid process size		Hypoplasia	Enamel defects
	EAM	External auditory meatus expression	**Skull**	Orbits	Abnormal bone in orbits
	Max L	L Maxilla completeness		Ectocran	Abnormal bone on outer skull
	R	R maxilla completeness		Vault thck	Vault plate thickness +1cm
	Nasal	Nasal region completeness	**Joints**	Most	Presence/ degree osteo-arthritis
	CrModH	Cranial modification: horizontal		One	Osteo-arthritis one joint
	CrModV	Cranial modification: vertical		Several	Osteo-arthritis several Joints
	PremSut	Sutures fused prematurely	**Vertebrae**	C	Cervical osteo-Arthritis
	MastMis	Mastoid process misaligned		T	Thoracic osteo-Arthritis
Mandible	Present	Mandible completeness		L	Lumbar osteo-Arthritis
	RobvGrac	Mandible robusticity		Fused V	Vertebrae fused
	Endentulous	All teeth lost premortem	**Fractures**	Single	Single fracture
	MntlEm	Mental Eminence robusticity		Multiple	Multiple fractures
	Condyl	Condyle robusticity		Ribs	Single rib fracture
	Gonial	Gonial angle robusticity		RibCond	Multiple rib fractures

Assessment Protocol Tested in Winchester

	TEETH	General observations	**Cortex**	UprLimb	Cortex in upper limbs
Long Bones	Present	Long bone presence and completeness		1 UprLimb	One Abnormal Limb
	RobvGrac	Long bone robusticity		LwrLimb	Cortex in lower limbs
	Joints	Joint completeness		1 LwrLimb	One abnormal limb
	Patella	Patella presence		MdshftTrb	Abnormal trabecular Bone
Thorax	ClavFuse	Medial clavicle maturity	**MSM**	UpperL	Muscle robusticity
	L&Rclav	Clavicles presence		LowerL	Muscle robusticity
	L&RScap	Scapulae presence and condition	**Miscellan-eous**	Endocran	Abnormal internal skull
	Rib yA	Medial rib youthful		VertPath	Vertebral lesions
	RibCup or Vee	Medial rib maturity		LSTV	Lumbo-sacral fusion
	RibCond	Rib completeness		Schmorls	Schmorl's nodes presence
Vertebrae	Present	Vertebrae present		RibDepIn	Bone deposit on inner rib
	Compl	Completeness		RibDepOut	Bone deposit on outer rib
	Count	Count		RibFused	Fused ribs
Podials	Carpal	Wrist bone count	**Inflamma-tion / Infection**	OutrShft	Lesions: shaft surface
	MetaC	Palm bone count		Medullary	Lesions: marrow cavity
	Phalan	Finger bone count		Active	Active lesions
	Tarsal	Ankle bone count	Orthopae-dic Disorders	HumHd	Humerus: Abnormal joint morphology

Assessment Protocol Tested in Winchester

	MetaT	Foot bone count	FemHd	Femur: Abnormal joint morphology
	Phalan	Toe bone count	OD	Joints: bone defects
Hip Girdle	OsCox Compl?	Pelvis completeness	Sacrum	Atypical sacral shape
	PubePres	Pubic bones presence	Rickets	Curvature: shafts, ribs scapulae
	L and R	Left and/or Right		
	SympBil	Pubic symphysis youthful		
	Flat	Pubic symphysis adult		
	EdgeFl	Symphyseal margins mature		
	Shrp	Symphyseal margins mature		
	Ragged	Pubic symphysis older adult		
	Ramus	Sub-pubic ramus robusticity		
	GrSc	Greater Sciatic notch morphology		
	L&Rsame	Left and Right notch symmetry		
	RimMorph	Acetabulum morphology		
	Aur Billo	Auricular surface youthful		
	Aur Rough	Auricular surface mature		
	Sulcus	Pre-auricular sulcus presence		
	Sacr Pre	Sacrum completeness		
	Sacr Fuse	Sacrum maturity		
	S1/S2	Sacrum maturity		
Femur	L Fem L	Maximum length Left femur		
	L Fem Hd	Diameter L femur head		

Assessment Protocol Tested in Winchester

	R Fem L	Maximum length Right femur	
	R fem Hd	Diameter R femur head	

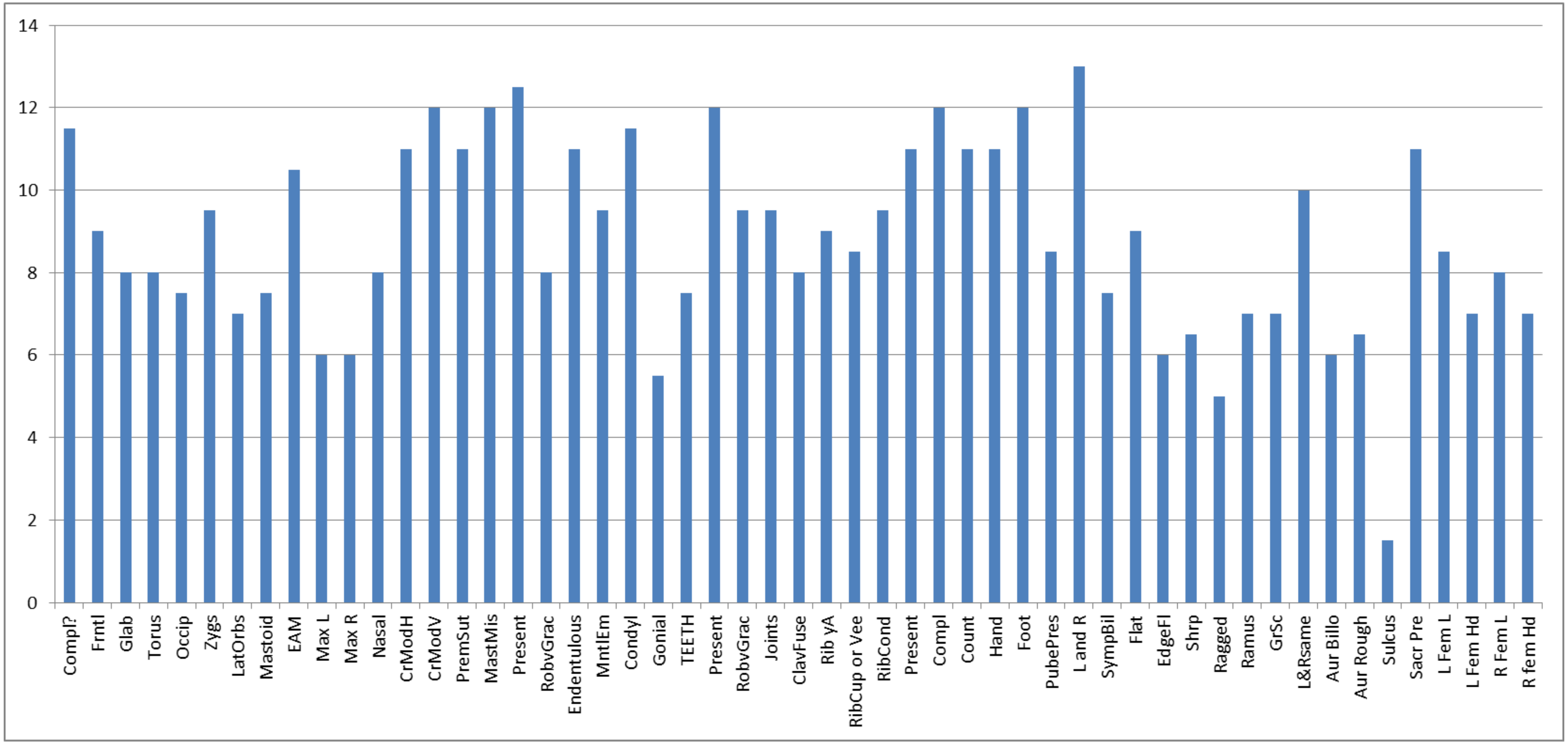


Figure 5.2. Session 1A Inventory. Correct answers per query from Session 1A for inventory section of protocol. Thirteen forms were scored thus the maximum number of correct answers for any query was limited to 13. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

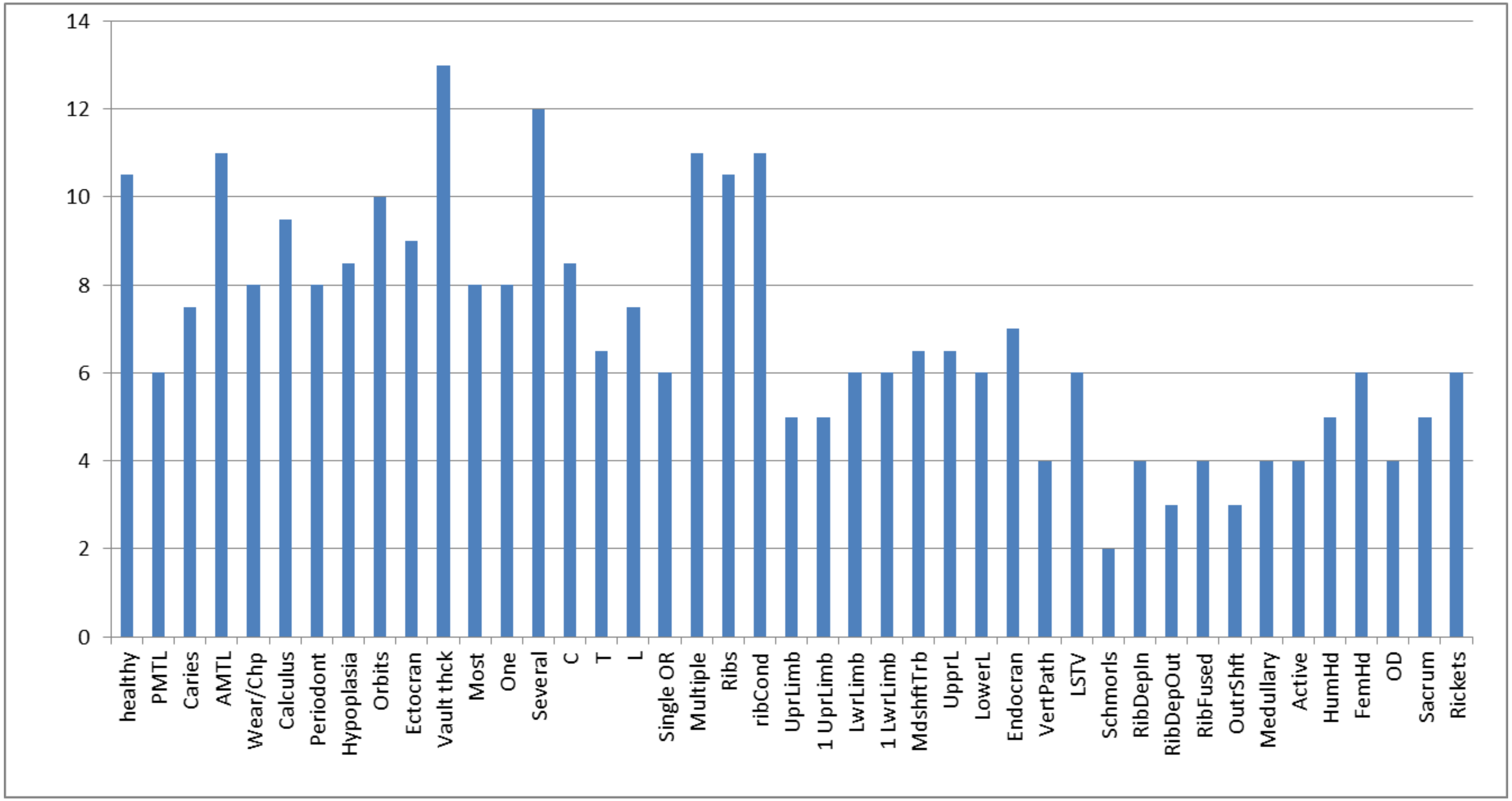


Figure 5.3. Session 1A Paleopathology. Correct answers per query from Session 1A for ‘pathology’ section of protocol. Thirteen forms were scored thus the maximum number of correct answers for any query was limited to 13. Six participants failed to answer about half of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

The obvious reason paleopathology scores (**Figure 5.3**) were less successful than those based on inventory and demographic traits (**Figure 5.2**) is related to unanswered questions. Six volunteers failed to answer any more queries after ones on dental health, joint and vertebral osteoarthritis, and bone fractures showing some healing (and thus pre-mortem). The abandoned questions, which represent about half of this segment (22 of the 43 questions), include observations of indicators of infection, trauma, micro-trauma at muscle insertion sites due to age or activity, cortical mass (the latter which may indicate osteoporosis: see **4.4.4.2**), and morphological abnormalities that can indicate healed rickets. If overall scores for participants who failed to answer these sections are grouped separately from those who at least attempted to, the scores of 'abandoning' volunteers (01JR, 02IC, 03RC, 04AH, 05GL, 06PH), average 48.5 (50.5%), and scores of those who finished (more of) the form (07RH, 08MH, 09CS, 10SH, 11JR, 12EJ, 13MW) average 67.9 (70.7%). Week One 'Abandoners' are compared to 'Completers' in **Table 5.9**and **Table 5.10.** Reasons why the form may have been abandoned are discussed in **Section 6.4.**

Volunteers pointed out small errors on the form, such as 'narror' for 'narrower'. Participants requested additional illustrations (text alone was insufficient), and expressed a desire for a separate booklet of drawings and explanatory text for each question; they suggested alternative phrases to add clarity. For example, instead of the awkward 'Check Only if Yes', 03RC suggested 'Only if Present'. 06PH, who abandoned the form partway into the 'pathology' section concluded that this first form would be best viewed as a learning experience. 'Perhaps with a novice the first few results could be discarded, but form a valuable part of the learning experience.' 05GL left the form incomplete, writing 'After three hours I could not continue! Overall the whole form needs to be simplified for amateurs. Absolutely exhausted!' A list of participant comments is in **Appendix 5**.

5.5.1.4 SESSION 1B Wednesday 14 March, Students, 11.00 a.m. session.

This session was for students from the Department of Archaeology. Following the previous session in which about half the volunteers abandoned the form and the rest were only able to view one specimen, only three specimens were laid out rather than five: Skeletons 2, 20, 21. These were in position before the students arrived. The selected specimens were of a young male, an adult female and an adolescent.

Also, by omitting Skeleton 15, which has fragmented elements, unnecessarily handling was avoided. Several students who had arranged to participate did not show, but a new participant arrived (19KM) for a total of six. In the event, three specimens for six volunteers allowed ready access to skeletal elements.

The students had none to modest bone and archaeological training (see **Table 5.2**), and were game to try the form and comment on any problems. Five of the participants answered all or most of the questions, whilst one left most of the paleopathology section blank. Several photos were taken of the group at work. The participants were 14YS, 15BD, 16WH, 17CB, 18AK, 19KM. The average score for the group was 66.9 (69.7%); with the range from 75.0 (BD) to 48.5 (16WH), the latter an incomplete form. If this score is omitted, the average for the participants completing the form is 70.7 out of 96 scored queries (73.6%). The standard deviation was 9.80.

Figure 5.4 shows the results for this group. There was less variability between the two segments for this group than had been noted for Session 1A. Out of a maximum score of 6 (based on the number of participants), the average score across 96 queries was 4.18 (69.7%). The Inventory segment had an average score of 4.07 (67.8%), and the Paleopathology segment an average score of 4.31 (71.8%). Problem areas included assessing the pubic symphysis and measuring the femur head (0 correct for both right and left heads) for the first segment; assessing osteoarthritis (OA) in thoracic vertebrae; and abnormal bone shafts in Paleopathology.

As with Session 1A, if the femur lengths were accurate, they were to within 1mm of the author’s findings. For example 15BD measured the left and right femur lengths of Skeleton 21 as 433mm and 431.8mm respectively; the author measured these elements as 433mm and 432mm. For Skeleton 2, 16WH measured the limbs as 431mm and 432mm for left and right, with the author finding lengths of 431mm and 429mm. For Skeleton 20, 18AK observed left and right lengths of 410mm for both; the author found the left femur 411mm and the right 409mm. **Figure 5.5** and **Figure 5.6** show Group 1B results for inventory and paleopathology segments respectively.

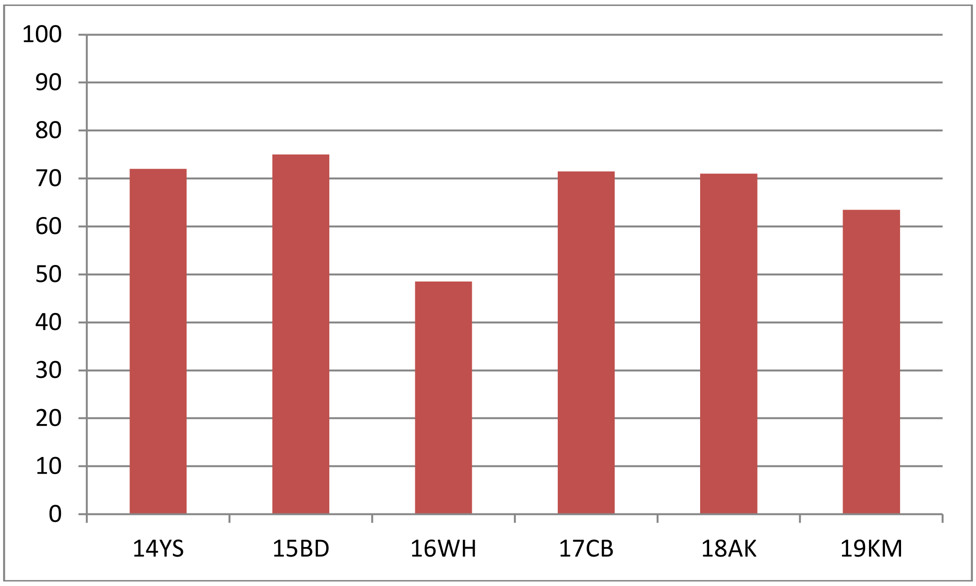


Figure 5.4. Session 1B. Scores for Session 1B. The x-axis lists participants in this session. Maximum number of correct queries was 96.

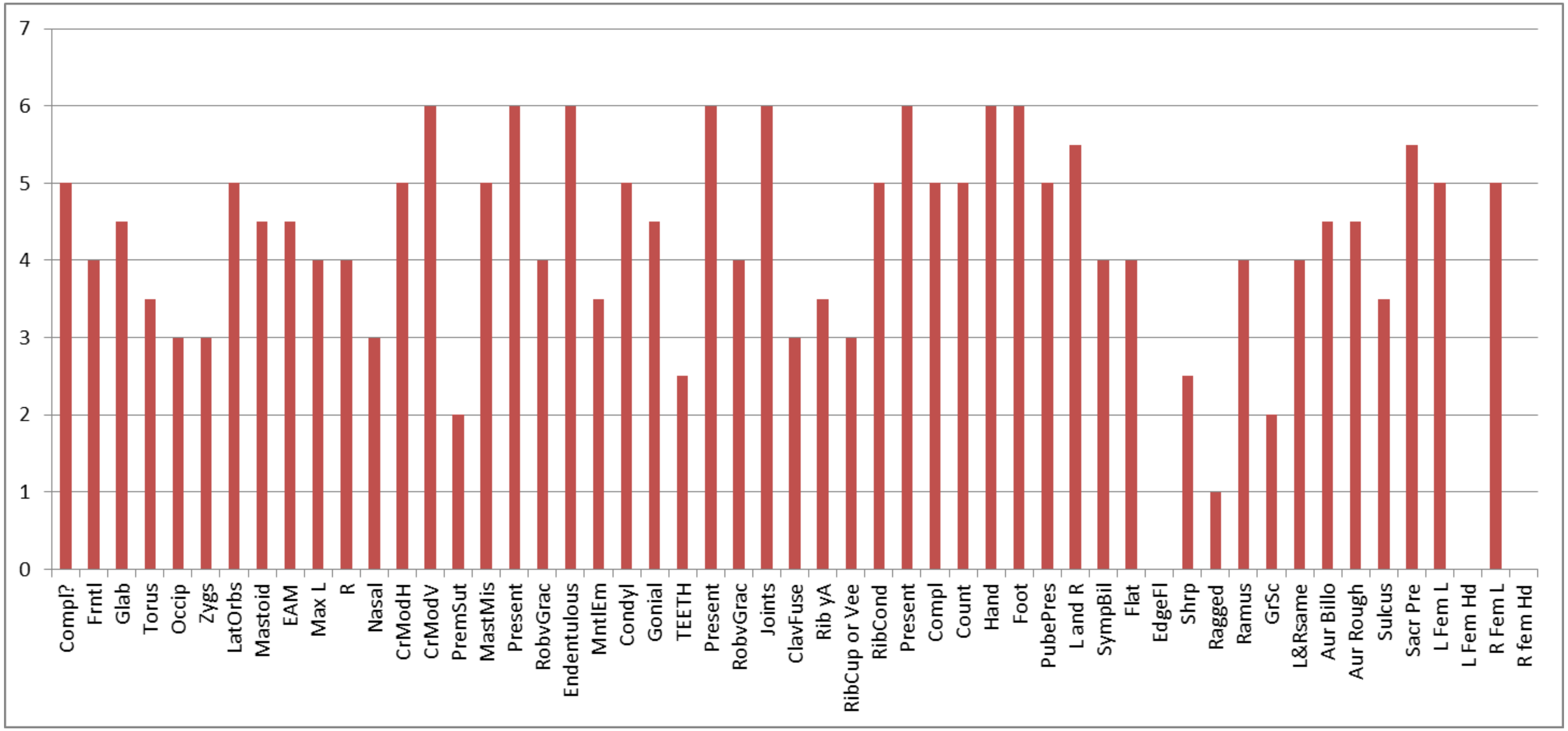


Figure 5.5. Session 1B Inventory. Correct answers per query from Session 1B for inventory section of protocol. Six forms were scored thus the maximum number of correct answers for any query was limited to 6. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

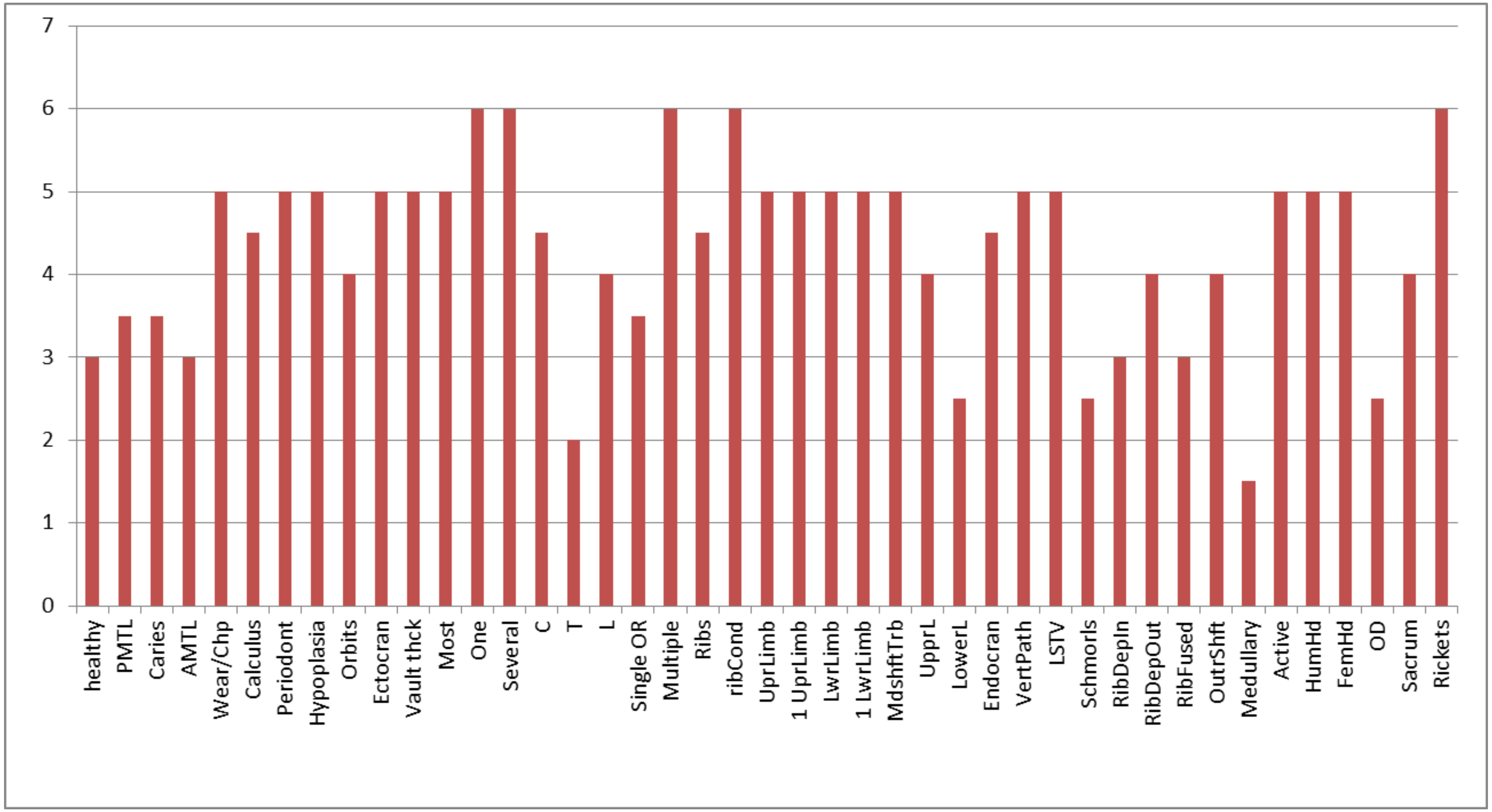


Figure 5.6. Session 1B Paleopathology. Correct answers per query from Session 1B for 'pathology' section of protocol. Six forms were scored thus the maximum number of correct answers for any query was limited to 6. One participant failed to answer about half of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

The students paired up to observe the specimens but did not seem to share answers. One comment was repeated, with slight variation, on several forms: “Would benefit from pictures [of pubic symphysis]” (15BD); “A diagram of each needed [vertebrae]” (16WH); “Need pictures to help” (17CB); “A sketch or something might help to identify?” (19KM).

5.5.1.5 SESSION 1C Wednesday 14 March, Students, 1.00 pm session.

The second session of the day was again reserved for archaeology students, using the specimens from session 1B, which had remained out in preparation for 1C (Skeletons 2, 20, 21). Eight volunteers took part (but only seven forms were scored, see below); the session began promptly at 1.00 pm. The students had a similarly modest amount of bone experience as the previous session (washing Mary Magdalen bone for Katie Tucker) but some had not particularly studied the material, and had just prepared them for gross examination with a light wash. Some students had never seen a skeleton before. Participants included 20ND, 21TR, 22ZE, 23MS, 24AF, 25SH, 26AY and 27PF. Photographs were taken of the group working.

Most of the students worked together in two distinct teams, with one or two participants working independently. The result was two-fold: some participants shared their work so completely that at least one form from each Wednesday afternoon session (1C, 2C, 3C) were omitted from scoring due to complete redundancy. The other consequence was a similar response to the form itself: one group in this session limited participation to commentary and critique of the form style, and neglected about two thirds of the questions. The other group engaged in a little answer sharing (27PF was omitted which reduced the forms by one) but retained independence in most answers.

The highest score was 73.5, the lowest 31.0, and the average score for seven participants was 52.3 (54.5%). The standard deviation was 18.66. When scores were separated between abandoned forms and completed forms, the average score was 35.5 (37.0% of 96 queries) for the three abandoned forms, and 64.9 (67.6%) for the completed forms. **Figure 5.7** shows the results of overall scores for this group.

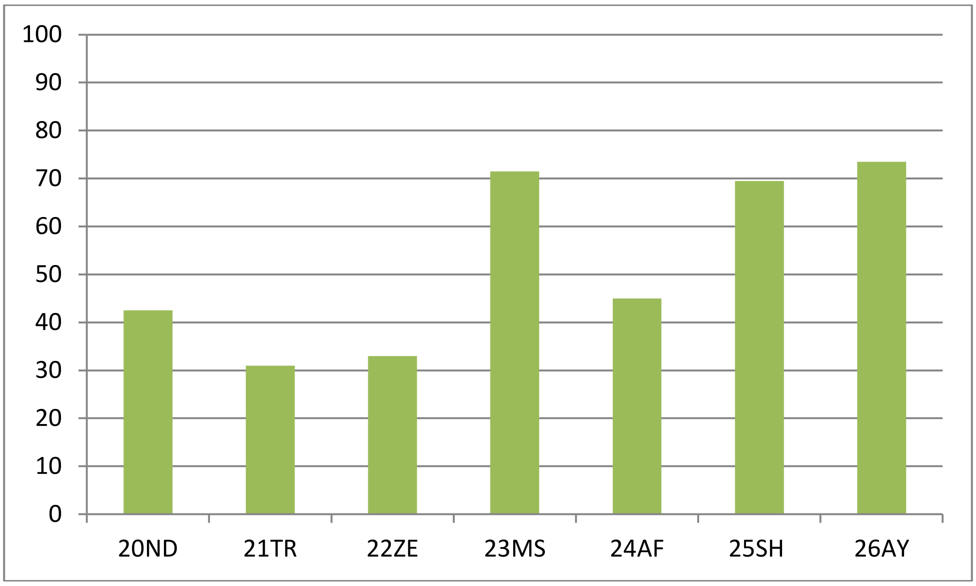


Figure 5.7. Session 1C. Scores for Session 1C. The x-axis lists participants in this session. Maximum number of correct queries was 96.

The queries answered for this session are based on 7 respondents which thus was the maximum score per query. These results are shown in **Figure 5.8** for Inventory and **Figure 5.9** for the Paleopathology segment. However, since most of the questions were left blank by three of the participants, the average of 'correct' queries is reduced: with scores of all 7 students considered, the average score is 3.81 out of 7.0 (54.3%). If the three students who did not complete the form (20ND, 21TR, 22ZE) are dropped, the remaining four participants have an average score of 2.70 based on a maximum score of 4.0 for successful queries (67.5% correct). For the Inventory segment, problem queries included assessing sexual dimorphism of the frontal plate, recognising ageing traits in the medial clavicles, locating the subpubic ramus (0 correct) and measuring the femoral heads (0 correct for both left and right heads). For the Paleopathology segment, presence or absence of abnormalities in the ectocranium, vertebrae and femur head were problem queries.

The metrics for femora were in perfect or near perfect agreement with the author, or off significantly. Some answers were shared. Of the three volunteers with correct femur lengths, 23MS and 25SH had identical answers for Skeleton 2: not impossible for femur length but also *identically incorrect* for femoral head diameter. For left and right femora, lengths and head diameters of each for 23MS and 25SH were: left femur 432mm/432mm length, 96mm/ 96mm head diameter; right femur 430mm/ 430mm and 95mm/ 95mm head diameter. Author's metrics for femoral lengths and head diameters were 432/47mm left, and 429mm / 47mm right, respectively. 26AY measured the left femur of Skeleton 21 at 433mm (perfect agreement with author) and the right femur at 410mm; the latter was incorrect as it exceeded 10mm from the author's findings of 432mm. 26AY mismeasured the femoral heads as did others but arrived at 75mm and 70mm for left and right respectively compared to the author's findings of 45mm for both heads.

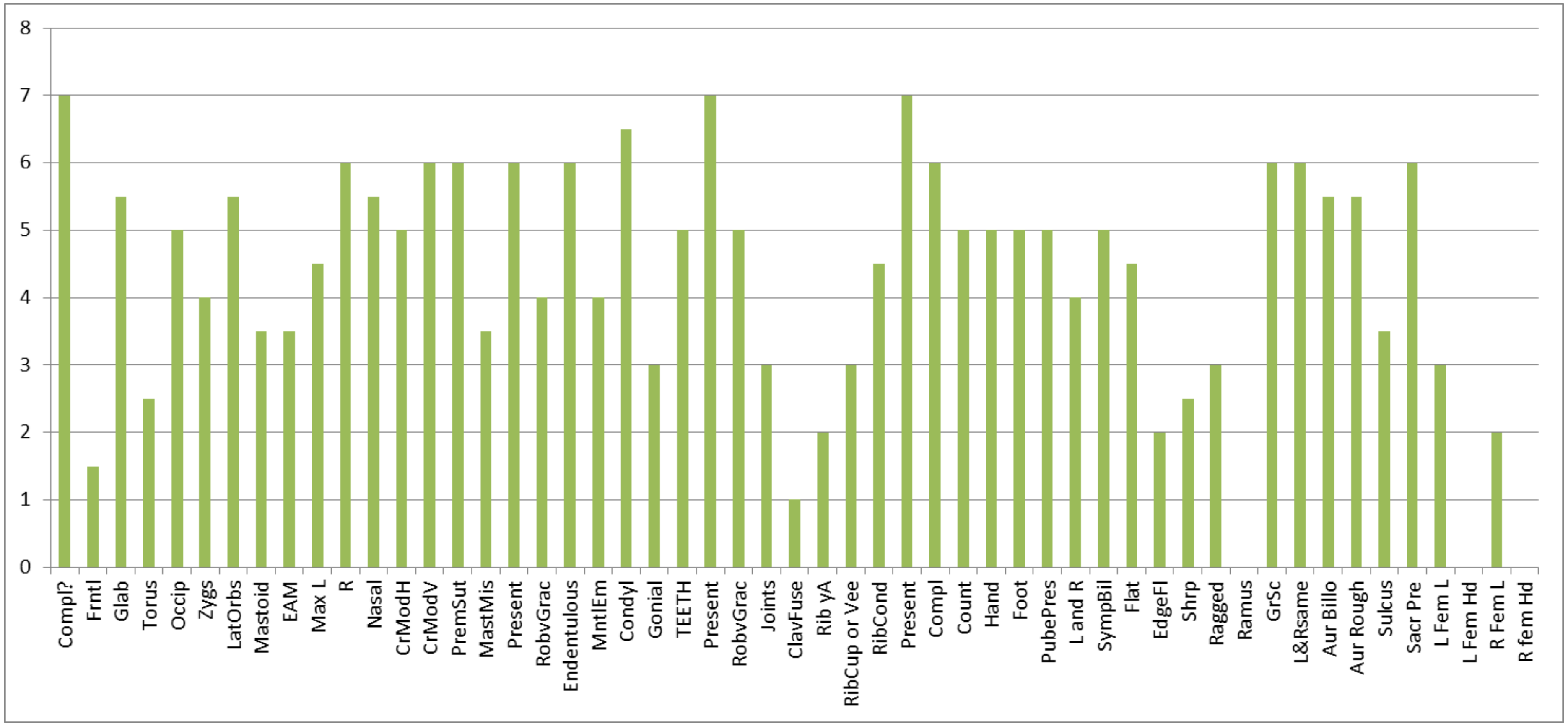


Figure 5.8. Session 1C Inventory. Correct answers per query from Session 1C for inventory section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

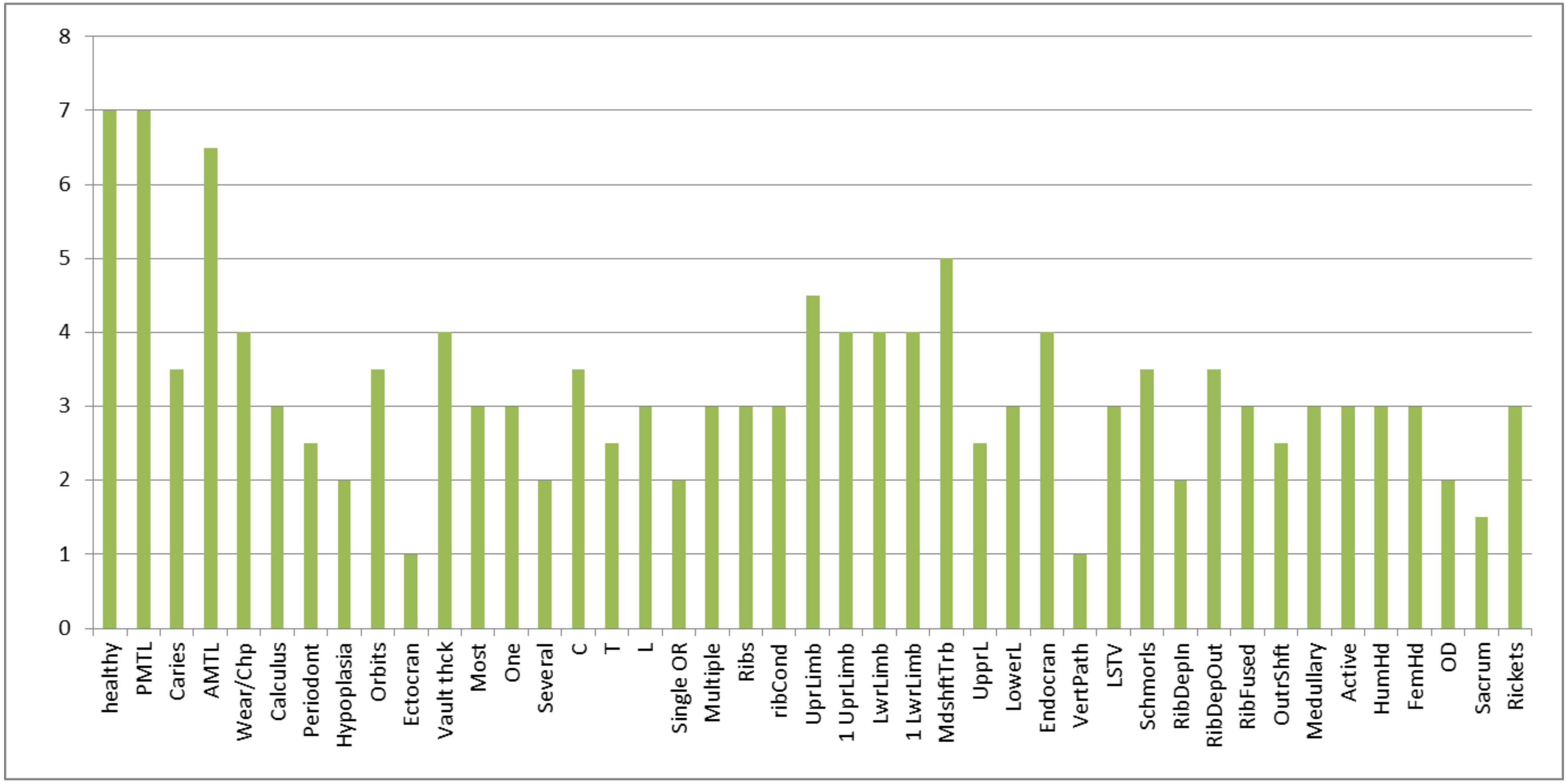


Figure 5.9. Session 1C Paleopathology. Correct answers per query from Session 1C for 'pathology' section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Three participants failed to answer most of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

Comments from the participants were recorded, and students were encouraged to write them on the answer sheets. During this session, the author completed two forms and noted several inconsistencies, errors and awkward phrasings. Subsuquent to comments from sessions 1A-1C as well as the author's own experience with the answer form, it was edited with an eye to revising the sheet in advance of the Week 2 sessions. However, the form was not changed before the final session of the week.

5.5.1.6 Session 1D Thursday 15 March, WARG and New Forest.

The final meeting of the week was similar to Session 1A in that it was arranged for WARG and New Forest members. As before, one student who was also a member of WARG attended and was assessed as a WARG member. In consideration of the time volunteers spent completing only one form during each of the prevous meetings, only three skeletons were laid out in preparation: Skeletons 1, 20, 21. Seven volunteers participated: 28AP, 29MY, 30JY, 31CW, 32BB, 33AB and 34OM; but eight forms were completed. Volunteer 33AB, who describes his previous experience as "Initial handling/ examination/ identification of human and animal bones at Bournemouth March 2012" (comments recorded on form by 33AB, March 15 2012), would not be able to attend any additional sessions and thus strove to complete two forms.

The average result for the group was 67.9 'correct' answers, or 70.7% of the 96 queries. The scores ranged from 56.5 to 82.0 and the standard deviation was 8.54. The lowest score, with 56.5 answers (58.9% of 96 questions) in agreement with the author, is from an incomplete form. **Figure 5.10** shows the results for this session.

Figure 5.10. Session 1D. Scores for Session 1D. The x-axis lists participants in this session. Maximum number of correct queries was 96.

Figure 5.11 and **Figure 5.12** illustrate the results per query, divided by segment. This session generated eight forms, therefore the highest possible score. The query mean is 5.66 (70.8%). The Inventory segment mean (**Figure 5.11**) is 5.69 (71.1%), the Paleopathology segment (**Figure 5.12**) is 5.62 (70.3%). Problem queries in Inventory included assessing the pubic symphysis and locating the pre-auricular sulcus. In Paleopathology, problems related to cortical thickness and OD.

Femur length and head diameter measurements were either omitted, completely wrong; or in close/exact agreement with the author, with one exception. 28AP measured 436mm for the left femur (author 433mm), but 442mm for the right femur (author measured 432mm). This was at the maximum variance of 10mm and counted as ‘correct’. Both 31CW and 32BB, observing Skeleton 1, measured one femur correctly and one off by 20-30mm; for 31CW the left femur was mismeasured at 460mm (author 430mm) and for 32BB the right femur was mismeasured at 410mm (author measured this element at 430mm maximum length). 31CW also found the femoral heads to be 87mm and 90mm (both left and right were 47mm) whilst 32BB was in perfect agreement with the author.

The actual recorded metrics for all participants are in the individual tables for each volunteer, saved in files labelled **Week 1, Week 2, Week 3** on the accompanying **CD (Items 8-10**); and the author’s findings are in **Questions for Protocol Version 1 and 2,** also on the CD in **Item 4.**

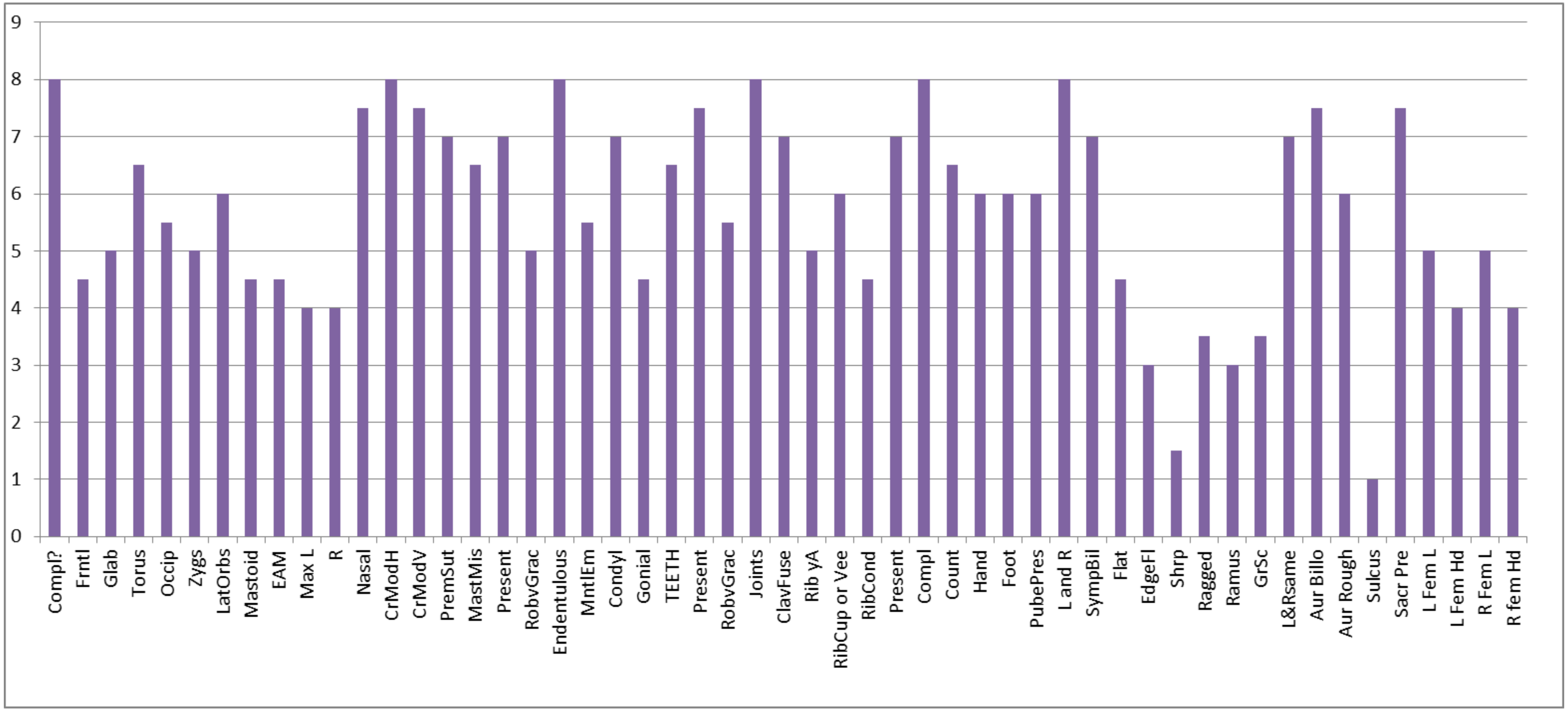


Figure 5.11. Session 1D Inventory. Correct answers per query from Session 1D for inventory section of protocol. Eight forms were scored thus the maximum number of correct answers for any query was limited to 8. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

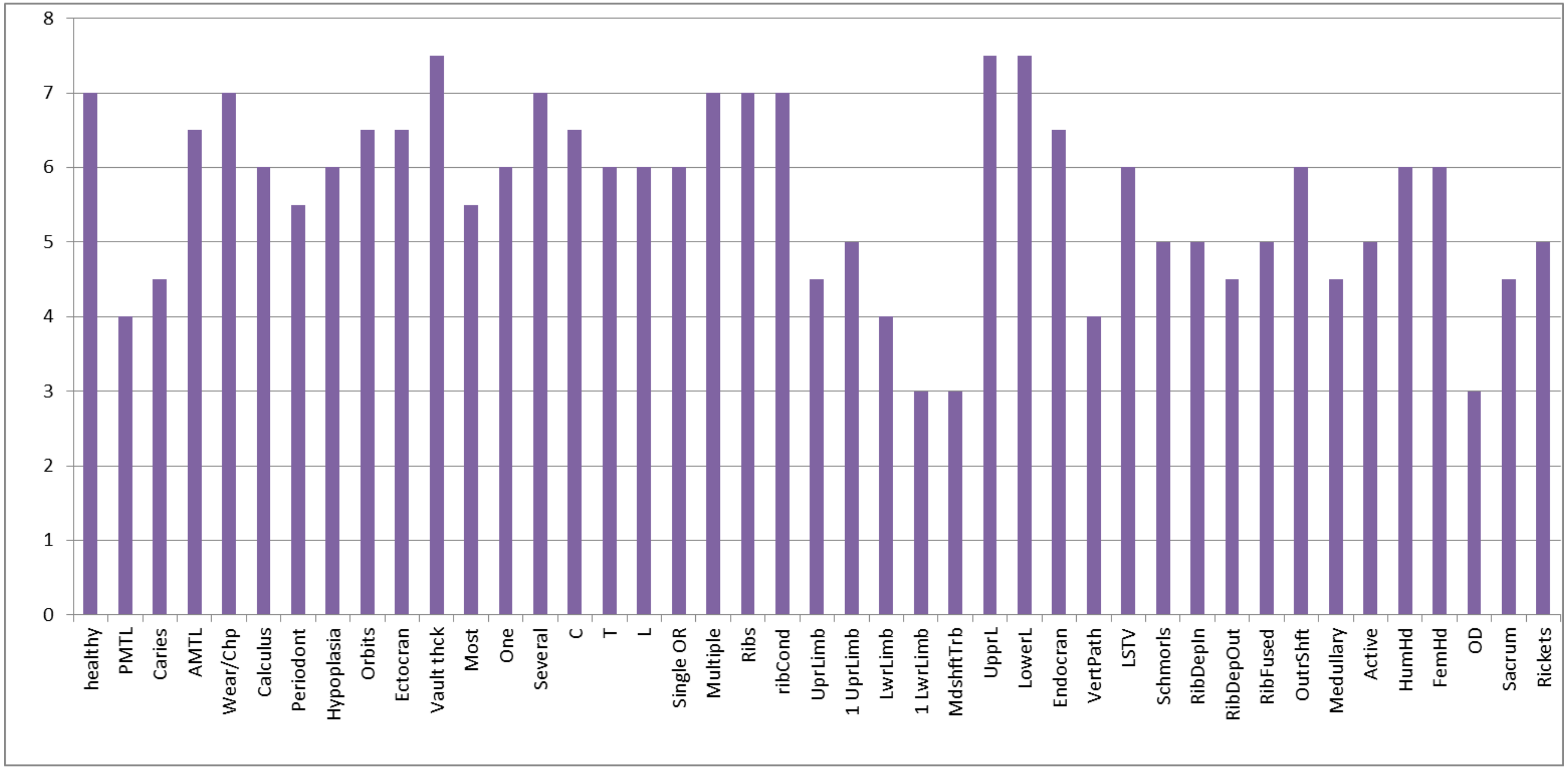


Figure 5.12. Session 1D Paleopathology. Correct answers per query from Session 1D for 'pathology' section of protocol. Eight forms were scored thus the maximum number of correct answers for any query was limited to 8. Three participant failed to answer most of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.1.7 Week One: Completed versus Abandoned Forms

For the Week 1 form as used in all four session, three columns were offered in the paleopathology segment: None or N/A, Present, and Notes. In addition, respondents often were asked to choose between *versions* of Present: for example, Mild (with descriptions of bone appearance associated with mild expression for the trait), Moderate (additional description), or Severe (additional description). If the answer chosen for a graduated query was off by one degree, for example Mild was selected for a trait the author finds is expressed Moderately, 0.5 points were applied. As long as respondents attempted to answer the questions, the scores were generally near or above 70% (with five exceptions: 11JR, 19KM, 24AF, 33AB [second form] and 34OM); the volunteer did flag potential bone anomalies such as healed rickets, or common pathologies such as caries and osteoarthritis of long bone joints or vertebrae. Blanks could not be presumed to represent an answer such as Mild (one degree from Normal) nor were blanks presumed to represent Normal bone and were marked as incorrect. The average score for the 22 participants who managed to complete the form was 68.9 answers correct out of 96 queries (**Table 5.9**).

However the total score does not reflect effort and comprehension in the Inventory segment. If the participant did not complete the form, they tended to abandon the process soon after starting the Paleopathology section. Some of these ‘abandoning’ participants scored the highest Inventory scores for all sessions in Week One. The highest Inventory-only score in the ‘completers’ was scored by 30JY with 41.5 correct out of 53; 12EJ and 15BD both scored 40.0. But in those who abandoned the form (**Table 5.10**), high scores for Inventory-only include 43.0 for 29MY, 42.0 for 02IC, 41.5 for 05GL, and 40.5 for 13MW. Scores across all weeks (91 forms), separated by Inventory and Paleopathology are examined in **Chapter 6.**

Assessment Protocol Tested in Winchester

Table 5.9. Completed Forms, Week One. Twenty-two Week One participants completed the form; scores are listed as the raw number correct of 96 queries. Participants include WARG/NF and student volunteers.

Participant	Score
07RH	71.5
08MH	75.0
09CS	68.0
10SH	68.5
11JR	62.0
12EJ	71.0
14YS	72.0
15BD	75.0
17CB	71.5
18AK	71.0
19KM	63.5
23MS	71.5
24AF	45.0
25SH	69.5
26AY	73.5
28AP	82.0
30JY	72.0
31CW	78.0
32BB	64.5
33AB	66.5
33AB	61.0
34OM	63.0
Average	**68.9**

Table 5.10. Abandoned forms, Week One. The twelve Week One participants who abandoned form are listed along with their raw scores, shown as the correct out of 96 queries. Participants include WARG/NF and students.

Participant	Score
01JR	48.5
02IC	61.2
03RC	43.5
04AH	47.0
05GL	55
06PH	36
13MW	59.5
16WH	48.5
20ND	42.5
21TR	31
22ZE	33
29MY	56.5
Average	**46.9**

Several respondents were uncomfortable with merely marking their choice of Mild, Moderate or Severe as 'Present' and in addition selected 'None or N/A' for all other choices in that section. This response was independently chosen by three participants who did not work together in session 1C (24AF, 26AY), and by a volunteer in 1D (28AP).

5.5.2 Week 2 Session 2, sections A, B, C, D (20, 21, 22 March 2012)

5.5.2.1 Materials

Two specimens from Week 1 were used again (Skeleton 2 and 15), and an additional skeleton was selected (Skeleton 17). All of these specimens are from young adults (**Table 5.1**), with 2 and 15 from probable males and 17 the skeleton of a probable female.

Skeleton 2: Adult Male, moderate to severe caries and dental wear; healed greenstick fracture on right femur. Skull, hips and most elements complete. Obscure pathology: premature fusion in lamboidal sutures.

Skeleton 15: Young Adult Male, tall, gracile. Tuberculosis and leprosy; mild dental wear; mild periosteal reactions on both tibiae, active at death. Skull shattered. Premature fusion of part of the sagittal suture.

Skeleton 17: Young Adult Female. One very large caries (+3 mm) with dentition otherwise healthy. Traits for ageing include youthful billowing/furrows at the pubic symphysis and medial clavicles. Sacral elements S1 and S2 retain a hiatus. Mild periosteal reactions on legs, osteochondritis dissecans in several joints: left and right humerii, and right fibula. Obscure pathologies include premature fusion of both sagittal and lamboidal sutures.

5.5.2.2 Methods

The second version of the protocol (**CD Appendix Item 4, Qs for Protocol Version 2**) extended the questions from 103 (including individual podial and vertebrae counts) to 110. Six questions were added to the inventory segment:

presence of one, both or neither patella, scapula, and clavicle; appearance of hip socket rim (round or oval with firm edges, irregular, ‘bumpy’, rough; or very uneven), and two additional questions on fusion of the sacral elements. For the latter, the first question is binary: is the sacrum fused into one bone yes or no; the second graduated: is there a gap between S1 and S2, a remnant of the fusion line, or ‘No’. The wording is awkward and will be streamlined. One question was added to the paleopathology segment, a query related to abnormal fusion of two or more vertebrae. For scoring, individual counts of the different types of vertebrae (cervical, thoracic, lumbar) and hand and foot podials (carpals or tarsals, metacarpals or metacarpals, phalanges) were combined into Correct, Partial or Incorrect scores (rationale in discussion), so the total scored queries for ‘Inventory’ rose from 53 to 59. The total queries for ‘Paleopathology’ rose from 43 to 44.

In addition, feedback from several Week One volunteers prompted a small redesign of the form. In the version used in Week One, the paleopathology segment offers three columns: two for recording the presence or absence of a trait: ‘None or N/A’, ‘Present on Bones’; and a column for ‘Notes’. Not everyone recorded a choice in either ‘None’ or ‘Present’, resulting in many queries being marked ‘incorrect’. For the Week Two version of the protocol, the three columns were reduced to two, with one labelled ‘Present?’ and the other ‘Notes’. Thus the form was modified from the Week One form (**Section 5.5.1.2**) due to additional questions and the loss of one column in the paleopathology segment.

A problem developed in the first session of the week (2A) using the modified form: due to a printer error, draft versions of the revised form, with only three of the six new queries were printed and inadvertently distributed. Therefore most of the participants for Session 2A were not queried on the appearance of the hip socket, which is an ageing trait as well as a potential indicator of osteoarthritis or other hip problems; nor queried on the state of fusion of the sacrum or on the level of fusion between the first and second sacral elements, which are ageing traits. This was corrected for Sessions 2B, 2C, and 2D. Two participants in 2A did use the correct form and indeed 09CS completed one erroneous form and one proper Version Two form. Specific traits and bone anomalies that were missed by more than 70% of the volunteers are examined in **Chapter 6.**

5.5.2.3 Session 2A Tuesday 20 March, WARG and New Forest.

The first meeting of this week was attended by semi-retired or retired adult members of WARG and New Forest, plus the Winchester University student who is also a member of WARG. Three skeletons were laid out before the session began: Skeletons: 2, 15, 17. Two skeletons had been available for observation the previous week (2, 15), and participants were reminded of their choice from Session 1A so as to ensure any new forms completed did not repeat earlier work.

Nine volunteers took part: 02IC, 03RC, 04AH, 06PH, 07RH, 08MH, 09CS, 11JR, 12EJ. Eight volunteers completed only one form based on observing one skeleton, with one volunteer completing two forms based on two different skeletons for a total of ten forms. One volunteer abandoned the form in the paleopathology segment, leaving 30 queries blank (04AH). This individual had the lowest score. The average score from all ten forms was 75.5 (out 100 queries for most participants in Session 2A). Scores ranged from 59.5 to 85.5 and the standard deviation was 8.63. **Figure 5.13** shows results for the group.

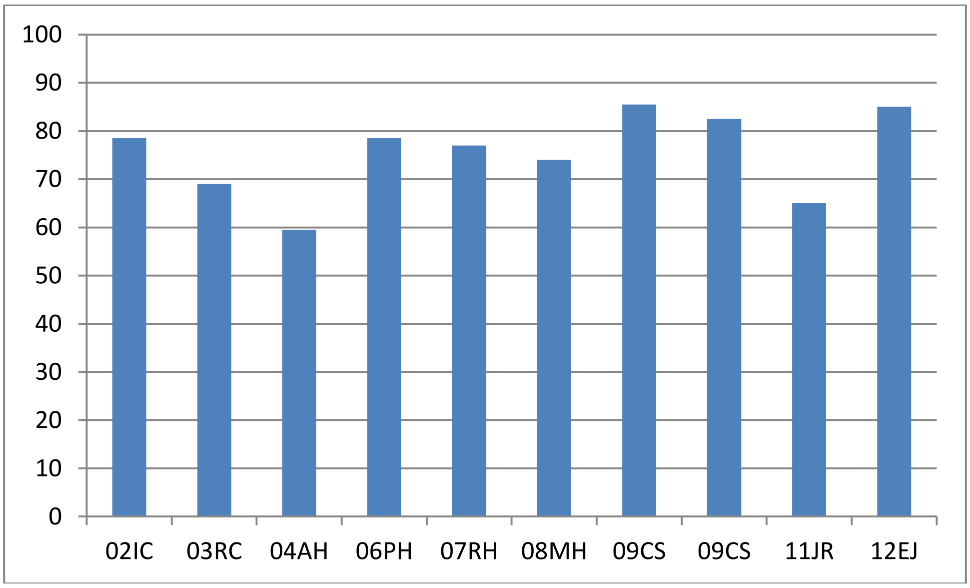


Figure 5.13. Session 2A. Scores for Week Two, Session 2A, with nine participants completing ten forms. The x-axis lists participants. Maximum number of queries on most forms was 100. 09CS completed two forms, one with 100 queries and one with 103. 04AH also used the form with 103 queries.

Figure 5.14 and **Figure 5.15** illustrate the overall success of each query. The maximum possible correct answers to any query are ten, the number of forms collected in Session 2A. Overall the success rate was 7.33 out of 10 (73.3%), with 7.34 successfully scored for ‘Inventory’ and 7.31 in ‘Paleopathology’. In

Paleopathology, observations regarding abnormal long bone shaft appearance (abbreviated 'Outr Shft' on **Figure 5.15**) and OD (osteochondritis dissecans) were problem queries. Most low-scoring queries in Inventory were due to flawed forms: eight of the ten forms were missing three new questions in this segment. Looking at the two participants who were offered these queries (04AH, 09CS), both correctly identified the state of the hip socket rim, both correctly surmised the fusion level between S1 and S2 in the sacrum, and one accurately described the sacrum as a fully complete bone. For ease of comparison, with the missing three queries removed from the Inventory segment, the group average is 7.50 out of a maximum of 10; Inventory is 7.64, and Paleopathology remains 7.31. Overall, considering the average total scores, with the partly answered questions removed, the group average is 75.0. Questions appearing on every form but suffering from similarly low scores were premature suture fusion and assessments of pubic symphyseal margins.

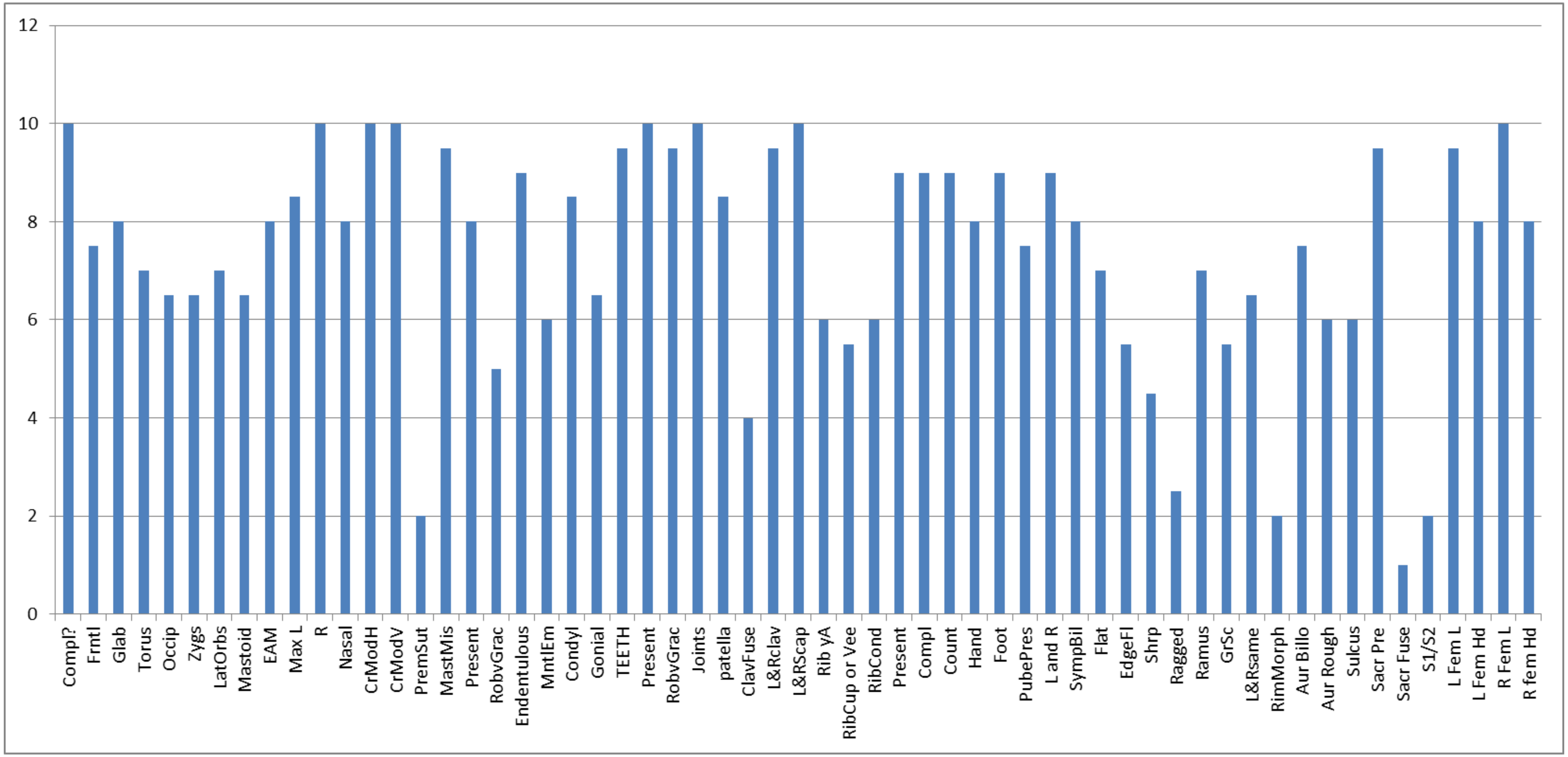


Figure 5.14. Session2A Inventory. Correct answers per query from Session 2A for inventory section of protocol. Ten forms were scored thus the maximum number of correct answers for any query was limited to 10. Eight forms were inadvertently missing three queries, abbreviated above as Rim Morph, S1/S2, and Sacrum Fused. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

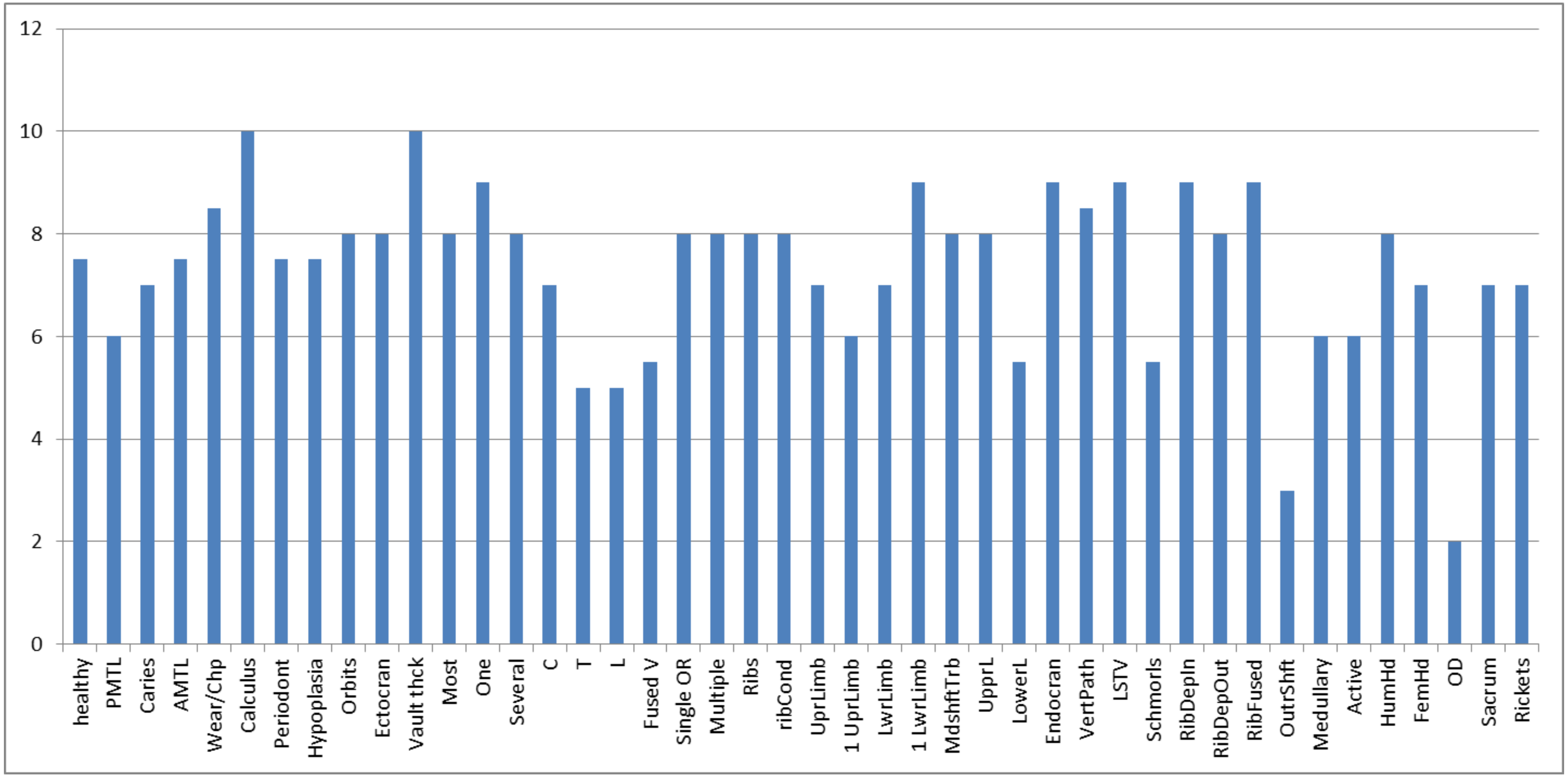


Figure 5.15. Session2A Paleopathology. Correct answers per query from Session 2A for 'pathology' section of protocol. Ten forms were scored thus the maximum number of correct answers for any query was limited to 10. One participant failed to answer most of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.2.4 Session 2B 21 March, Students, 11.00 am.

This session was for undergraduate students from the Department of Archaeology. Five of the six participants from the previous second session returned: 14YS, 15BD, 16WH, 17CB, 19KM. Two of the three skeletons observed by the 2A session were used for this one, the skeleton of young adult male (Skeleton 15) and that of a young adult female (Skeleton 17). Whilst both are of younger individuals, they represented both biological sexes, and the cranium is shattered for one, whilst complete for the other. Neither set of remains had been seen by this group the previous week. As in previous sessions, the remains were laid out before the session began.

This session ran very well, with all participants completing one form. It had been hoped that with volunteers becoming familiarised with the form the previous week that a second form might be completed by some of them but that did not occur. The scores ranged from 64.5 to 77.5, with the average score 69.0; the standard deviation between participants was 5.40. The highest scores were based on observing Skeleton 15 (77.5, 71.0) with scores based on Skeleton 17 very similar in final tally (64.5, 65.0, 67.0).

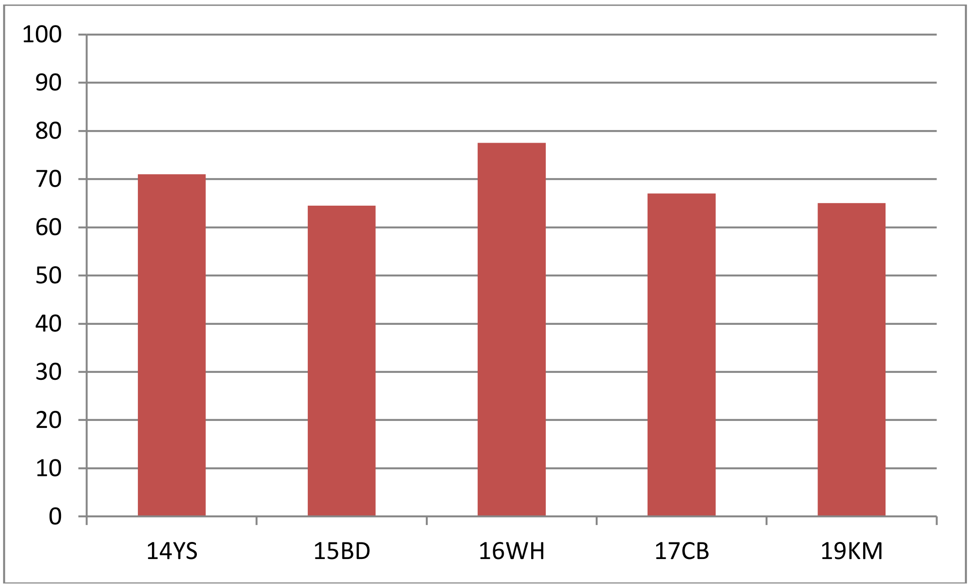


Figure 5.16. Sessions2B. Scores for Week Two, Session 2B, with five participants completing five forms. The x-axis lists participants. Maximum number of queries on the forms was 103.

The maximum number of forms was five, which was thus the maximum score for any query. The average score for the full form was 3.35 (67.0%); for the Inventory segment the average was 3.32 (66.4%). **Figure 5.17** illustrates these results. The problem queries were on premature suture fusion in the skull, youthful or billowy appearance of the medial clavicles (0 out of five) and questions related to the pubic symphysis. The query average in the Paleopathology segment was 3.39 (67.8%) with the problem questions related to abnormal long bone appearance (periosteal inflammation) and on whether rough and 'spiculated' bone is present; and on vertebrae with evidence of infectious disease or other trauma. Results for the Paleopathology segment are depicted in **Figure 5.18.**

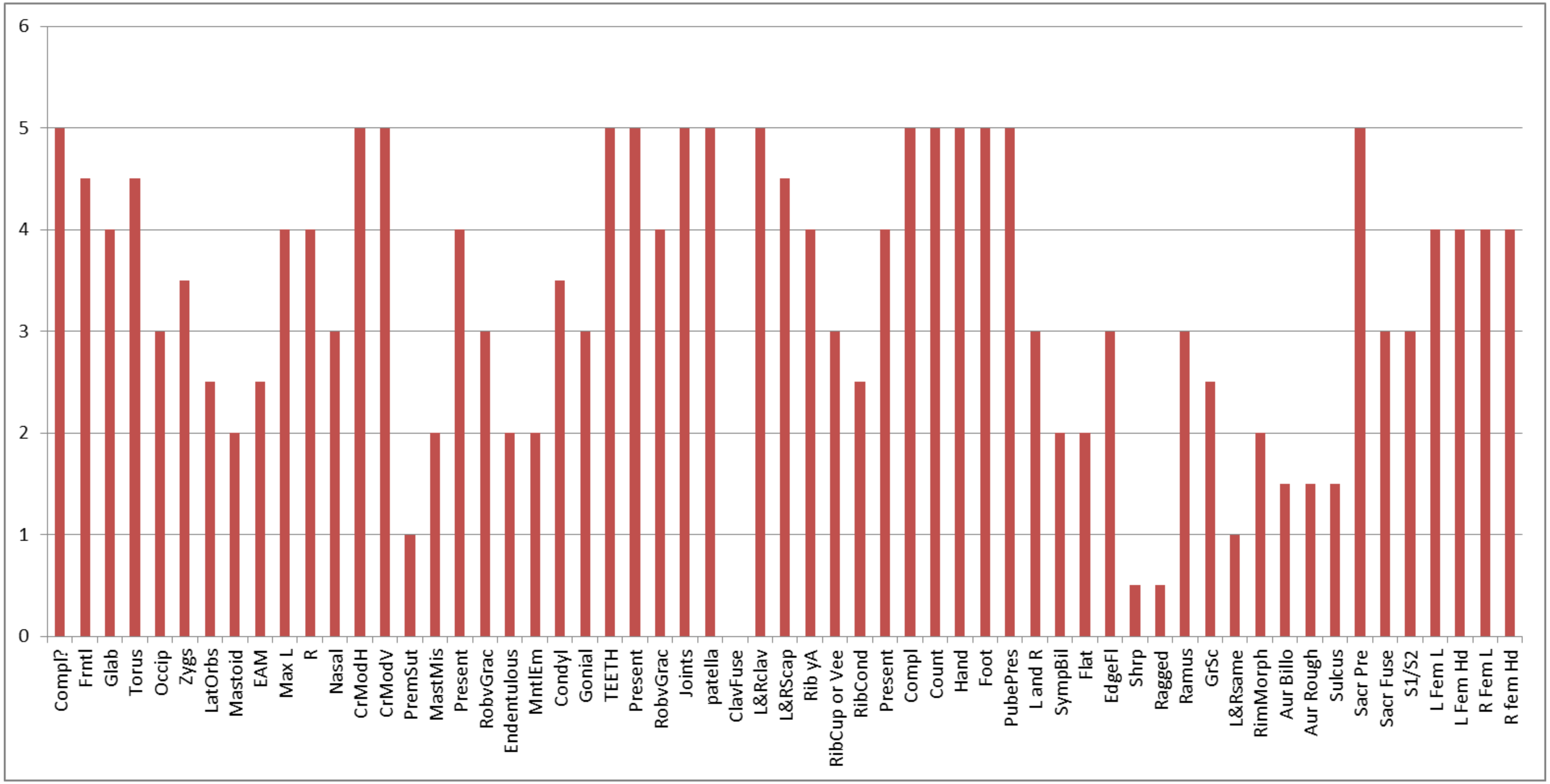


Figure 5.17. Session2B Inventory. Correct answers per query from Session 2B for inventory section of protocol. Five forms were scored thus the maximum number of correct answers for any query was limited to five. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

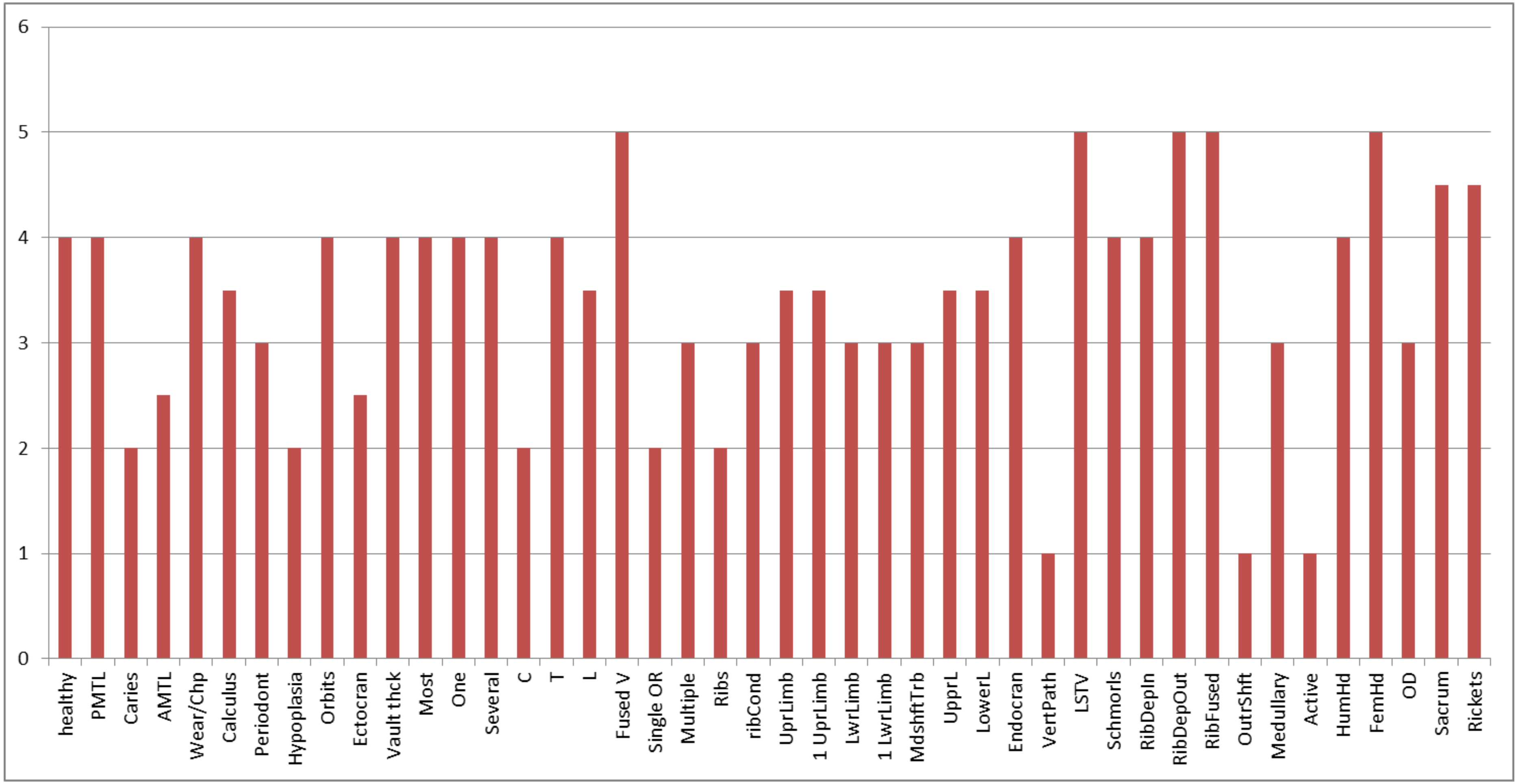


Figure 5.18. Session2B Paleopathology. Correct answers per query from Session 2B for 'pathology' section of protocol. Five forms were scored thus the maximum number of correct answers for any query was limited to five. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

Photograph 5.7: Week 2. Student session. By the second week, participants were more confident in handling the remains.

Photograph 5.8: Week 2. Student session.

5.5.2.5 Session 2C 21 March, Students, 1.00 pm.

This session was the second meeting of the day for student volunteers. The same skeletons observed in Session 2B were again used in this session (Skeletons 15 and 17), despite there being eight participants. Students readily moved aside as needed in order for everyone to have access to the remains. The two specimens are both young adults, but one is a probable male, the other a probable female; neither had been previously viewed by this group.

In retrospect this crowded situation may have facilitated answer sharing, with some volunteers using the exact same wording in jotted down comments, and the exact same measurements for femoral dimensions: which were also wrong and thus easy to spot. When answers across two forms were absolutely identical, one form was dropped. For this session, the form for 22ZE was omitted.

The seven scored participants were 20ND, 21TR, 23MS, 24AF, 25SH, 26AY and 27PH. The average score was 72.9 of 103 queries (70.8%) and the narrow range was from 65.5 to 77.5. The standard deviation was 4.01. **Figure 5.19** illustrates results for Session 2C participants.

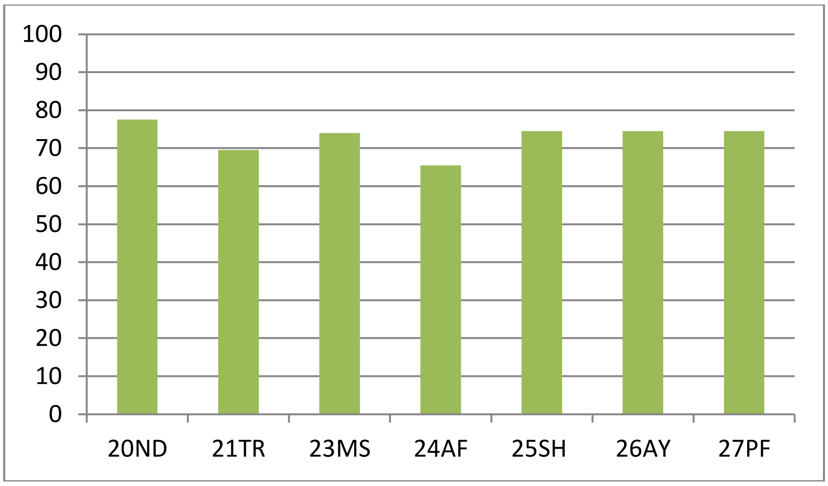


Figure 5.19. Sessions2C. Scores for Week Two, Session 2C, with seven participants completing seven forms. The x-axis lists participants. Maximum number of queries on the forms was 103.

The total number of forms scored was seven and thus the top score for any query was also seven. The average score across all queries was 4.95 (70.7%). For the Inventory segment (**Figure 5.20**) the average score was 4.79 (68.4%). Problems included premature suture fusion, identifying an immature medial clavicle (0 correct), locating the pre-auricular sulcus and measuring the femoral heads (1 correct out of 14 opportunities if left and right heads considered separately). **Figure 5.21** illustrates the Paleopathology scores, for which the average score was 5.17 (73.9%). Problem areas related to recognising abnormal bone in the orbits (scurvy, cribra orbitalia); correctly identifying moderate to severe osteoarthritis in the lumbar vertebrae, identifying abnormal bone on the outer long bone shafts (0 correct) and identifying OD.

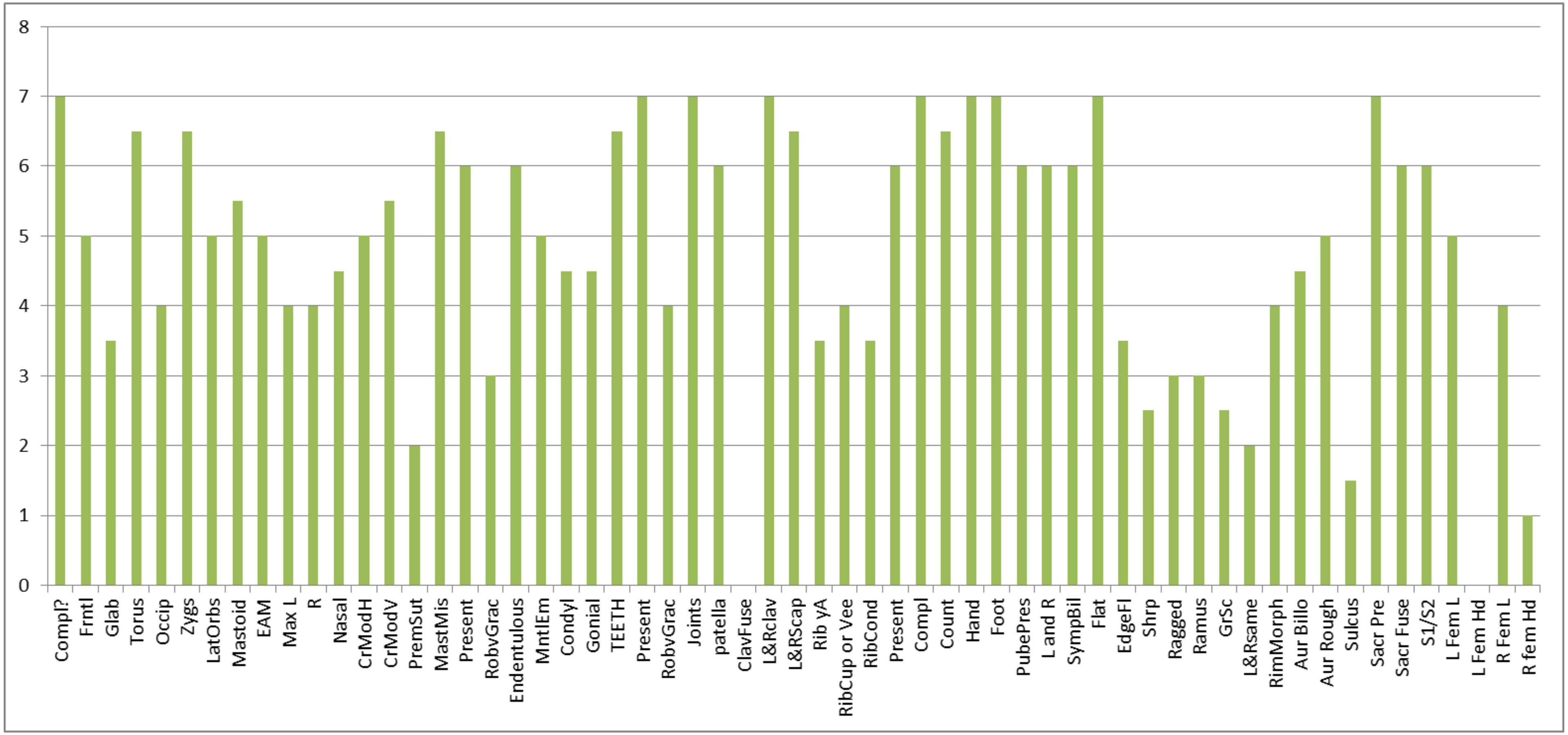


Figure 5.20. Session2C Inventory. Correct answers per query from Session 2C for inventory section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

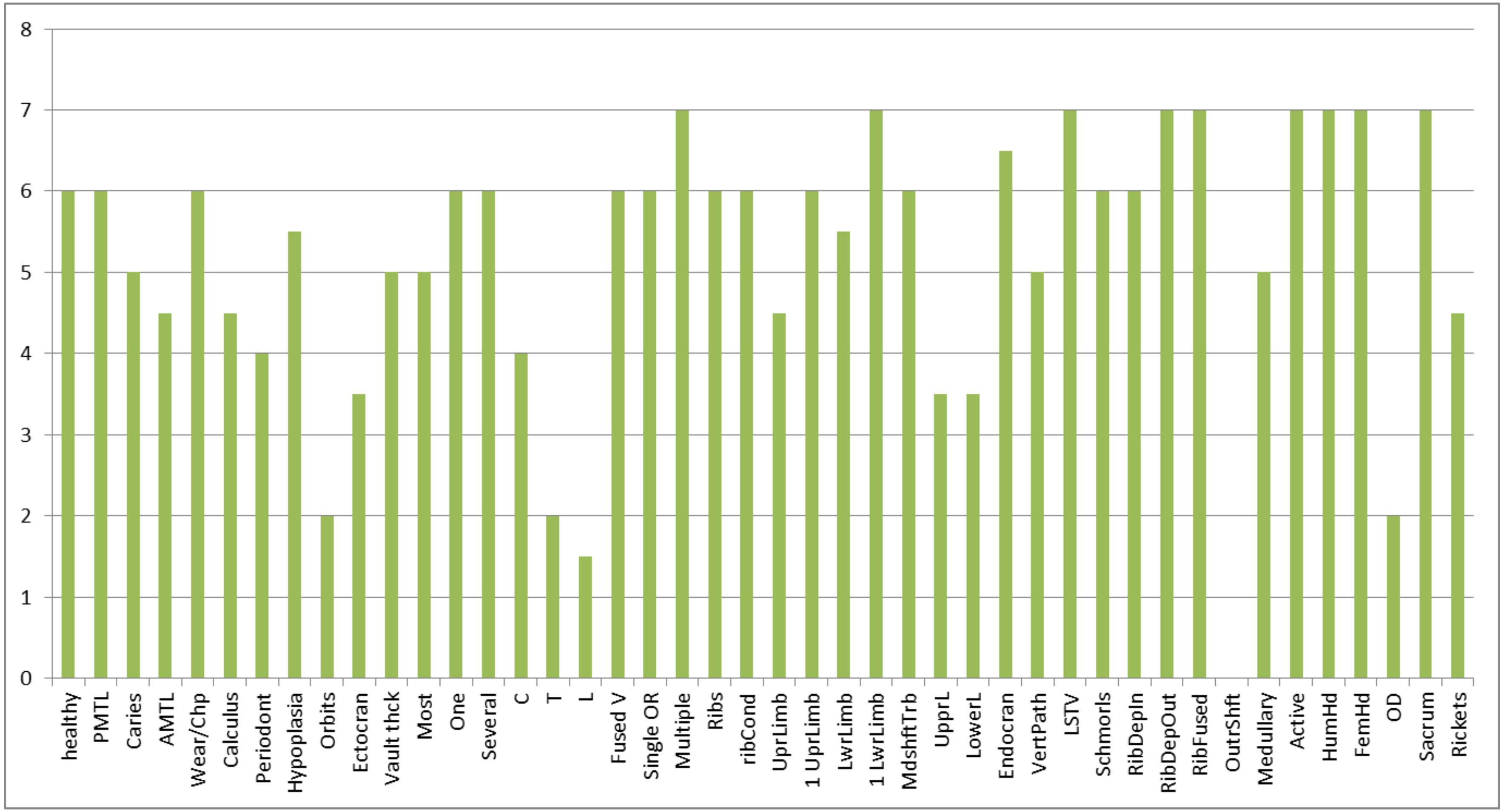


Figure 5.21. Session2C Paleopathology. Correct answers per query from Session 2C for 'pathology' section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.2.6 Session 2D 22 March, WARG and New Forest.

The final session of Week Two was another session for WARG and New Forest members; one student participated as a member of WARG, and brought her mother along. Two new participants joined the group (they had been previously expected to attend at some point) for a total of nine volunteers. The same three skeletons studied in 2A were also observed by this group: Skeletons 2, 15, 17, of which two (2, 15) had been available for viewing the previous week. Participants were reminded of their choice from Session 1D to ensure fresh results. The nine participants were 28AP, 29MY, 30JY, 31CW, 32BB, 34OM, and the three first-time participants 35JD, 36DH, 37IN.

The full scores ranged from 65.5 to 90.5 (out of 103 possible answers) with an average of 77.33 (75.1%). The standard deviation between participants was 7.81. The lowest score 65.5 (37IN) was from one of the new participants, but he left the first half of the Inventory segment completely blank. Another new participant (36DH) scored 83.0, and claimed to have never handled a human skeleton before. Altogether the three new volunteers, new to the form and with no prior experience scored an average of 73.8. **Figure 5.22** illustrates the scores.

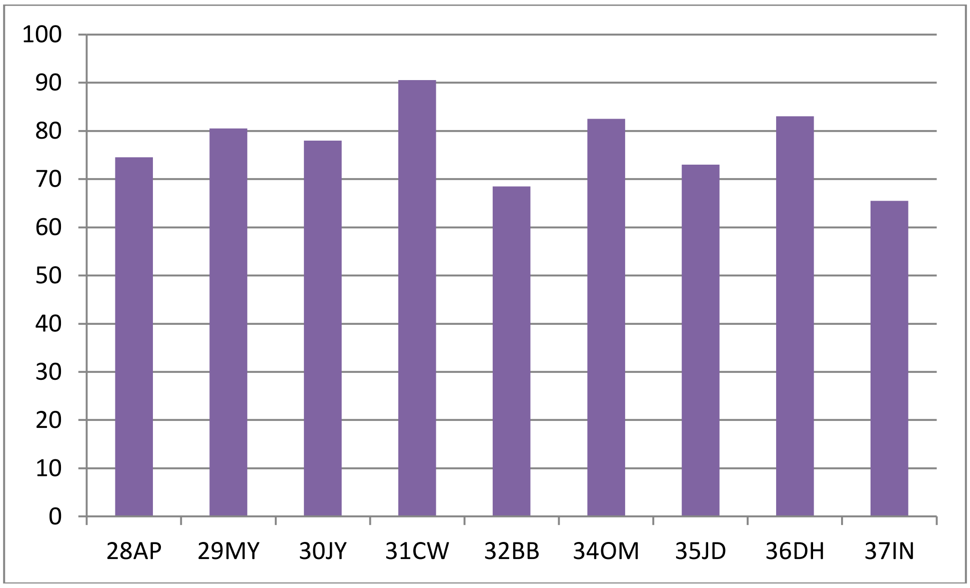


Figure 5.22. Sessions2D. Scores for Week Two, Session 2D, with nine participants completing nine forms. The x-axis lists participants. Maximum number of queries on the forms was 103.

Photograph 5.9: Week 2. WARG and New Forest volunteers, session 2D. This session was particularly interesting, as three new volunteers participated for the first time. The form had been slightly expanded from Week 1, with typos corrected, and a separate Information Booklet available.

With nine participants, the maximum possible score for any query was nine. **Figure 5.23** and **Figure 5.24** illustrate the query scores for Session 2D. The average score was 6.76 (75.1%). The Inventory segment had an average score of 6.47 (71.9%), but one participant was unable to answer half of this segment: out of 59 possible queries, he scored 29.0. Problem areas across the group include premature suture fusion (0 correct), recognising the ageing trait in medial clavicles, and assessing the pubic symphysis. The Paleopathology segment was more successful with an average score of 7.15 (79.4%). Here, problems related to recognising osteoarthritis in thoracic vertebrae, healed bone fractures, and assessing abnormal bone deposits (0 correct).

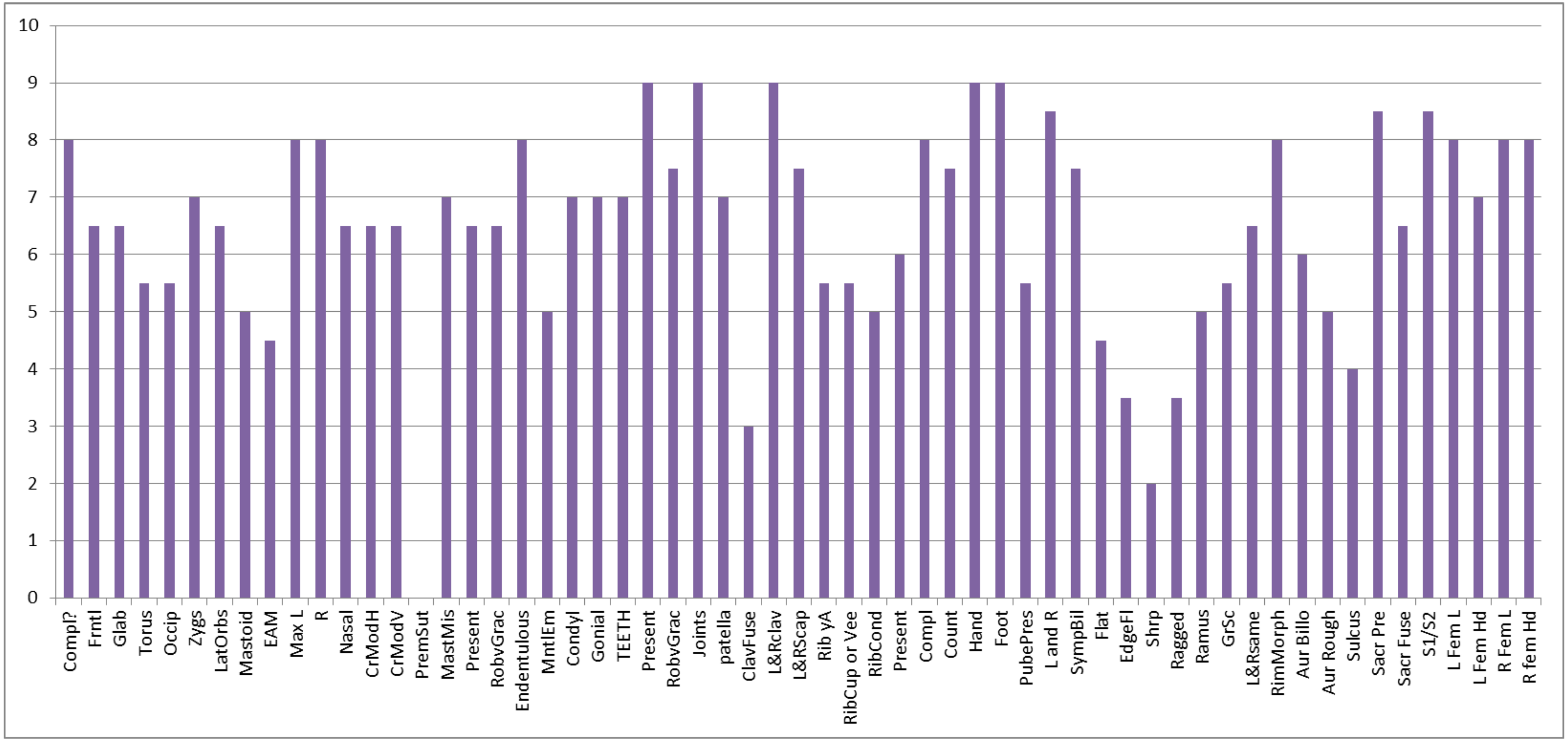


Figure 5.23. Session2D Inventory. Correct answers per query from Session 2D for inventory section of protocol. Nine forms were scored thus the maximum number of correct answers for any query was limited to 9. One participant failed to answer about half of the queries in this segment. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

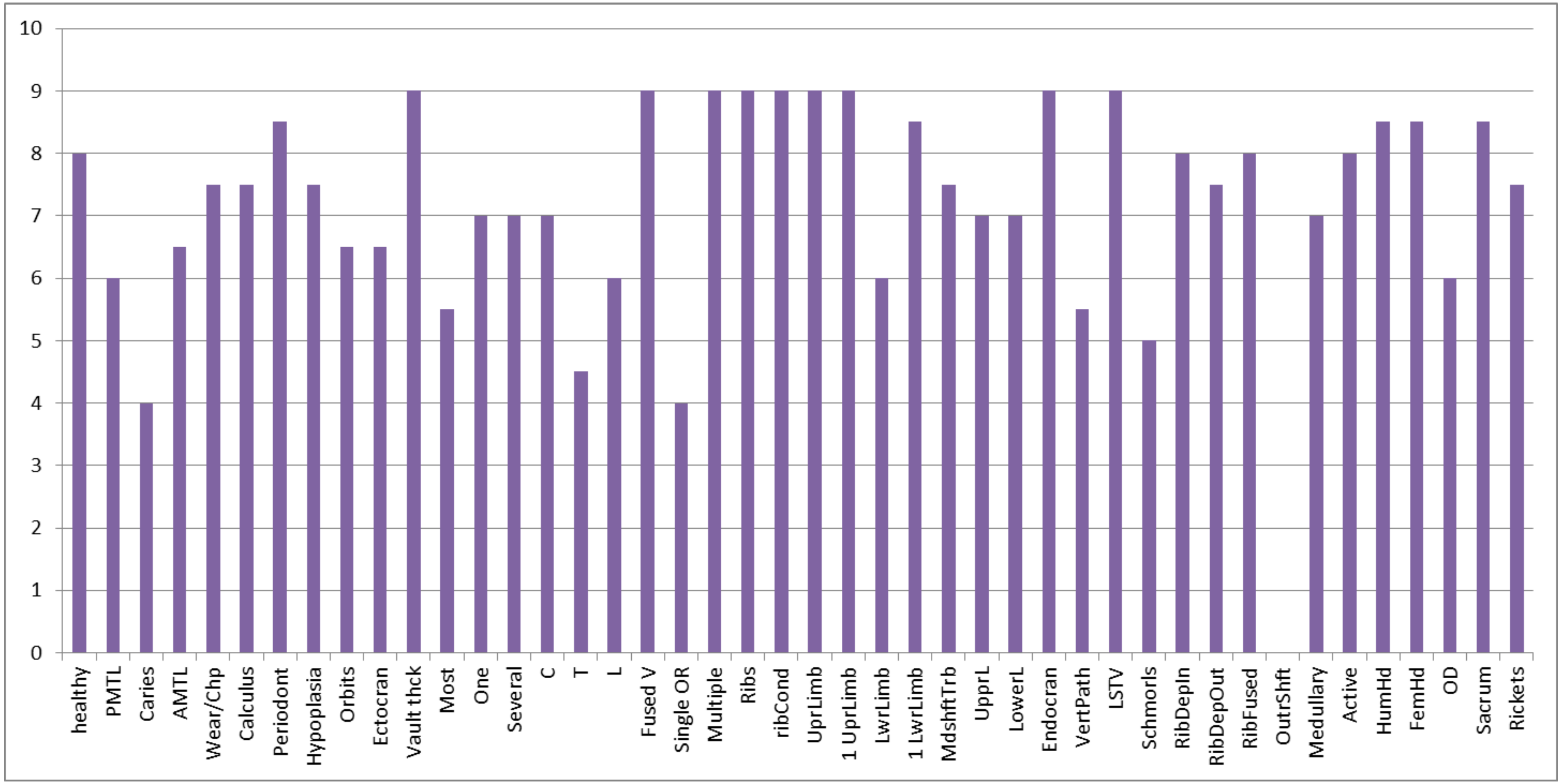


Figure 5.24. Session2D Paleopathology. Correct answers per query from Session 2D for ‘pathology’ section of protocol. Nine forms were scored thus the maximum number of correct answers for any query was limited to 9. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.3 Week 3 Session 3, Sections A, B, C, D (March 27, 28, 29 2012).

5.5.3.1 Materials

One specimen from Week Two was used again (Skeleton 17), as well as two skeletons that had not been previously observed: Skeleton 7 and 9. These three offered a range of age cohorts from young adult to older adult, and represented both biological sexes, as 17 is a probable female and both 7 and 9 are probable males (**Table 5.1**).

Skeleton 7. Adult Older Male with very poor dental health including severe wear and severe periodontal disease. The legs have extremely abnormal periosteal bone at the right ankle due to a slightly unreduced, poorly healed fracture of the distal fibula, but this is subsumed by exuberant adjacent bone growth, as well as on the tibia, and the fracture is not readily obvious. There is moderate to severe abnormal bone deposited on the shafts of the left tibia and fibula. The individual also has one unreduced rib fracture. The obscure pathological conditions include premature fusion of the sagittal and lambdoidal sutures.

Skeleton 9. Adult Male. Ageing accomplished due to hiatus between S1 and S2 and very mild dental wear; the individual can be considered to have no dental issues. There is mild periosteal reactions on the legs and OD in several joints: right humerus, right fibula, left femur. Obscure and specialist bone abnormalities include premature fusion of the sagittal suture, and sacralisation of the lowest lumbar vertebra (fusion of fifth lumbar with the sacrum).

Skeleton 17: Young Adult Female. One very large caries (+3 mm) with dentition otherwise healthy. Traits for ageing include youthful billowing/furrows at the pubic symphysis and medial clavicles. Sacral elements S1 and S2 retain a hiatus. Mild periosteal reactions on legs, osteochondritis dissecans in several joints: left and right humerii, and right fibula. Obscure pathologies include premature fusion of both sagittal and lamboidal sutures.

5.5.3.2 Methods

In Week Two, an amended version of the protocol had been given to volunteers (**CD Appendix, Qs for Protocol Version 2**), in which the number of queries had been increased from 103 (including individual podial and vertebrae counts) to 110. One more query was added for Week Three, an observation of the condition of the pelvic bones for a total of 111 questions. For scoring, individual counts of the different types of vertebrae (cervical, thoracic, lumbar) and hand and foot podials (carpals or tarsals, metacarpals or metacarpals, phalanges) were combined into Correct, Partial or Incorrect scores (rationale in discussion), so the total scored queries for 'Inventory' rose from 59 to 60. The total queries for 'Paleopathology' remained at 44.

One change was made to the design of the Paleopathology segment: the one column for recording *presence only* of a trait was modified to read 'Presence? or N/A'. The second column remained titled 'Notes'. No other changes were made on the form. The separate Information Booklet was provided to participants as in Week Two. Specific traits and bone anomalies that were missed by more than 70% of the volunteers are examined in section **6.7.1.3** *Problem Queries.*

5.5.3.3 Session 3A 27 March, WARG and New Forest.

The first meeting of the week was for adult members of WARG and New Forest; one student also attended as a member of WARG. There were ten participants, and 11 forms handed in: 09CS once again completed two forms within the session. Alone of all the volunteers, 09CS managed to assess five skeletons, one the first week and two each for Weeks Two and Three. In preparation for the session, three skeletons were laid out in anatomical position: Skeletons 7, 9, 17. Two specimens had not been viewed before (7, 9) but 17 had been available the previous week; participants who had observed this specimen were reminded to choose another.

The ten participants were 02IC, 03RC, 04AH, 05GL, 06PH, 07RH, 08MH, 09CS, 11JR and 12EJ. **Figure 5.25** illustrates the overall performance of the participants. The scores ranged from 46.5 to 89.5, with an average score of 71.0 correct answers out of 104 queries (68.3%). The standard deviation was 15.52. Only five of the 11 forms had all or most questions answered; the other six participants abandoned the form partly through the Paleopathology segment. Therefore, whilst Inventory segments had relatively high scores, the second half of the protocol was not successful.

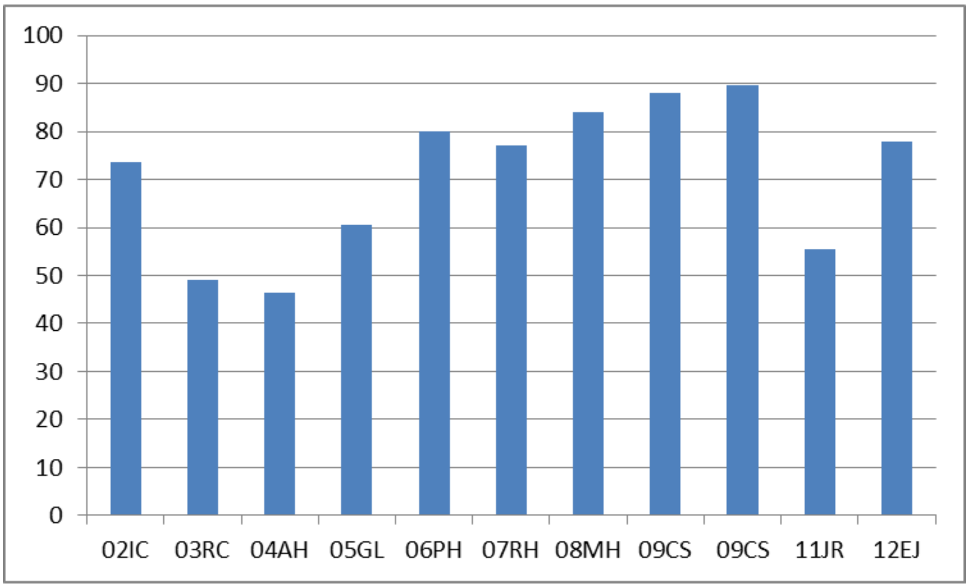
:


Figure 5.25. Session 3A. Scores for Week Three, Session 3A, with ten participants completing 11 forms. The x-axis lists participants. Maximum number of queries on forms was 104.

Photograph 5.10: Week 3. WARG and New Forest volunteers. Skeletal remains were out of their bags; confidence had increased. Despite difficulties with assessing moderate to severe bone disease, results for Inventory improved overall.

With the maximum possible correct queries limited to 11 forms, the overall score averaged 7.51 out of 11 (68.3%). Because most participants struggled with the second half, examining each segment separately is particularly instructive. The average score for the Inventory segment is 8.79 correct (79.9%); these results are depicted in **Figure 5.26**. The problem areas were premature suture fusion (1 correct) and assessments in the pubic symphysis. The Paleopathology segment, shown in **Figure 5.27** was difficult for reasons discussed below, but can be summarised as a result of 'highly abnormal bone' on two of the specimens, and due to a design flaw in the protocol. The average score for this segment was 5.77 out of 11 (52.5%) with problem queries in OA and OD (confused by the participants) and determining the level of long bone involvement with the rather obvious periosteal infectious response. Another trait with low recognition was the sacralised fifth lumbar in Skeleton 9.

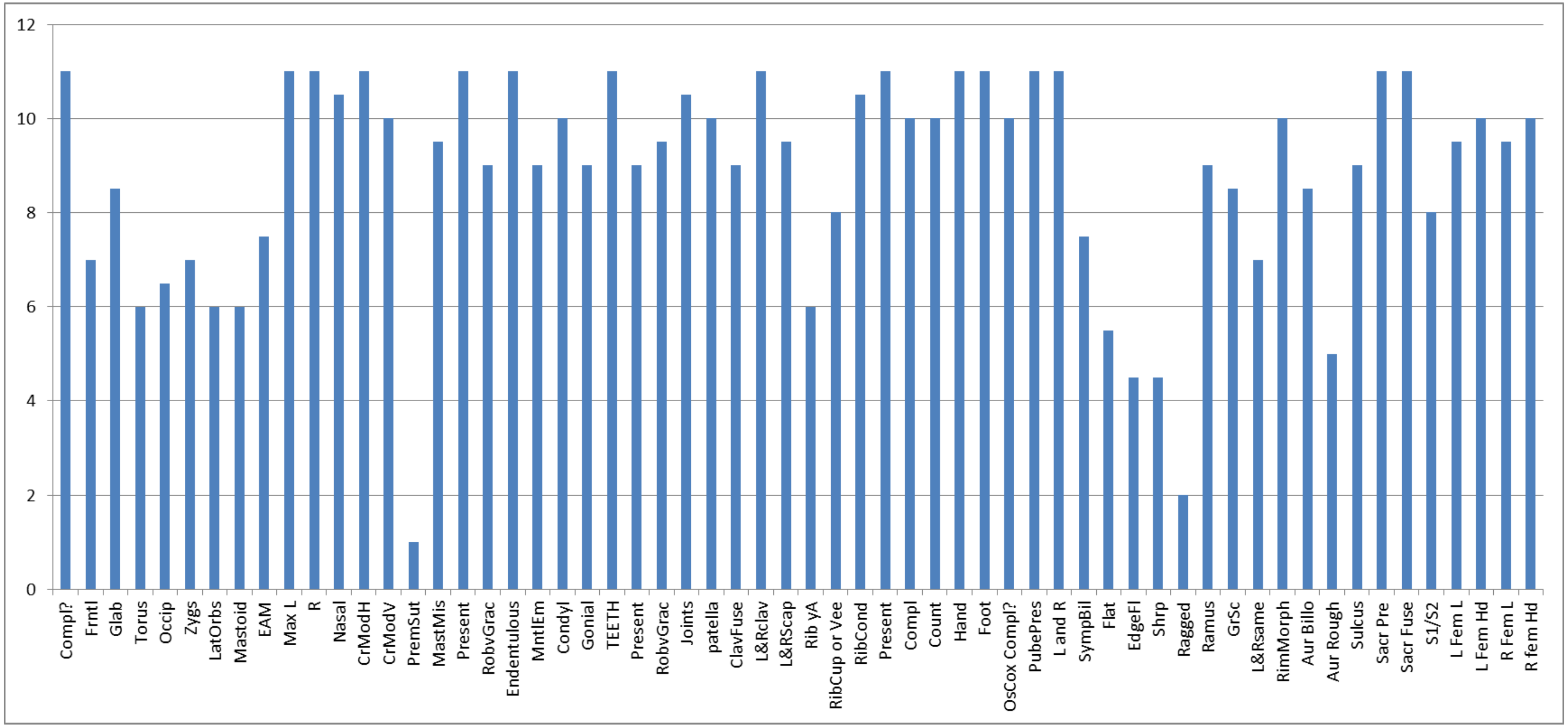


Figure 5.26. Session 3A. Correct answers per query from Session 3A for inventory section of protocol. Eleven forms were scored thus the maximum number of correct answers for any query was limited to 11. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

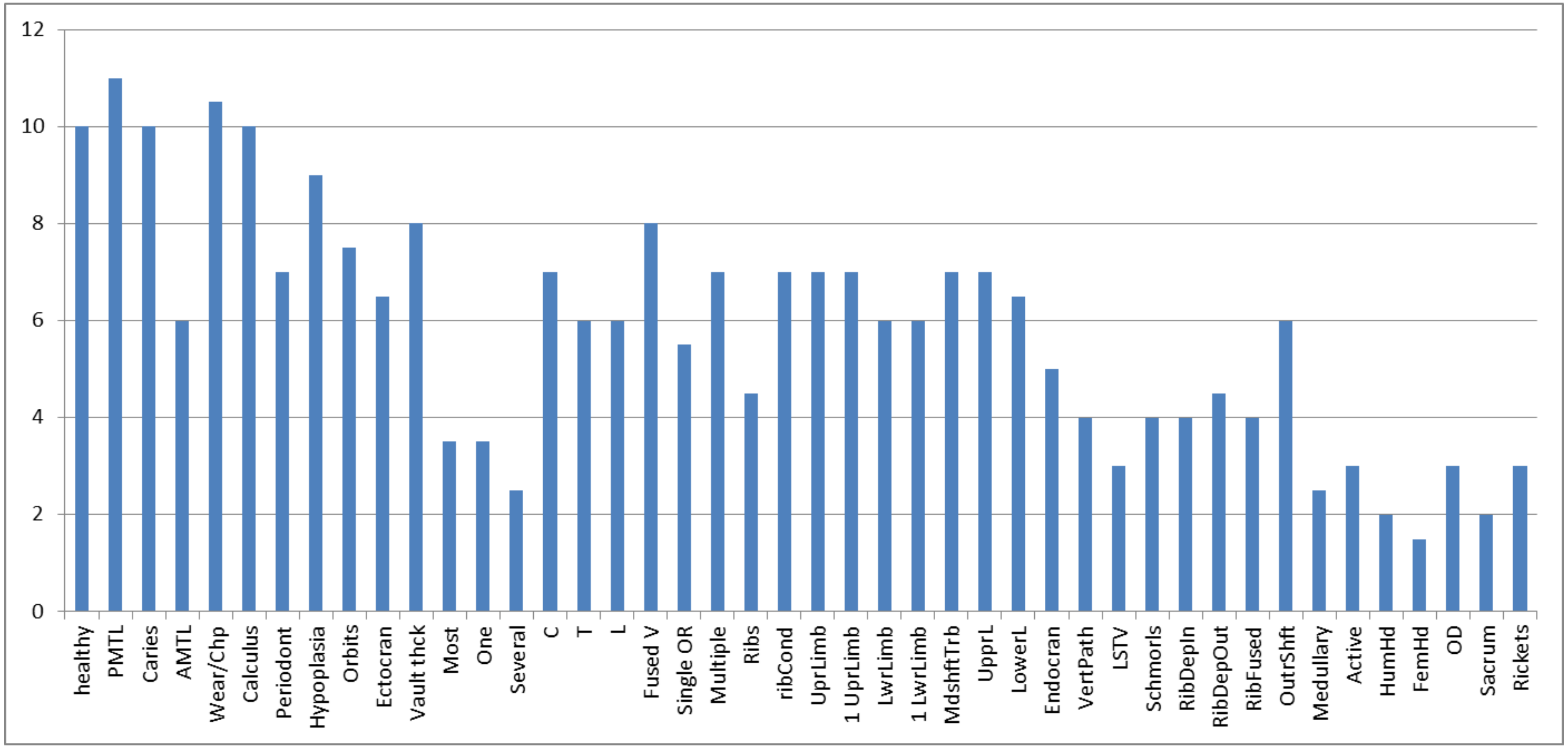


Figure 5.27. Session 3A Paleopathology. Correct answers per query from Session 3A for 'pathology' section of protocol. Eleven forms were scored thus the maximum number of correct answers for any query was limited to 11. Six participants failed to answer many of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.3.4 Session 3B 28 March, Students, 11.00 am.

This session was attended by only three students. Two skeletons were laid out in preparation (7, 9) but the small group worked on just one, Skeleton 7. Some answers were shared (the typically abysmal femur head metrics were identically wrong) but otherwise, observations seemed to be reached independently. This specimen had not been viewed by the group before. As science students, one supposes that they were familiar with sharing lab observations such as weights and other measurements taken during science classes. In future the necessity for each to come to independent conclusions will be stressed. The participants were 14YS, 15BD, 17CB, and the results are illustrated in **Figure 5.28.**

The scores were 68.5, 69.0, 75.5 for an average of 71.0 out of 104 queries (68.3%), and a SD = 3.91. With three participants, queries could have a maximum score of three. The average query score was 2.05 (68.3%). Separated by type, the average Inventory score was 2.17 (72.3%), and the Paleopathology segment average was 1.89 (63.0%). Problem areas in the Inventory segment (**Figure 5.29)** were assessing zygomatic bones for robusticity (0 correct), premature suture fusion (0 correct), recognising maturity of medial clavicles, assessing pubic symphyseal faces, and measuring the femur heads (0 correct) For this last task, the volunteers shared the work without question. The femur lengths were recorded identically as left femur length 459.74mm (author measured 458mm), right femur length 457.2mm (author 460mm) and femoral heads 101.6mm and 104.14mm for left and right heads respectively (50mm and 48mm respectively by author). The students presumably took the width of the entire proximal region, from greater trochanter to head, as ‘femoral head width’ but identical data recorded by all three participants for femoral metrics show answers were shared. Problems with Paleopathology assessments (**Figure 5.30**) included assessing abnormal bone in the orbits (0 correct), OA (0 to 1 correct) and identifying healed fractures.

Assessment Protocol Tested in Winchester

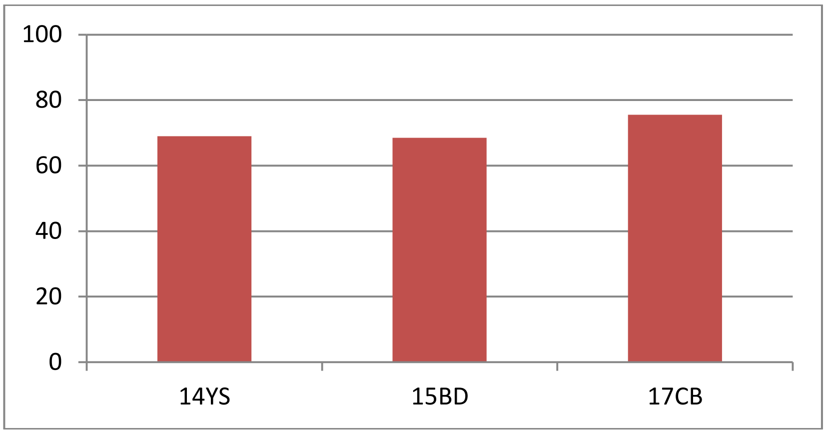


Figure 5.28. Session 3B. Scores for Week Three Session 3B, with three participants completing one form each. The x-axis lists participants. Maximum number of queries on most forms was 104.

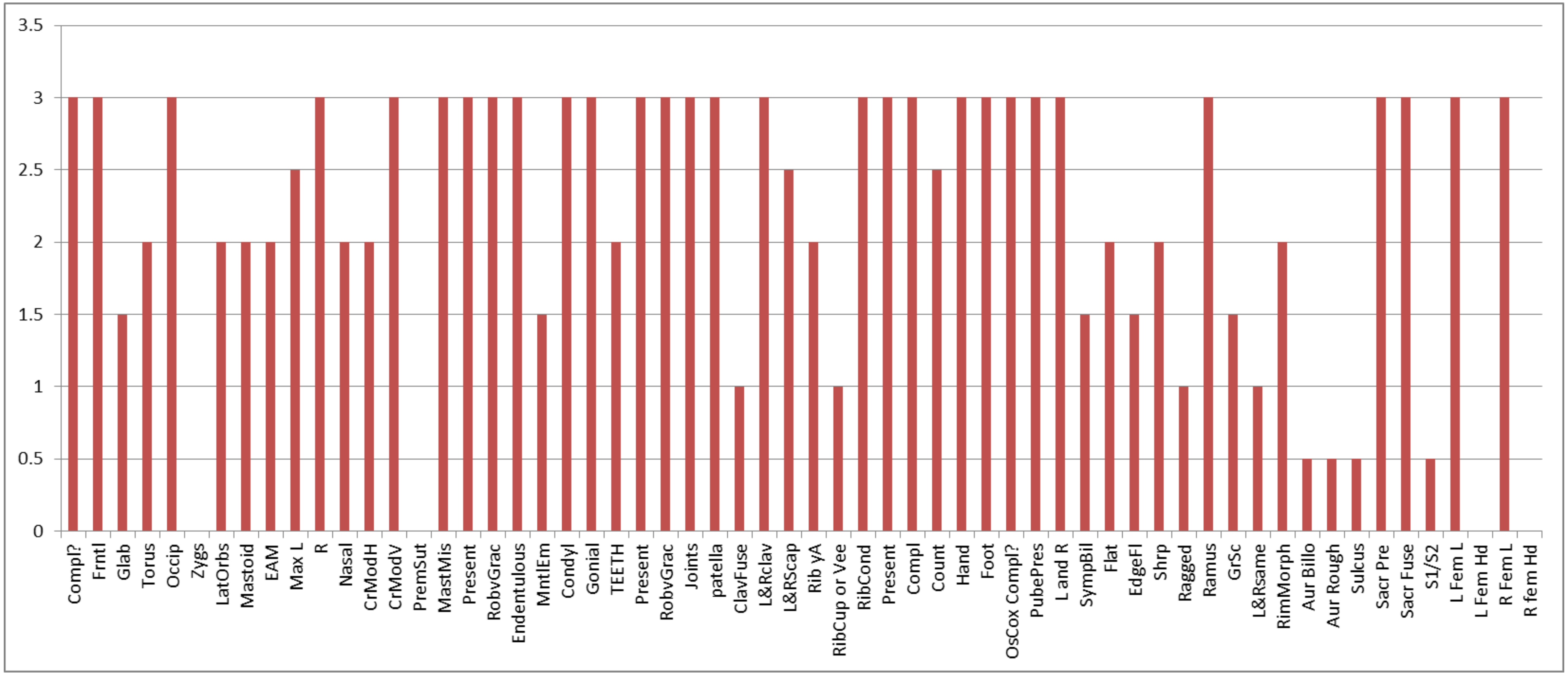


Figure 5.29. Session 3B Inventory. Correct answers per query from Session 3B for inventory section of protocol. Three forms were scored thus the maximum number of correct answers for any query was limited to three. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

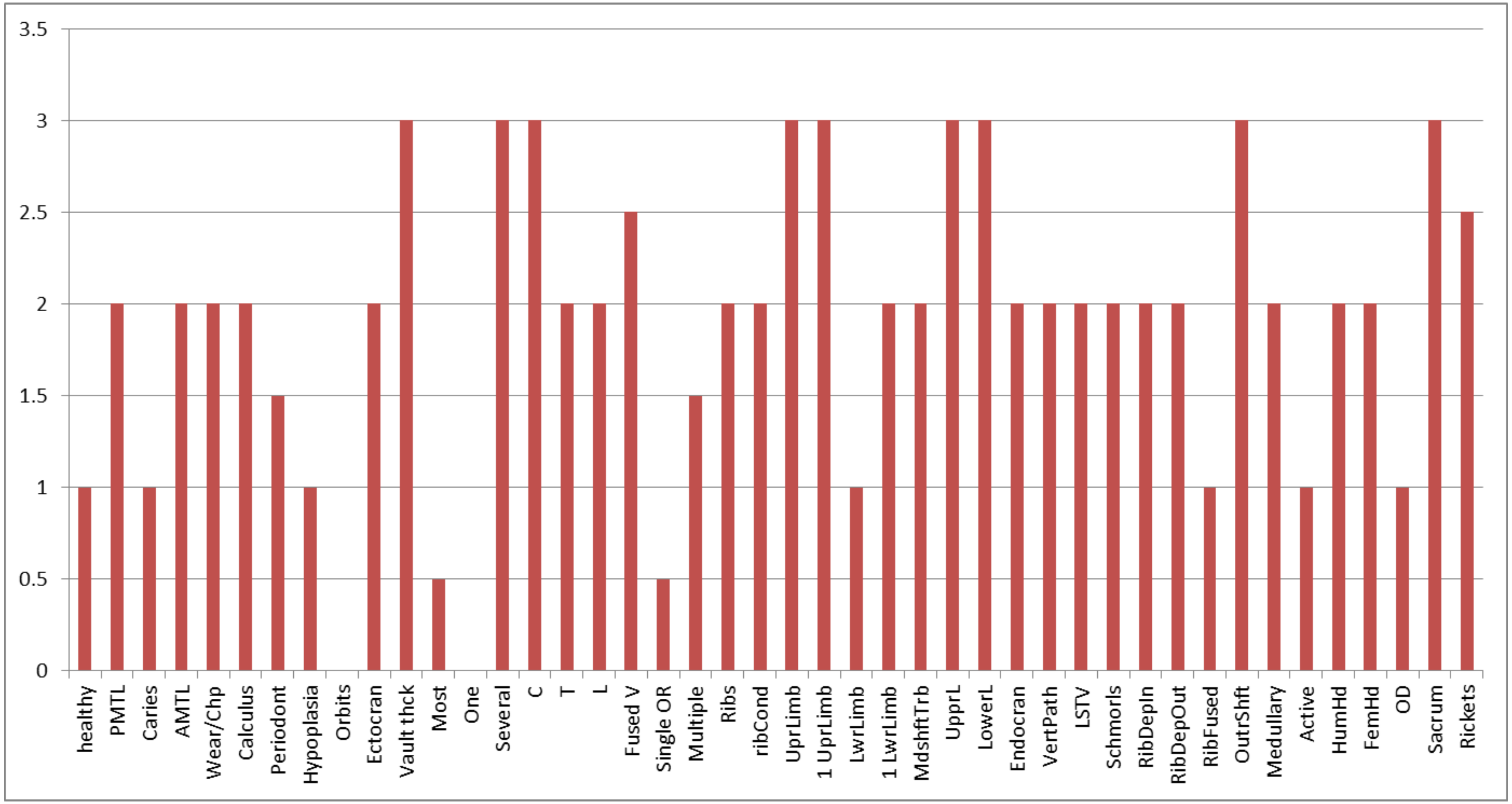


Figure 5.30. Session 3B Paleopathology. Correct answers per query from Session 3B for 'pathology' section of protocol. Three forms were scored thus the maximum number of correct answers for any query was limited to 3. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.3.5 Session 3C 28 March, Students, 1.00 pm.

The final session for students was attended by eight participants, but assessed results were reduced due to identical answers on two sets of forms. One form from each pair was discarded. One volunteer (26AY) completed two forms and both were used, thus seven forms were collected and analysed. The two sets of human remains from the previous student session were utilised for this meeting. The six participants were 20ND, 21TR, 23MS, 24AF, 25SH, 26AY; and the two skeletons observed were 7 and 9, neither of which had been viewed by this group previously. **Figure 5.31** illustrates overall scores for Session 3C.

Photograph 5.11: Week 3. Student session. During this session, several students were able to complete more than one form.

The scores ranged from 50.5 to 72.5 out of 104 queries, with both extremes obtained from viewing the same specimen (Skeleton 7). The average of the scores was 66.9 (64.3%) and the standard deviation was 7.77. One score is an outlier and if removed, the average of the six remaining scores is 69.6 (66.9%) and the standard deviation is 3.15. The seven maximum possible correct answers to each query average 4.50 across all queries. By type of query, answers in the Inventory segment average 5.07 (72.4%), and Paleopathology queries average 3.73 (53.3%). Problems in Inventory (**Figure 5.32**) include premature suture fusion, ageing traits in ribs, assessing pubic symphyses (0 correct for 'ragged') and measuring femoral head diameters: 0 correct. Interestingly every participant in the session correctly identified that the medial clavicles for their observed skeleton had lost the youthful billowing and furrows (**Questions for Protocol Version 1 and 2, CD Appendix**). Problems in the Paleopathology segment (**Figure 5.33**) predominately relate to participants becoming confused by the arbitrary division of pathologies on the form, necessitating them to choose the 'correct' form location to identify what appear to be similar conditions to the novice. Like participants in other Week Three sessions, trying to determine where to record the highly abnormal long bones and joint problems observed on Skeleton 7 resulted in much of the Paleopathology segment being abandoned.

Figure 5.31. Session 3C. Scores for Week Three, Session 3C, with six participants completing seven forms. The x-axis lists participants. Maximum number of queries on most forms was 104.

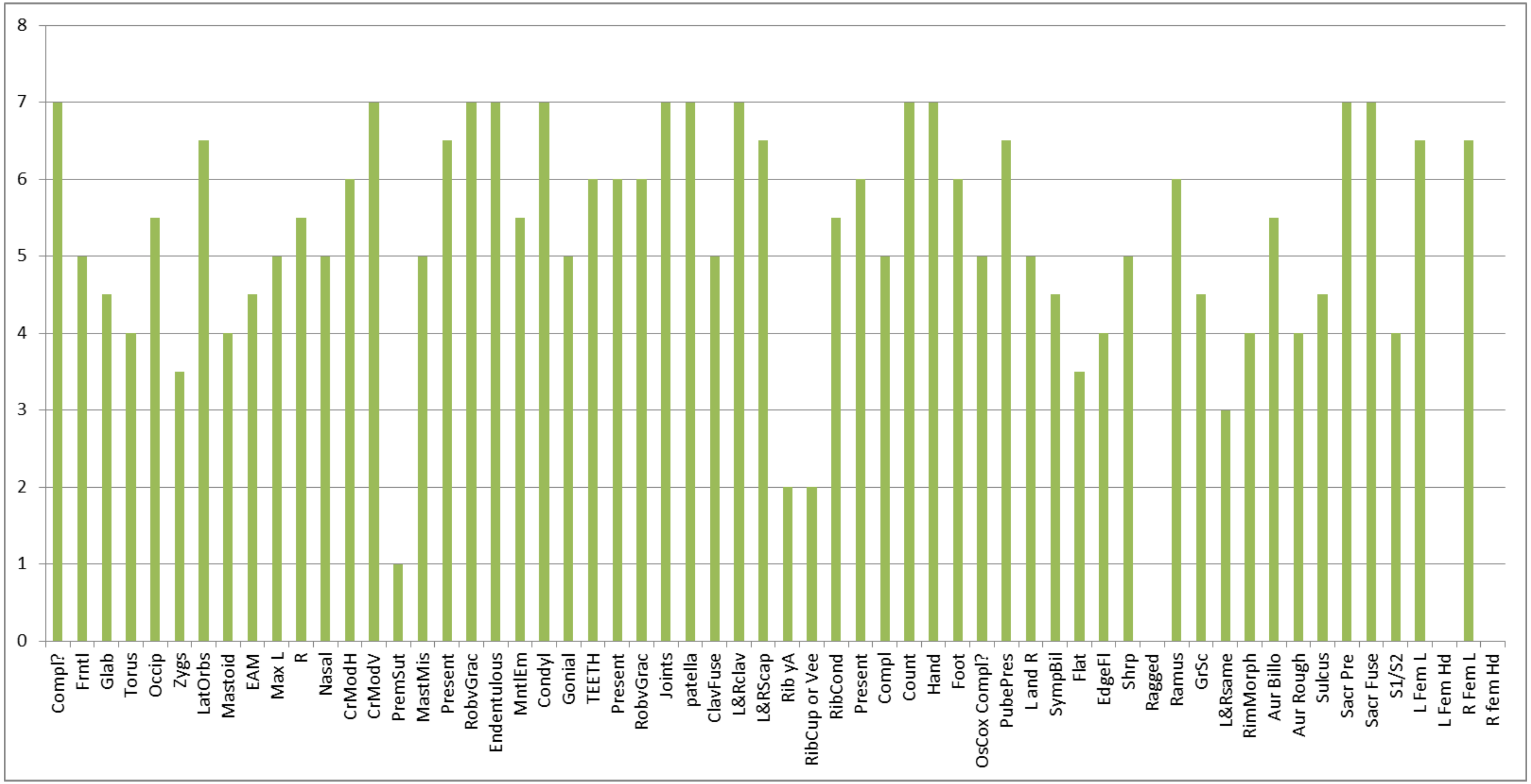


Figure 5.32. Session 3C Inventory. Correct answers per query from Session 3C for inventory section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

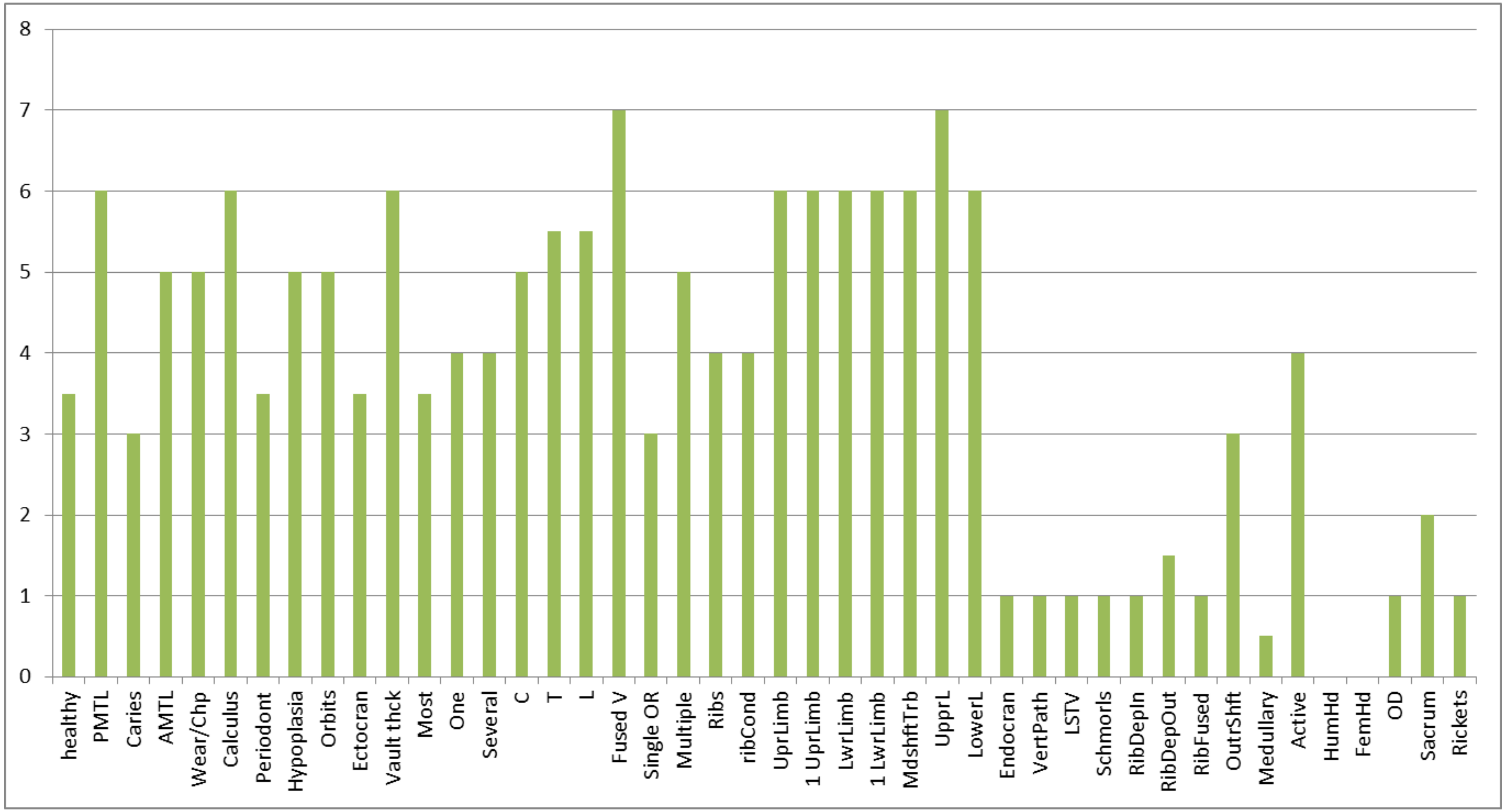


Figure 5.33. Session 3C Paleopathology. Correct answers per query from Session 3C for ‘pathology’ section of protocol. Seven forms were scored thus the maximum number of correct answers for any query was limited to 7. Most participants failed to answer about half of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.5.3.6 Session 3D 29 March, WARG and New Forest.

The final session of the trial was for members of WARG and New Forest. One of the three new volunteers from Week Two returned (36DH). Five participants attended, with each completing one form: 31CW, 28AP, 29MY, 30 JY, 36DH. The two skeletons laid out in advance of the session were Skeletons 7 and 9, both adult males with varying degrees of abnormal bone. Neither specimen had been previously viewed by this group.

The forms were mostly completed but a large number of queries were left blank by four volunteers, with even the most persevering volunteer (28AP) unable to answer queries regarding joint disease. This was due to a major design flaw that will be corrected in future versions, which made it exceedingly difficult to judge how best to assess a skeleton with multiple abnormalities. The total scores ranged from 60.0 to 71.0 correct answers out of 104 questions (**Figure 5.34**), with an average of 66.2 (63.7%). The standard deviation was 5.20.

With five forms collected, the maximum number of correct answers for any query is five. The overall average of query scores is 3.18, with Inventory queries successfully answered at an average of 3.78 times (75.6%). The Paleopathology segment was more difficult for volunteers, with queries correctly answered an average of 2.38 times (47.6%). Problems with Inventory queries (**Figure 5.35**) included recognising robusticity in the torus (1 correct), premature suture fusion (0 correct), and correctly assessing the pubic symphyses and auricular regions (1 correct in each), both used for ageing. Problems with the Paleopathology segment (**Figure 5.36**) relate to mass abandonment of this part of the form. Due to a highly abnormal joint region in Skeleton 7 adjacent to extremely profuse periosteal bone deposits, and mild OD in several joints in Skeleton 9, questions regarding joint problems (OA and OD) were left blank. Recognising abnormal bone on long bone shafts was more successful but in general the last third of this segment was left blank.

Assessment Protocol Tested in Winchester

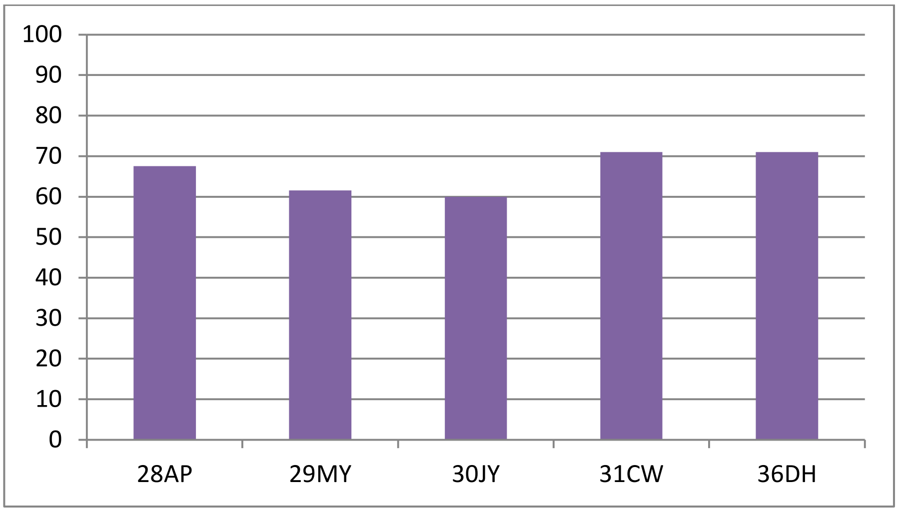


Figure 5.34. Session 3D. Scores for Week Three, Session 3D, with five participants completing five forms. The x-axis lists participants. Maximum number of queries on the forms was 104.

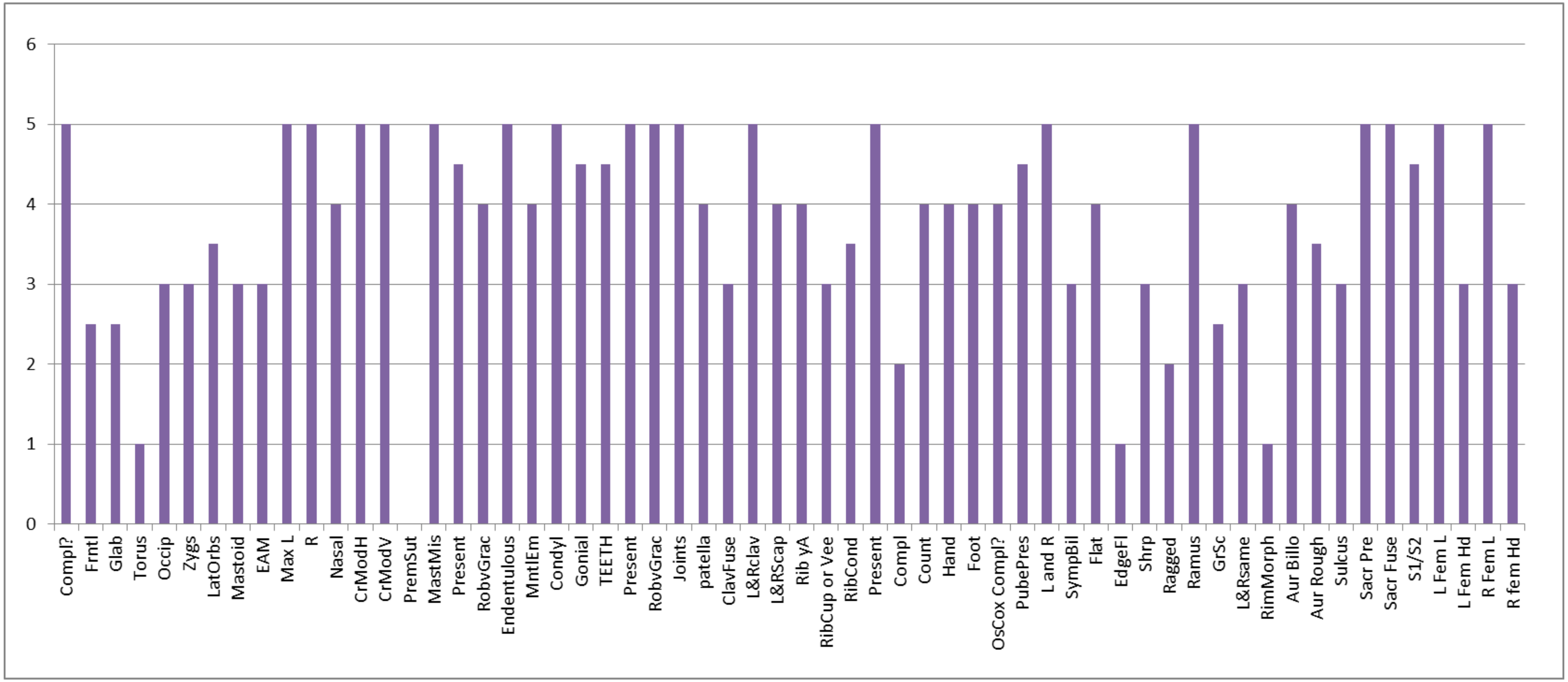


Figure 5.35. Session 3D Inventory. Correct answers per query from Session 3D for inventory section of protocol. Five forms were scored thus the maximum number of correct answers for any query was limited to 5. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

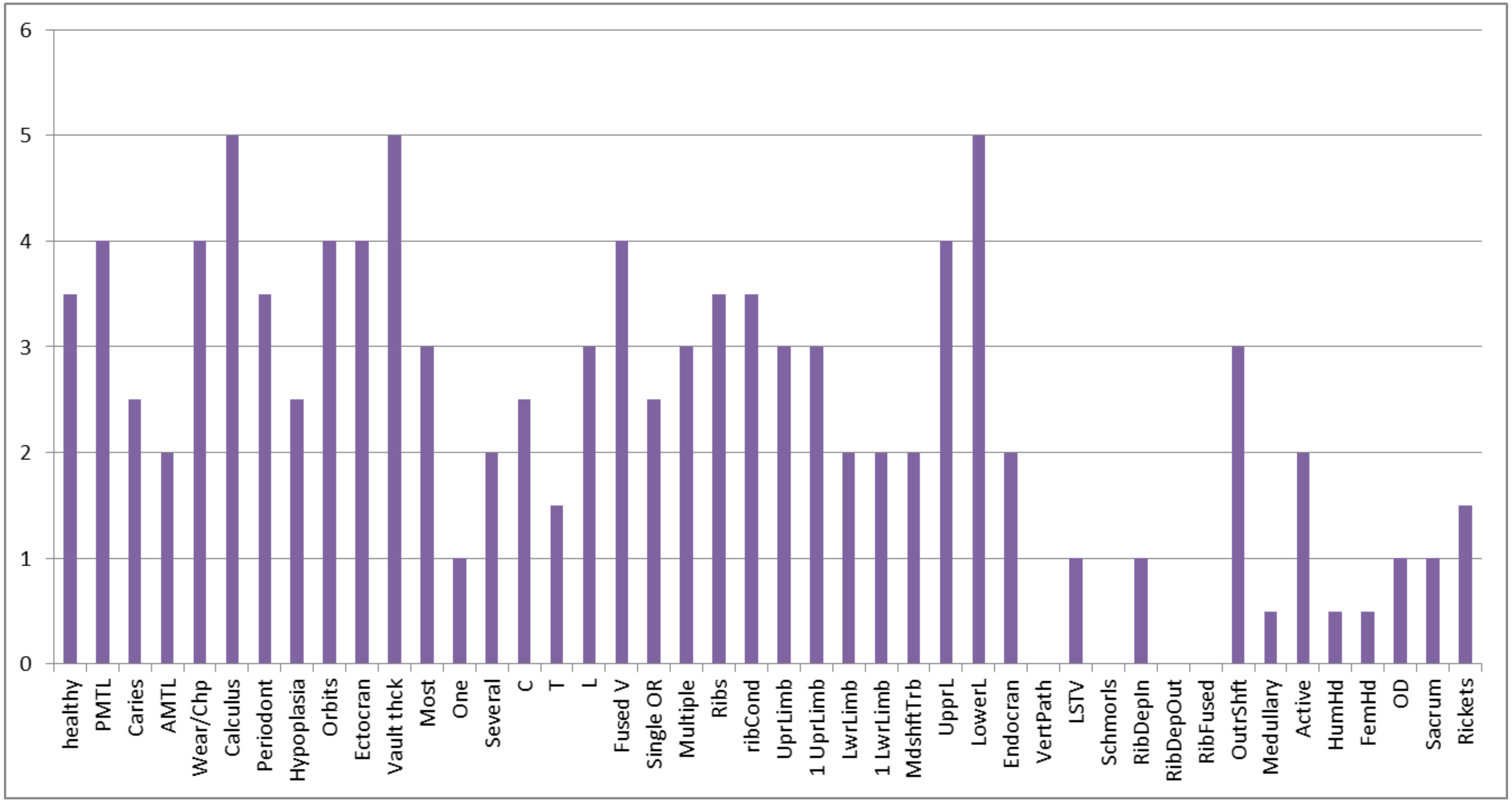


Figure 5.36. Session 3D Paleopathology. Correct answers per query from Session 3D for ‘pathology’ section of protocol. Five forms were scored thus the maximum number of correct answers for any query was limited to 5. Most participants failed to answer about half of the questions for this segment of the protocol. Queries are abbreviated; **Table 5.8** interprets all abbreviations.

5.6 Statistics

The original plan to have as many volunteers as possible examine up to 10 skeletons was flawed, with expectations modified accordingly in Week One. No volunteer viewed 10 skeletons, but 20 volunteers observed 3 skeletons; two additional volunteers observed four (26AY) or five (09CS) (**Table 5.4**). The remaining 15 volunteers viewed only one or two skeletons. Without three or more groups viewing the same skeleton, or a large sample viewing at least three skeletons, ANOVA tests cannot be calculated.

It was decided that, of the approximately 100 queries on the form, a sub-group of 20 'important' queries would be used to test between-group and within-group variation, using the independent samples *t*-test. Skeleton 2 was observed by 15 volunteers, but only 4 were students, 11 were adult amateur archaeologists; Skeleton 15 was observed by 12 volunteers but again only 4 were students with 8 members of WARG/NF. Whilst pooled variance can accommodate different sample sizes for a *t*-test, it was felt that due to the small size of all groups of volunteers examining the same specimen, a group of 4 volunteers was too few to compare with 8 or 11 other volunteers. Only one specimen, Skeleton 17 was observed by 16 volunteers, divided evenly by group.

5.6.1 Between Group Variation Assessing Skeleton 17

The two independent groups were comprised of 8 WARG/NF volunteers and 8 Students, all of whom examined Skeleton 17, a young adult female. The adult amateur archaeologists (WARG/NF) correctly answered an average of 14.69 times (73.5%), with a standard deviation of 1.69. The 8 Students had a mean of 12.94 correct answers (64.7%), SD = 1.11. An independent samples *t*-test was run for each query in order to identify any significant differences between the means. **Table 5.11** lists each member of the two groups, the 20 Important Queries, and the corresponding answers from each volunteer.

The tests were run using IBM SPSS statistics for Windows Version 19.0.0 (Colman and Pulford 2008), with results included in **Item 6, CD Appendix**. The *t* statistic could not be computed for four queries because the standard deviations of both groups equaled 0.0. These were Q1: Skull completeness; Q7: Long bones present; Q9: Joints present; and Q15: Sacrum present. Members of both groups answered these questions in total agreement with the author. The results for Levene's test of equality of variance are unexpected: four queries indicate significant difference between groups: teeth general; clavicle fused; femur head diameter; and periosteal inflammation ('long bone outer shaft'). For 'teeth general' and 'long bone outer shaft', $F = 5.44$, $p = .035$. The former query was answered almost perfectly by both groups; the latter was missed completely by every member of both groups except for 02IC. For assessment of whether the medial clavicle had formed an epiphysis (an ageing trait), the adults scored very low, but the students all missed this query: $F = 21.00$, $p < 0.001$. The query itself is problematic. There is a clear difference between how volunteers in each group comprehended the fourth question, taking the femur head diameter. All 8 WARG/NF volunteers correctly measured this diameter, whilst only two of the 8 students were able to do so. Levene's test for equality of variance for this query is $F = 21.00$, $p < 0.001$.

Of the sixteen queries for which the *t* statistic could be computed, only one is highly significant, that for measuring the head of a femur. Based on Levene's test, equality of variances is not assumed. The independent samples *t* test showed that Student volunteers were significantly less able to accurately measure the diameter of a femoral head ($M = 0.25$, $SD = 0.46$) than WARG/NF volunteers ($M = 1.00$, $SD = 0.0$), $t(7.0) = 4.58$, p = .003 (two-tailed).

Table 5.11. **Inter-group Variation.** Two groups who have examined the same specimen are compared. Group WARG/NF is comprised of 8 members from the adult amateur volunteer pool; Group STUDNT is comprised of 8 undergraduate student volunteers. The 'Important Queries' abbreviated here are listed in more detail in **Table 5.6**.

VOL	Sk Compl	Torus	Lat Orbs	Mand Pres	Mand RvG	Teeth Gnrl	LB Pres	LB RvG	Jnts	Clav Fusd	Vert Pres	Pube Pres	Symp Bil	Symp Shrp	Sacr Pres	L Fem L	L Fem Hd	AMTL	Wr/ Chp	LB Outr Sft
WARG/ NF																				
02IC	1	1	0.5	1	1	1	1	0.5	1	0	1	1	1	0.5	1	1	1	1	1	1
03RC	1	0	1	1	0	1	1	0	1	0	1	1	1	0.5	1	0	1	0	1	0
07RH	1	1	1	1	0	1	1	0.5	1	0	1	0	1	0.5	1	1	1	1	1	0
08MH	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0.5	0
09CS	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	1	0
11JR	1	1	0	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	1	0
28AP	1	1	1	0.5	0	1	1	0.5	1	0	1	1	0	0	1	1	1	1	1	0
32BB	1	1	0.5	0.5	0.5	1	1	0.5	1	0	0	1	1	1	1	0	1	0.5	0.5	0
STUDNT																				
15BD	1	1	0.5	1	0	1	1	0	1	0	0	1	1	0	1	1	0	1	1	0
17CB	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	0	0	0
19KM	1	0.5	0	0.5	0	1	1	1	1	0	1	1	1	0.5	1	0	1	0.5	1	0
21TR	1	1	1	1	0	1	1	0.5	1	0	0	1	0.5	1	1	0	0	1	1	0
23MS	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0	0
24AF	1	0.5	0	0	1	0.5	1	0	1	0	1	1	0.5	0	1	1	0	0	1	0
25SH	1	1	1	1	0	1	1	1	1	0	1	0	1	0	1	1	0	0.5	1	0
26AY	1	1	0.5	1	0	1	1	0.5	1	0	1	1	1	1	1	0	0	1	1	0

VOL = Volunteer; **WARG/NF** = adult amateur archaeologists; **STUDNT** = student volunteers. **1.0** = one full point for a 'correct' answer, **0.5** = half a point for a partly correct answer; **0** = 'incorrect' or unanswered question.

5.6.2 Specimen Influence: Intra-group Difference

In a test of specimen variability influencing scores, two skeletons both observed by a range of volunteers were examined using the 20 Important Queries. Two nonmatching groups of 9 volunteers each observed the same two specimens: one group of 9 (six WARG/NF, three students) observed Skeleton 02 and Skeleton 17; another group of 9 (three WARG/NF, six students) observed Skeleton 07 and Skeleton 17. The next-largest group to observe the same two skeletons were 8 volunteers (five WARG/NF, three students) who all examined both Skeleton 02 and Skeleton 07. Skeleton 02 and 07 are both adult males; Skeleton 17 is a young female. It was decided to test results from Skeleton 07 (older male with moderate to severe abnormal periosteal bone) against those from Skeleton 17 (young female, few abnormalities) since these two individuals are very different in appearance. Therefore, paired samples *t*-tests were run on each of the 20 Important Queries as observed by 9 volunteers, three members of WARG/NF and six students. (**Table 5.12**).

The tests were again run using IBM SPSS statistics for Windows; results for the 16 paired samples *t*-tests can be found in **Item 7, CD Appendix**. Similarly to results for two groups assessing the same specimen, for the paired samples the answers to four queries were identical and thus the standard deviation was 00.0 for each: the *t* statistic could not be computed. The four queries are: Q1: Skull completeness; Q6: Teeth (general condition); Q9: Joints (completeness); Q15: Sacrum present. Therefore, 16 paired-samples *t* tests (two-tailed) were run, one for each of the remaining queries, to investigate whether any variation between the samples may have influenced scores.

Six queries had significant differences between the specimens. The queries relate to sexing traits in the brow ridge and mandible; ageing traits in the medial clavicles and pubic bones; and successfully identifying abnormal bone deposits. Most problems are associated with assessing Skeleton 17, a young, gracile probable female with mild evidence of disease.

Q2, assessing torus robusticity, was significantly more difficult for Skeleton 07 (*M* = 0.44, *SD* = 0.39) than for Skeleton 17 (*M* = 0.94, *SD* = 0.17), $t(8) = 4.24$, $p = .003$ (two-tailed). Q5, mandible robusticity was significantly more difficult to discern for Skeleton 17 (*M* = 0.22, *SD* = 0.44) than for Skeleton 07 (*M* = 1.00, *SD* = 0.0), $t(8) = 5.29$, $p = 001$ (two-tailed). Q10, assessing development of epiphyses in the clavicles (an ageing trait) was significantly more difficult to identify for Skeleton 17 (*M* = 0.11, *SD* = 0.33) than for Skeleton 07 (*M* = 0.67, *SD* = 0.50), $t(8) = 3.16$, $p = .013$ (two-tailed). Q13, recognising the youthful trait of 'billowing' in the pubis, was just at the edge of being significantly more difficult for Skeleton 07 (*M* = 0.56, *SD* = 0.17) than for Skeleton 17 (*M* = 0.83, *SD* = 0.35), $t(8) = 2.29$, $p = .051$ (two-tailed). On the other hand, Q14, recognising the pubic symphyseal face had developed 'sharp' margins (a trait indicating older age), was just at the edge of being significantly more difficult for Skeleton 17 (*M* = 0.17, *SD* = 0.35) than for Skeleton 07 (*M* = 0.61, *SD* = 0.42), $t(8) = 2.29$, $p = .052$ (two-tailed). Q20, recognising periosteal inflammation was significantly more difficult for Skeleton 17 (*M* = 0.0, *SD* = 0.0) than for Skeleton 07 (*M* = 0.67, *SD* = 0.50), $t(8) = 4.00$, $p = .004$ (two-tailed). Differences between the two skeletons that led to significant variation between how they were interpreted are discussed in **Chapter 6.**

Assessment Protocol Tested in Winchester

Table 5.12. Intragroup variation. Twenty Important Queries as scored by nine volunteers are compared between two specimens, Skeleton 7, an older adult male with moderate to severe abnormalities, and Skeleton 17, a gracile young adult female with few observable indicators of disease or injury. The first three volunteers are members of WARG or New Forest, the remaining six volunteers are undergraduate student participants. 1.0 signifies an answer in agreement with author; 0.5 signifies partial agreement and 0.0 signifies an answer in disagreement with the author's findings. The Twenty Important Queries are listed by full term and most common abbreviation in **Table 5.6.**

Q1 Skull			Q2 Torus			Q3 Lateral Orbits			Q4 Mandible Pres		
VOL	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**
07RH	1.0	1.0	**07RH**	0.5	1.0	**07RH**	1.0	1.0	**07RH**	1.0	1.0
08MH	1.0	1.0	**08MH**	0.5	1.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0
09CS	1.0	1.0	**09CS**	0.5	1.0	**09CS**	0.5	1.0	**09CS**	1.0	1.0
15BD	1.0	1.0	**15BD**	0.5	1.0	**15BD**	0.5	0.5	**15BD**	1.0	1.0
17CB	1.0	1.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0
23MS	1.0	1.0	**23MS**	1.0	1.0	**23MS**	1.0	1.0	**23MS**	0.5	1.0
24AF	1.0	1.0	**24AF**	0.0	0.5	**24AF**	1.0	0.0	**24AF**	1.0	0.0
25SH	1.0	1.0	**25SH**	0.0	1.0	**25SH**	1.0	1.0	**25SH**	1.0	1.0
26AY	1.0	1.0	**26AY**	0.0	1.0	**26AY**	1.0	0.5	**26AY**	1.0	1.0

Q5 Mand Rob v Grac			Q6 Teeth Gnrl			Q7 Long Bones Pres			Q8 LB Rob v Grac		
VOL	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**
07RH	1.0	0.0	**07RH**	1.0	1.0	**07RH**	0.0	1.0	**07RH**	1.0	0.5
08MH	1.0	0.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0
09CS	1.0	0.0	**09CS**	1.0	1.0	**09CS**	1.0	1.0	**09CS**	1.0	1.0
15BD	1.0	0.0	**15BD**	1.0	1.0	**15BD**	1.0	1.0	**15BD**	1.0	0.0
17CB	1.0	1.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0
23MS	1.0	0.0	**23MS**	1.0	1.0	**23MS**	1.0	1.0	**23MS**	1.0	1.0
24AF	1.0	1.0	**24AF**	0.5	0.5	**24AF**	1.0	1.0	**24AF**	0.0	0.0
25SH	1.0	0.0	**25SH**	1.0	1.0	**25SH**	1.0	1.0	**25SH**	1.0	1.0
26AY	1.0	0.0	**26AY**	1.0	1.0	**26AY**	1.0	1.0	**26AY**	1.0	0.5

Q9 Joints			Q10 Clav Fusd			Q11 Vert Pres			Q12 Pubes Pres		
VOL	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**
07RH	1.0	1.0	**07RH**	1.0	0.0	**07RH**	1.0	1.0	**07RH**	1.0	0.0
08MH	1.0	1.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0
09CS	1.0	1.0	**09CS**	1.0	0.0	**09CS**	1.0	1.0	**09CS**	1.0	1.0
15BD	1.0	1.0	**15BD**	0.0	0.0	**15BD**	1.0	0.0	**15BD**	1.0	1.0
17CB	1.0	1.0	**17CB**	0.0	0.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0
23MS	1.0	1.0	**23MS**	1.0	0.0	**23MS**	1.0	1.0	**23MS**	0.5	1.0
24AF	1.0	1.0	**24AF**	0.0	0.0	**24AF**	1.0	1.0	**24AF**	1.0	1.0
25SH	1.0	1.0	**25SH**	1.0	0.0	**25SH**	1.0	1.0	**25SH**	1.0	0.0
26AY	1.0	1.0	**26AY**	1.0	0.0	**26AY**	1.0	1.0	**26AY**	1.0	1.0

Table 5.12. Continued. Intragroup Variation.

Q13 Symph Billowy			Q14 Symph Sharp			Q15 Sacrum Pres			Q16 L Fem Length		
VOL	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**
07RH	0.5	1.0	**07RH**	0.5	0.5	**07RH**	1.0	1.0	**07RH**	1.0	1.0
08MH	1.0	1.0	**08MH**	0.0	0.0	**08MH**	1.0	1.0	**08MH**	1.0	1.0
09CS	0.5	1.0	**09CS**	0.5	0.0	**09CS**	1.0	1.0	**09CS**	1.0	1.0
15BD	0.5	1.0	**15BD**	0.0	0.0	**15BD**	1.0	1.0	**15BD**	1.0	1.0
17CB	0.5	0.0	**17CB**	1.0	0.0	**17CB**	1.0	1.0	**17CB**	1.0	1.0
23MS	0.5	1.0	**23MS**	1.0	0.0	**23MS**	1.0	1.0	**23MS**	1.0	1.0
24AF	0.5	0.5	**24AF**	1.0	0.0	**24AF**	1.0	1.0	**24AF**	0.5	1.0
25SH	0.5	1.0	**25SH**	1.0	0.0	**25SH**	1.0	1.0	**25SH**	1.0	1.0
26AY	0.5	1.0	**26AY**	0.5	1.0	**26AY**	1.0	1.0	**26AY**	1.0	0.0

Q17 L Fem Hd			Q18 AMTL			Q19 Wear Chipping			Q20 LB OutrShft		
VOL	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**	**VOL**	**07 OM**	**17 YF**
07RH	1.0	1.0	**07RH**	1.0	1.0	**07RH**	1.0	1.0	**07RH**	0.0	0.0
08MH	1.0	1.0	**08MH**	1.0	1.0	**08MH**	0.5	0.5	**08MH**	1.0	0.0
09CS	1.0	1.0	**09CS**	0.0	0.0	**09CS**	1.0	1.0	**09CS**	1.0	0.0
15BD	0.0	0.0	**15BD**	1.0	1.0	**15BD**	1.0	1.0	**15BD**	1.0	0.0
17CB	0.0	1.0	**17CB**	0.0	0.0	**17CB**	0.0	0.0	**17CB**	1.0	0.0
23MS	0.0	0.0	**23MS**	1.0	0.0	**23MS**	1.0	0.0	**23MS**	0.0	0.0
24AF	0.0	0.0	**24AF**	0.5	0.0	**24AF**	0.0	1.0	**24AF**	0.0	0.0
25SH	0.0	0.0	**25SH**	0.5	0.5	**25SH**	1.0	1.0	**25SH**	1.0	0.0
26AY	0.0	0.0	**26AY**	1.0	1.0	**26AY**	1.0	1.0	**26AY**	1.0	0.0

Q1, Q2 etc: Twenty Important Questions; **VOL**: Volunteer identifier; **07 OM**: Skeleton 07, an older male; **17 YF**: Skeleton 17, a younger female.

5.6.3 Comparisons between WARG/NF and Students

Using the 20 Important Queries, results of all participants and of both types of volunteers were compared. **Table 5.13** shows the 20 Important Queries, pooled results from all 91 forms shown as a sum of correct or partially correct answers, and this sum shown as a percentage of the 91 forms. The total forms competed by the adult amateur archaeologists was 56, and the total number of forms completed and scored by the students was 35. **Table 5.11** also shows the pooled scores of all adult amateur archaeologists ('WARG/NF') both as a summed total of correct scores, and as a percentage of the 56 adult forms; and pooled scores of all the students ('STUDENT'), both as a summed total of correct student scores, and as a percentage of the 35 student forms. **CD Appendix Sheet 10** has all results in Excel.

Some inter-group variation between the scores is observed. Very slight differences are not investigated. Variation of 5.0% (for assessing general appearance of dentition) and more than 10% (lateral orbits) were subjected to chi square analyses, testing for significant variation using number of forms and the sum of correct answers. Thus, for assessing general dentition, WARG/NF volunteers were correct 46.0 times out of 56 forms, and students were correct 27.0 times out of 35 forms. But $x^2 = 0.075$ ($p=0.05$) and is not significant. Next, the apparently larger variation for assessing lateral orbits was examined. Adult volunteers agreed with the author 36.0 times on 56 forms, and students agreed with author 26.5 times on 35 forms. Here, $x^2 = 0.479$ ($p=0.05$) and is not significant. The two Important Queries that have notable variation between groups are for medial clavicle assessment and measuring the diameter of the femur head. For the clavicle, the adults are correct 34.0 times out of 56, and students correct 10.0 times out of 35. Here, $x^2 = 6.608$ ($p < 0.05$), significant at 95% confidence level and indeed at the 98% level. In accurately measuring the femur head diameter, adults agree with author 39.0 times on 56 forms, and student agree with author 4.0 times on 35 forms. Here, $x^2 = 24.07$ ($p < 0.001$), a highly significant result.

Table 5.13. Summary of results for 20 Important Queries: Inter-group variation. Results of summed correct and partly correct scores from the volunteers. All Scores refers to the total correct scores from all 91 forms per Important Query; WARG/NF refers to the total correct scores from the 56 forms competed by adult amateur archaeologists; and STUDENT refers to the 35 competed and scored forms provided by the student volunteers. Each type of volunteer score is also expressed as a percentage of the forms filled in by that group: 91 forms for 'All', 56 forms for 'WARG/NF' and 35 forms for 'STUDENT'. Differences between adult and student scores greater than 5.0% are in **bold**; differences that are significant (*p*=0.05) are in ***bold italics***.

Query	All Scores	Avg	WARG/NF	Avg	STUDENT	Avg
Compl?	87.5	96.2	53.5	95.6	34.0	97.1
Torus	58.5	64.3	35.5	63.4	23.0	65.7
LatOrbs	62.5	68.7	36.0	**64.3**	26.5	**75.7**
Present	81.0	89.0	49.5	88.4	31.5	90
RobvGrac	61.5	67.6	37.5	67.0	24.0	68.6
Teeth Gnrl	73.0	80.2	46.0	**82.1**	27.0	**77.1**
Present	86.5	95.1	52.5	93.8	34.0	97.1
RobvGrac	72.5	79.7	46.5	**83.0**	26.0	**74.3**
Joints	83.0	91.2	52.0	92.9	31.0	88.6
ClavFuse	44.0	48.4	34.0	***60.7***	10.0	***28.6***
Present	81.0	89.0	49.0	87.5	32.0	91.4
PubePres	73.5	80.8	43.0	**76.8**	30.5	**87.1**
SympBil	63.5	69.8	40.5	**72.3**	23.0	**65.7**
Shrp	37.0	40.7	22.0	39.3	15.0	42.9
Sacr Pre	86.0	94.5	52.5	93.8	33.5	95.7
L Fem L	72.0	79.1	45.5	**81.3**	26.5	**75.7**
L Fem Hd	43.0	47.3	39.0	***69.6***	4.0	***11.4***
AMTL	63.0	69.2	39.5	70.5	23.5	67.1
Wear/Chp	71.5	78.6	45.5	**81.3**	26.0	**74.3**
OutrShft	34.5	37.9	21.0	37.5	13.5	38.6

5.6.4 Incomplete Forms and Outliers

In general, scores were influenced by whether the participant completed the form (**Table 5.9, Table 5.10**). In addition, scores for Paleopathology assessments across all weeks were generally low, again due to many queries or even sections left blank, or when, based on how the query was framed, a blank was interpreted as 'correct'. Statistical comparisons between scores with wide ranges do not seem particularly instructive.

Assessment Protocol Tested in Winchester

Two specific sessions, Session 1C and Session 3C are statistically examined, using volunteer performance and form completion for comparison. The lowest scores for Session 1C (31.0, 33.0, 42.5) were from forms that skipped the last few queries in Inventory and that were abandoned after part of the dental assessment in the Paleopathology segment, with an average score of 35.5 (37.0% of 96 scored queries), SD = 6.14. The average score for the four participants who completed the form (71.5, 45.0, 69.5, 73.5) was 64.9, SD = 13.4 (67.6% of 96 scored queries). When a two-tailed independent samples t-test is run between abandoned forms (Group A) and completed forms (Group B), with answers pooled due to groups size variation, critical value is +/- 2.571 ($p = 0.05$, two-tailed) and the test statistic t =-2.91 confirms a significant difference between the groups despite the large standard deviation for the completed forms.

For Session 3C, the average of the seven scores was 66.9 and the standard deviation was 7.77. One score is an outlier and if removed, the average of the six remaining forms is 69.6 and the SD = 3.15. However, when an independent samples t-test is calculated for the two means and two standard deviations, there is no significant difference: t =-0.73, critical value = +/-2.201 ($p = 0.05$, two-tailed). This may be because total scores include the paleopathology scores and for both the full group and the group without the outlier, these scores are low: 3.73 for 7 forms (53.3%) and 3.34 out of 6 forms (55.7%) respectively.

5.6.5 Kappa Statistics

Kappa statistical testing is different from inferential or descriptive statistics. Kappa scores are meant to measure participant agreement by luck or coincidence as opposed to true agreement (Cohen 1960; Fleiss and Cohen 1973) and is a measure of reliability: it is a test of a test. Kappa is usually applied to lab tests such as cancer screens, where consistency in reading images is a matter of life and death; and psychological analyses to ensure that patients are properly identified and treated, with consistent standards used to diagnose mental illness. Because this project aims to permit novices to create initial databases of human skeletal remains, it is important that the results are reliable, accurate and reproducible; thus it had been suggested to apply Kappa testing to RAS results.

Kappa testing was not applicable for the York results due to the small population size of volunteers who participated in all segments, and arguably due to the nature of the queries. At best, paleopathology diagnoses are based on varying criteria, and at worst are fraught with controversy (for example, Schmorl's Nodes may indicate herniated discs or mean nothing: Dar *et. al.* 2010). Thus the Winchester 2012 queries focused on general description, with a few odd anomalies included as they interest the author. Indeed, assessment of paleopathological conditions fared poorly both in York and Winchester. But what about Inventory queries?

In the Winchester study, 37 individuals participated, with 91 forms at least partly completed. Twenty-two volunteers completed at least three forms. Whilst the available data was therefore much improved over the scant numbers from York, Kappa testing was nevertheless not applicable to Inventory scores due to the nature of morphological traits (e.g. robust versus moderate): such terms are relative depending upon the population assessed. Also, there are few ambiguities when determining if a box of remains are fragmented or relatively complete; or observing the presence or absence of a certain type of skeletal element. Because of this, it was concluded that Kappa testing would not add to the findings.

5.7 Commentary on Winchester 2012 Trials

The Winchester trials built on successes from the York trials, by viewing the York study as an extended series of Focus Group sessions (Babbitt and Nystrom 1989). Problems with the York experiment included the limited number of participants; possible bias introduced by the group's prior work with the author, which may have concealed shortcomings in textual support; and the inability to revise the protocol and retest on York students.

Assessment Protocol Tested in Winchester

When the project moved from York to Winchester, the opportunity to test the findings from York was realised. The apparent increased success of binary over graduated (multiple choice) queries observed in York could be assessed; and most importantly, the number of participants could be increased. Accordingly the protocol was expanded from 40 complex queries to approximately 100, and the pool of volunteers expanded from 17 to 37. In York, only four participants managed to attend all parts of the testing, in which the protocol was split into four main segments. In Winchester, the segments were combined, queries expanded and yet simplified, and 22 volunteers assessed three different skeletal specimens. The results will be examined via descriptive statistics in the next chapter, with a Discussion of the findings, and an analysis of what these results signify for the protocol as a tool for non-expert assessment of remains.

Photograph 5.12: Week 3. WARG and New Forest session. Participants enjoyed themselves during the three week experiment, especially once they gained confidence in handling remains. Most kept their Information Booklet and were delighted to have taken part.

Chapter 6: Discussion: Winchester 2012 Test of Protocol

> *"Much more work remains to be done in developing methods for coping with archaeological skeletal data in all their imperfect and peculiar glory."*
> John Robb, *'Analysing Human Skeletal Data'* (2000:484)

6.1 Applying Descriptive Statistics to Results

Data analysis, including selecting statistical tests, begins before data collection. Due to the idiosyncratic nature of archaeologically obtained human skeletal remains, in which few specimens are complete, certain expectations and presumptions must be controlled for as best as possible. Interestingly this is also reflected in creation and administration of a questionnaire: for whom are these results meant? What happens if the data collected are deemed 'wrong'? (Babbitt and Nystrom 1989: 20-21). Once collected, data are subjected to a range of analyses, which can be described as descriptive, inferential, or exploratory. The latter includes cluster analysis; regression; discriminant analysis to identify predominate variables (Robb 2000: 482). The two techniques used in this project are descriptive statistics and, to a lesser extent, inferential techniques.

Interrogating the data allows one to identify patterns, which can be achieved by presenting the data as summaries in tables and graphs, and by identifying tendencies such as means, percentages and standard deviations. Once a pattern is noted (for example, that WARG/New Forest volunteers correctly measure femora), the assumption can be tested for reliability, to see if the tendency due to chance; or if the apparent difference between groups, between skeletons or between queries is truly significant (Robb 2000: 482). Most statistical techniques require a certain sample size; too small and any differences are magnified. Finally, due to human variation, Robb (2000: 487) suggests researchers consider using the median as well as the mean, to reduce the effect of skewing due to outliers.

The original study design planned for most volunteers to take 30 minutes per form, certainly after acquiring some familiarity with the system. Presumably, experience with the form would lead to faster completion times. This did not happen. In the end, almost every volunteer required most of a session to complete one form, with very few participants (09CS, 26AY, 33AB) managing two forms in two hours. That the author, with years of experience and complete familiarity with her own form required 20-30 minutes per skeleton was further confirmation that presumptions regarding novice time requirements were flawed.

In York, most participants were familiar with skeletal material, and readily worked through various sections. In addition, with the York experiment split into short weekly segments, volunteers could establish a routine, with repetitive observations becoming easier during an evening meeting. In Winchester, all was new: examining actual skeletons, using simplified and yet unfamiliar terminology; and by requiring volunteers to work through the full protocol in a linear fashion, no process of repetitious familiarity was established. By the end of the Winchester trials, 60% of the volunteers (22 out of 37 volunteers: **Table 5.5**) did examine at least three skeletons, but these same skeletons were not observed by all 22 volunteers. Thus options for statistical testing have become limited, since ANOVA and other multivariate tests compare variation between and within groups that are either exactly or roughly the same size and have observed, or been subjected to, the same set of conditions. The data collected in Winchester can thus be termed 'unruly'. Most inferential testing used in this project consists of chi square and *t*-tests.

Statistical shortcomings cannot be repaired, due to the complex scheduling and lab space negotiations that the March 2012 tests required: study flaws relating to statistical testing were realised too late in the process. However, despite the inability to interrogate naïve observations with a range of tests, important findings have been made. The York concept – that cash-strapped institutions can realistically tap enthusiastic community volunteers to collect some basic observations – transferred successfully to a set of volunteers with limited to no experience with human remains. With all weeks combined, 172 Inventory queries were asked, with 123.0 answered in agreement with the author for a success rate of 71.5%. Comparisons are therefore predominately descriptive, with participant and query averages, specimen averages and standard deviations the most common findings. Results are presented in graph format.

Osteology 'taster day' sessions are increasingly offered to the public. Universities such as Sheffield and Bournemouth offer one-off courses once or twice a year; at least one museum programme explicitly trades training for data gathering. The growth in marketing 'osteology short courses' to novices, some of whom pay £100 or more per short course, will be discussed in **Chapter 7**.

6.2 Success of 'Inventory' versus 'Paleopathology' Segments, by Volunteer Scores

Scores for the two segments of the form, Inventory and Paleopathology have differential rates of score success over the three weeks. The complete results are depicted on a series of Excel spread sheets on the accompanying CD: **Week One All Answers, Week Two All Answers, Week Three All Answers**; and **All Skeletons All Volunteers All Weeks Inventory Only, All Skeletons All Volunteers All Weeks Paleopathology Only**. The two segments are examined by week and by session (see below and **Results 5.5.1, 5.5.2, 5.5.3**) and between types of volunteer (adult avocational archaeologist versus student) with all weeks pooled. On the large Excel spread sheets, the two segments are examined both via volunteer score and query score: volunteers are in columns, with queries in rows. Viewing overall scores, whilst up to seven questions were added to the form after the first week, 12 of the 28 participants who completed more than one form had an improvement in scores from Week 1 to Week 2 (or Week 1 to Week 3 for 05GL) which surpassed this increase in possible maximum scores (**Table 5.4**).

6.2.1 Week One

Among the 34 participants in Week One, for the Inventory segment the average score was 35.6 (out of 53: 67.2% correct), with a range of 26.5 to 42.0 (50.0% to 79.2%) and *SD* = 4.37. If the lowest score (26.5) is dropped, the average and SD improve slightly to 35.9 (67.7% correct) and 4.12 respectively. The median, the middle score obtained with scores arranged in order, is 36.0, which is virtually the same as the averages obtained with (35.6) or without (35.9) the outlier. This suggests a normal distribution (Kranzler and Moursund 1999).

Week One scores for all participants in the Paleopathology Segment average 25.4 (out of 43 questions: 59.1%), with a range of 3 to 42, SD = 11.17. The median score was 30.0 (69.8%). The more stable, slightly higher average Inventory scores amongst the Week One participants (**Week One All Answers: Excel Sheet One**) suggest that the Inventory segment was more straightforward for many participants. Even if the form was abandoned during the Paleopathology segment, the participant was applying effort to answer what they could. Indeed the two highest Inventory scores were made by volunteers who quit shortly after starting the Paleopathology section: 29MY with 43.0 out of 53 (81.1% correct) and 02IC with 42.0 out of 53 (79.2% correct). The variation between participants is wider in the Paleopathology segment than in Inventory, in which the lowest score (28.0) represented correct or partly correct answers for 52.8% of the questions; for the Paleopathology segment, the lowest score (3.0) signifies less than 7.0% of the answers were correct, whilst the top score, 42.0 out of 43 queries, is in almost total agreement with the author.

6.2.2 Week Two

All results are shown on **Week Two All Answers: Excel Sheet Two**. Inventory scores for the 31 completed forms average 41.7 correct answers out of 59 questions (70.7%), an improvement from Week One, with participant scores ranging from 29.0 to 51.0 (49.2% to 86.4%) and a standard deviation of 4.45. The median score was 41.5 and thus very similar to the mean. The spread between *most* participants' scores for this segment is lower than for Week One: volunteer 37IN was attempting the form for the first (and only) time and balked at answering the first 22 queries, all of which relate to the skull. Consequently, 37IN's score is the lowest at 29.0. Removing this score does not appreciably alter the average, but the spread improves; the average changes from 41.7 to 42.1 correct answers (71.4%) and the standard deviation changes from 4.45 to 3.84.

One query was added to the Paleopathology segment for a total of 44. Week Two Paleopathology scores benefit from two aspects: the specimens chosen for assessment, and a change in form design. The specimens have conspicuous anomalies. Skeleton 2, adult male, has poor dental health, a noticeable bend to the right femur (likely a healed greenstick fracture) and mild abnormal periosteal bone; Skeleton 15, young adult male has a conspicuously shattered skull (thus most cranial traits are N/A), mild periosteal bone deposits and two vertebrae with infectious disease; Skeleton 17 is a young adult female with few anomalies aside from one markedly large dental caries. Thus most disease or trauma is identifiable.

In addition the form had been redesigned, dropping one column in the Paleopathology segment (see **Methods 5.5.2.2**) with the unfortunate result that assessments for 'normal' bones would *require* the query left blank. Thus, in Week One the volunteer was penalized for *not* selecting Present *or* N/A but for Week Two with only one column for marking a choice and the option described as 'Present?', leaving the box blank if the participant determined no abnormality was present would be considered as 'Correct'. On one hand, these specimens had few abnormalities; on the other hand, a blank now defaulted to 'correct'. Thus scores for Paleopathology were much improved from Week One. Scores range from 11.5 to 39.5 (26.1% to 89.8%), the average was 32.7 correct answers out of 44 (74.3%) and the SD = 5.75. The median was 34.0.

6.2.3 Week Three

By the final week, all participants had attended at least once session previously, and were presumably more confident in how to interpret the form, and use the accompanying Information Booklet. The scores were based on a maximum of 60 queries for the Inventory segment, and volunteer scores ranged from 33.5 to 52.0 (55.8% to 86.7%), with an average of 45.7 out of 60 (76.2%) and SD = 4.40; the median was 45.5. With the lowest score dropped, the range is from 39.0 to 52.0, the average for correct answers is slightly improved to 46.2 (77.0%); the most notable improvement is in standard deviation which adjusts from 4.40 to 3.70. The results are shown on **Week Three All Answers: Excel Sheet Three.**

However, the most dramatic changes for Week Three were within the Paleopathology segment and point to a return of Week One strategy for hesitant volunteers: this segment was abandoned by several (03RC, 04AH, 05GL), and proved too ineptly designed for others. A few persevered and gained excellent scores, despite twin difficulties of skeletal specimens with highly abnormal bone (Skeleton 7, Skeleton 9) and a form design that forced novice volunteers with no osteological training to determine where best to record what can appear to be similar joint disorders: in the section for ‘osteoarthritis’ (OA) or the section for ‘osteochondritis dissecans’ (OD). This problem is now repaired (see **7.3.5**) but the resultant confusion is understandable. Due to earlier specimens simply not presenting with much joint disease this was avoided and thus (regrettably) not noted in time to amend the form.

The other problem was potentially related to a form alteration. In Week One, multiple columns for paleopathology options had been deemed confusing. In Week Two, the answer column format was altered, with a response only required if the trait, anomaly or disorder was present, a change which arguably led to overall high scores due to a blank being considered a default for ‘normal’ (**Methods 5.5.2.2**). Most specimens were relatively free of extreme disease, or had fairly conspicuous disorders. For Week Three, the last section of the Paleopathology segment was returned to a modified Week One format, with the answer column labeled ‘Present

= √, Not present = N/A' and thus required a response. This choice was added to 'miscellaneous' bone conditions, periosteal reactions and bone infections. Thus a blank could not be inferred a positive value. It does seem that most blanks were the result of novice confusion over abnormal bones rather than anyone viewing the highly abnormal bone on Skeleton 7 and interpreting this as 'normal'. Thus scores for Week Three in Paleopathology average 23.3 correct answers out of 44 (53.0%), with a range of 4.0 to 37.5 (9.1% to 85.2% correct) and a standard deviation of 8.65. The median of 23.8 agrees with the mean; the distribution is normal but results are still poor.

Volunteers preferred an answer of some sort to be selected. In Week One, several participants would choose a disorder or trait expression (e.g., mild, moderate, severe) as present, but *then also* write in N/A in the unselected options (**5.5.1.7**). A digitalised format of the protocol with an answer required, two columns, one headed 'Present' and the other 'None / N/A', with only one choice selectable would reduce ambiguity.

6.3 Query Results for Inventory

The results of the Inventory queries are summarised in **Figure 6.1**and **Figure 6.2** (Week One)**, Figure 6.3** and **Figure 6.4** (Week Two), and **Figure 6.5** and **Figure 6.6** (Week Three). Raw scores are in soft copy on the CD: **All Skeletons All Volunteers All Weeks Inventory Only: Excel Sheet Seven**. Results are summarised below, by week.

6.3.1 Week One

Considered as successful *query* scores rather than successful *participant* scores provides similar results: the participants are successful if they answer queries correctly. Therefore, with a maximum possible correct score of 34 per query (if all Week One forms contained the correct answer), the query score average of 22.8

correct answers is 67.1%, or about the same success rate of participant Inventory scores for Week One, with 53 questions and an average participant score of 35.6 (67.2% out of 53 questions). The median score is 23.0. **Figure 6.1** illustrates results for the first 23 Inventory queries, and **Figure 6.2** illustrates the remaining 30 queries. The queries are abbreviated in the tables, but the full descriptors can be found in **Table 5.8**.

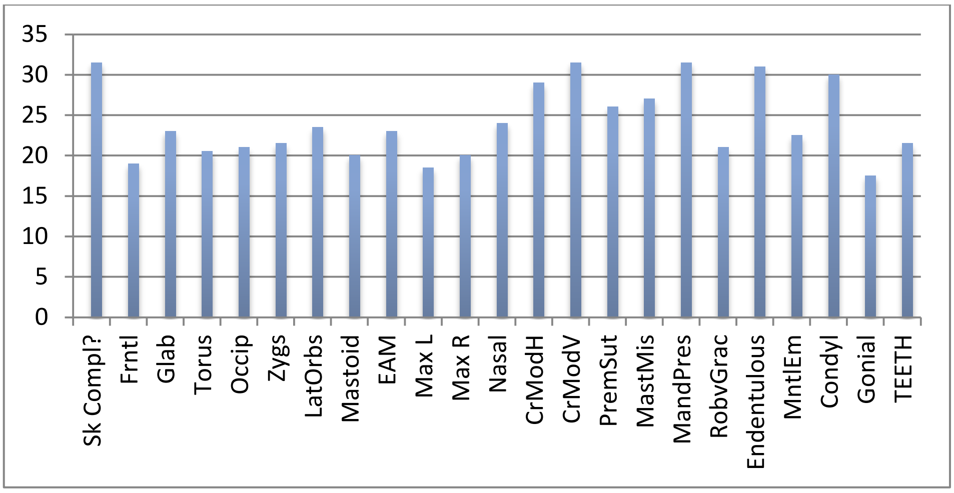


Figure 6.1 Week One Inventory First Half. This figure illustrates the relative success of the first 23 queries in Week One, which generated 34 forms. The Inventory segment for Week One had 53 queries.

Query score range is 9 to 31.5 and the SD = 6.06. The problematic questions are subjective observations, such as sexually dimorphic cranial traits (first 9 queries in **Figure 6.1**): although the average of 21.4 correct (62.9%) resembles experiential variation between novice and professional anthropologist (see Đjurić *et al.* 2005); age-related 'billowing' and 'furrows' on pubic symphyseal faces ('SymphBil') and auricular surfaces ('AurBillo') (**Figure 6.2**), recognised 67.4% of the time (average of 22.9 times out of 34); and age-related 'billowing' at the medial clavicle ('ClavFuse'), a forensically important trait recognised only 19 times (55.9%). A 'forced' binary query, with only 'Robust' or 'Gracile' offered as options for all the mandibles ('RobVGrac' in **Figure 6.1**), was equally unsuccessful, with 19 correct (55.9%) for what is in actuality a graduated trait.

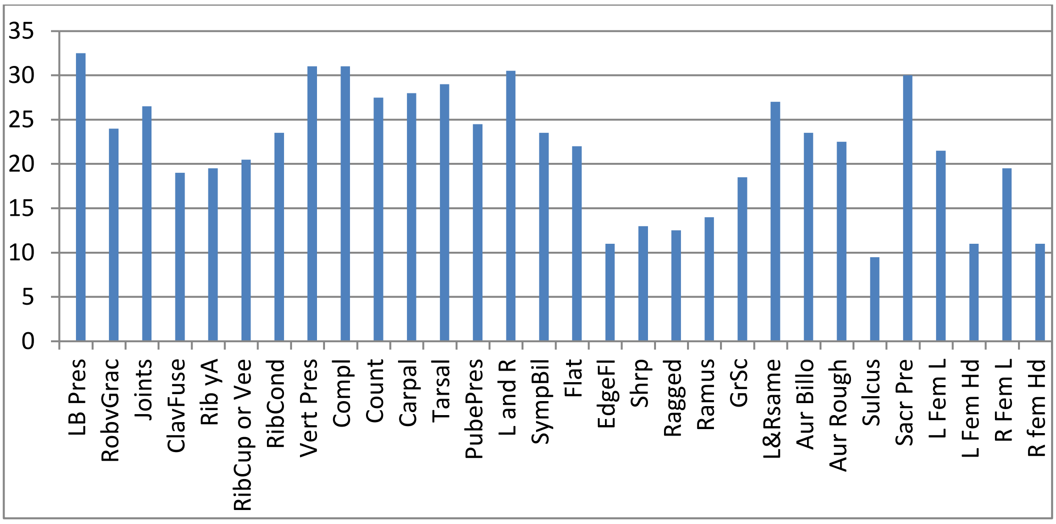


Figure 6.2 Week One Inventory Second Half. This figure is a continuation of Figure 6.1, and illustrates the relative success of the remaining 30 queries in Inventory segment for Week One, which generated 34 forms. The Inventory segment for Week One had 53 queries.

The queries that were deemed failures relate to detailed (and difficult to describe in lay terms) changes to pubic symphyseal margins due to age ('EdgeFl', 'Shrp', 'Ragged'), which averaged 12.6 times out of 34 (37.1%); locating the sulcus from written description alone (9.5 times, or 27.9%); and correctly measuring the femoral head with only text support: 11 times out of 34, or 32.3% success. Recognition and counts of podials and vertebrae were excellent, but in this collection these items are bagged by side and clearly labelled.

Effective queries related to item identification and correctly choosing the condition. Differentiating between a complete skull and a shattered one (**Figure 6.1**, 'Sk Compl?') was almost universally successful: 31.5 out of 34 correct (92.6%). Similarly, identifying a mandible ('MandPres') and its condition (complete, in large fragments, in small fragments), and if it was edentulous received an average of 31.3 correct answers (92.1%); presence and completeness of long bones, joint surfaces, pubic bones, and whether the sacrum was present was correctly identified 83.5% of the time (average 28.3 correct of 34: **Figure 6.2**). Discerning whether vertebrae were complete was also successful.

The answers for premature suture synostosis were correct for 26 out of 34 times (76.5%). However, most of the five specimens observed for Week One did not have premature suture fusion (Skeletons 1, 20, 21) and thus the ‘correct’ choices for 6 out of 7 observers (Skeleton 1), 6 of 8 observers (Skeleton 20) and 9 out of 10 observers (Skeleton 21) may have been fortuitous guesses. Skeleton 15 has a shattered skull and yet 2 of the 3 observers for Week One (03RC, 11JR) discerned the external angulation that denotes a prematurely fused suture with the resultant upward or outward plate displacement as the brain continues to grow. For Skeleton 2, also with premature synostosis, 3 of the 6 observers (08MH, 23MS, 25SH) correctly identified the anomaly.

6.3.2 Week Two

Query scores are similar to participant scores: participants are successful if they answer queries correctly. With a maximum possible correct score of 31 per query (if all 31 Week Two forms had the correct answer), the *query* score average of 21.9 ‘correct’ answers is 70.6% or essentially the same as the success rate of *participant* Inventory scores. **Figure 6.3** shows the first 27 queries and **Figure 6.4** the remaining 32 queries.

The median score is higher at 23.5, reflecting skewed results due to one volunteer’s inability to answer many of the Inventory queries; and the effect of eight Session 2A participants inadvertently receiving forms missing out three questions: six of the eight are dependably high scoring participants. The three omitted queries were answered with reasonable to excellent success on the other 23 forms. One question is on the morphology of the hip socket rim (‘RimMorph’: 16.0 correct out of 23 or 69.6%); one enquires if the sacrum had fused (‘Sacr Fuse’: 16.5 correct, or 71.7%); the third whether the two proximal sacral elements were fully fused (‘S1/S2’: 19.5 correct out of 23: 84.8%). All three are traits associated with ageing, although hip sockets may become irregular if subjected to trauma. The range of Inventory answers are 5.0 to 31.0 with SD = 6.02.

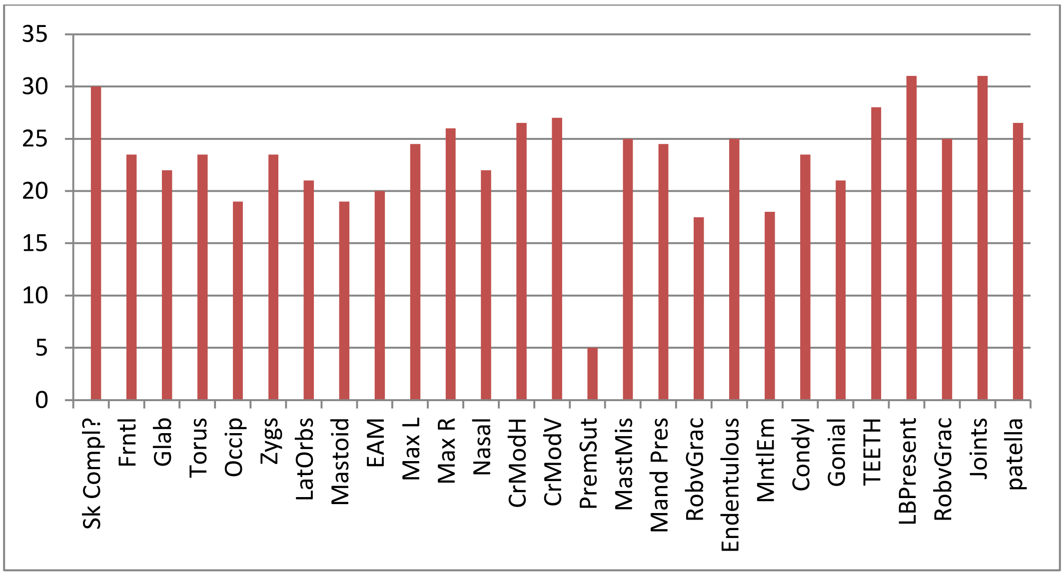


Figure 6.3 Week Two Inventory First Half. This figure illustrates the relative success of the first 27 queries in Week Two, which generated 31 forms. The Inventory segment for Week Two had 59 queries.

Between Week One and Week Two, by query, the SD remained high, but the overall success increased marginally from 67.1% to 70.6%. The successful questions continued to be on presence and condition of easily identified elements such as skull, mandible, long bones, joints, vertebrae, podials, pubic bones and sacra; and the new ones on clavicles, scapulae and patellae, with an average score of 28.6 (92.3% correct) for these thirteen queries. Sexually dimorphic (and to an extent age-related) traits in the skull were correct 21.4 times out of 31 (69.0%), with similar results for discerning billowing versus flat pubic symphyseal faces (22.0 times, or 71.0% correct). Symphyseal margins (11.5 times; 37.1%) and age-related changes to the medial clavicles (recognised correctly only 7.0 times, or 22.6%) were not understood or more accurately, not well depicted and explained. Volunteers did well at selecting choices that best described overall dentition (28.0 out of 31: 90.3%) and improved in taking metrics on femoral length (26.25 or 84.7%) and on maximum femoral head diameter (20.0 out of 31: 64.5%). The forced binary query on robusticity versus gracility of the mandible was still too hard to call for many volunteers, with only 17.5 agreeing with the author (56.5%).

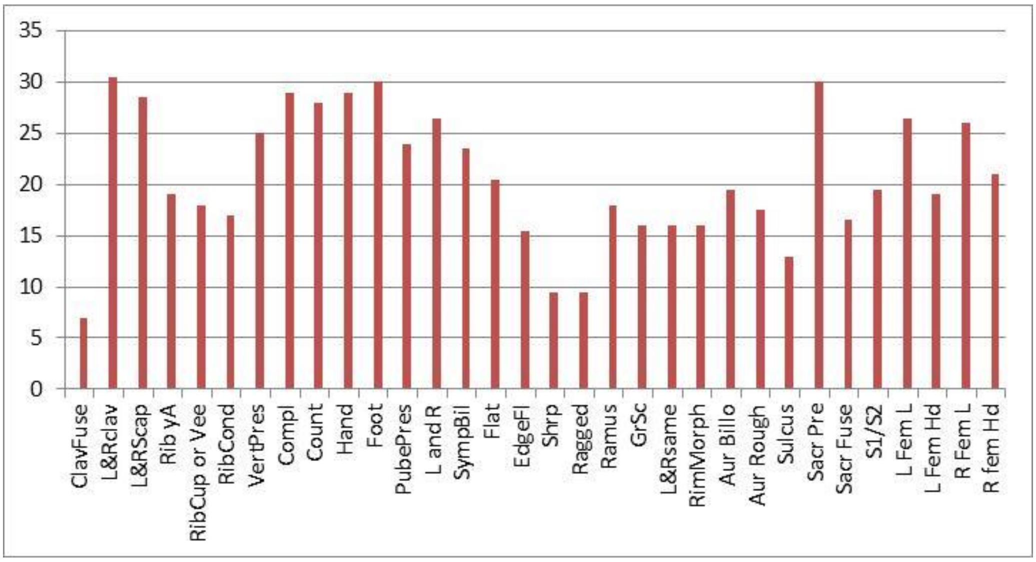


Figure 6.4 Week Two Inventory Second Half. This figure is a continuation of Fig 6.3 and illustrates the relative success of the remaining 32 queries in the Inventory segment. Week Two generated 31 forms, but only 23 participants for three queries missed off the forms for Week 2A: Rim Morphology, Sacrum Fused, S1/S2 Fused. The Week Two Inventory segment had a total of 59 queries.

The questions on premature suture synostosis were correctly identified only 5.0 out of 31 times. This week, all three specimens had prematurely fused cranial sutures. 03RC was the only one of nine observers of Skeleton 2 to correctly recognise this trait: this same volunteer had recognised the trait in Week One on the shattered skull of Skeleton 15. Nine observers viewed Skeleton 15, with only 3 recognising the synostosis (16WH, 20ND, 27PF). Thirteen participants observed Skeleton 17, but only 08MH recognised the synostosis, as she had in Week One for Skeleton 2.

6.3.3 Week Three

With a maximum possible correct score of 26 per query (if all 26 forms had the correct answer), the *query* score average of 19.8 ‘correct’ answers is 76.2% or the same success rate of *participant* Inventory scores, with 60 questions and an average participant score of 45.7 (76.2% out of 60 questions). The range of answers was 5.0 to 26.0 with SD = 5.40. One new question was added on the condition of the pelvic bones: complete versus shattered, and was successfully answered 22 times (84.61%). At 21.8, the median score is slightly higher than the mean (19.8), perhaps related to difficulties assessing morphological traits in robust younger females and unwell, older males and will be discussed in **6.7.4.**

Figure 6.5 illustrates the first 27 queries and **Figure 6.6** the remaining 33 queries. Successful queries were predominately noted on presence and condition of the skull, mandible, long bones, joints, patellae, clavicles, scapulae, vertebrae, podials, pubic bones and sacra, with an average of 24.3 out of 26 queries correct (93.5%). Interestingly, participants were able to successfully decide on relative robusticity versus gracility for the mandible 23.0 out of 26 times (88.5%) in the 'forced binary' query offering only two options for an element with graduated morphology. The state of the medial clavicle, with either youthful billowing, or the development of a medial epiphysis (thus obliterating the youthful billowing) was correctly identified 18.0 out of 26 times (69.2%), an improvement over previous weeks. The medial clavicle was correctly assessed only 44.0 times (48.4%) when all 91 forms are considered.

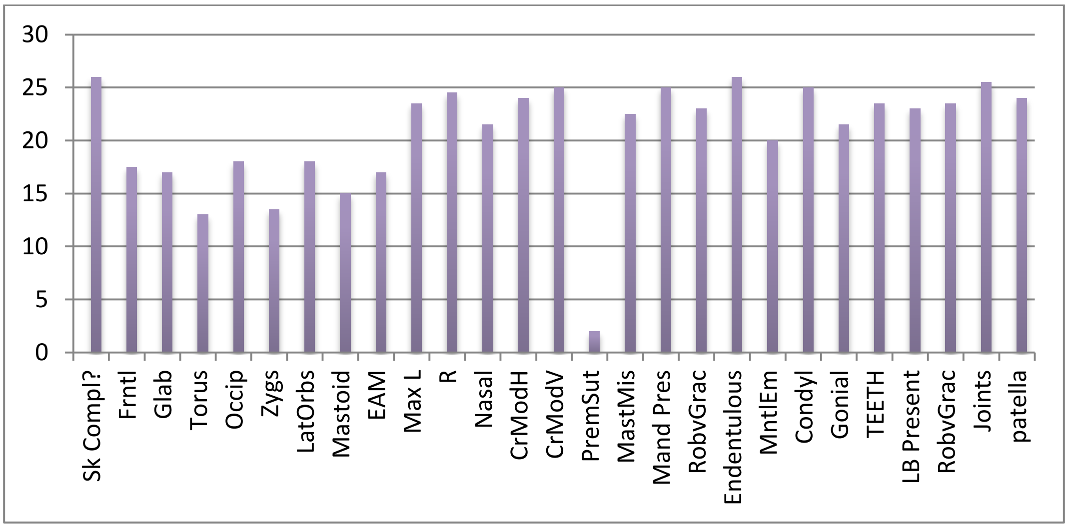


Figure 6.5 Week Three Inventory First Half. This figure illustrates the relative success of the first 27 queries in Week Three, which produced 26 forms. The Inventory segment for Week Two had 60 queries.

Important age and sex related traits with unsatisfactory results include assessments of cranial morphology, pubic bones, auricular surface, and presence of a preauricular sulcus. The aim had been for 70-80% success; with an average of 57.5% this was not achieved. The pubic symphyses were correctly assessed for age-related billowing or flattened surfaces 15.8 times (60.6%) with pubis margin descriptions correctly selected 10.2 times out of 26 (39.2%). Age-related changes in the auricular surface were in agreement with the author 60.6% of the time (15.8 out of 26). Dimorphic cranial traits primarily associated with sex, and in older females with age (Walker 1995) were deemed correct 16.1 times (61.5%). The sulcus was located and correctly defined as to expression (mild, moderate) 17.0 out of 26 times (65.4%). Equally unsatisfying observations related to age-related changes at costal rib ends (14.0 out of 26 or 53.8%) and defining the shape of the greater sciatic notch (17.0 out of 26, or 65.4%) for which adequate lay terminology has not been found; but the query on subpubic ramus morphology was effective at 23.0 (88.5%).

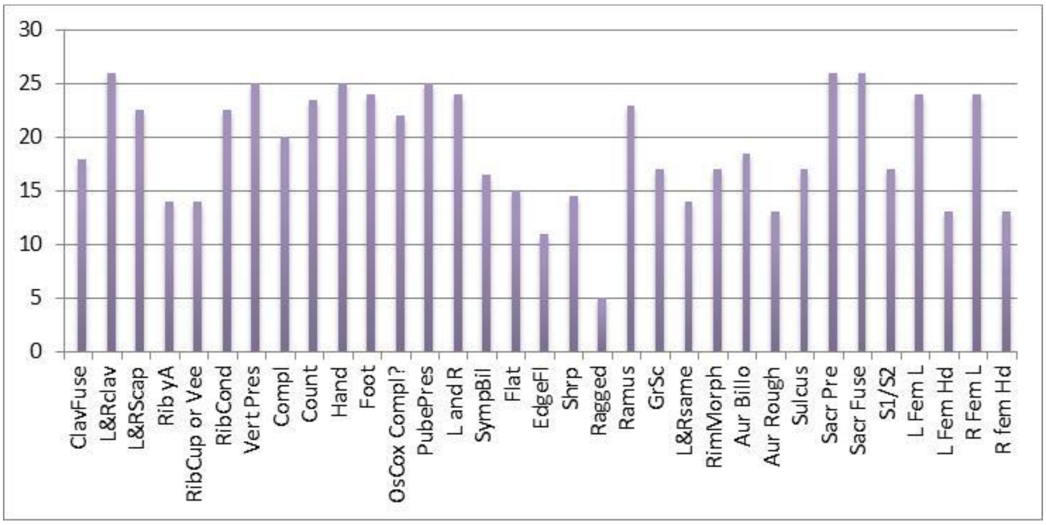


Figure 6.6 Week Three Inventory Second Half. This figure is a continuation of Fig 6.5 and illustrates the relative success of the remaining 33 queries in the Inventory segment. Week Three produced 26 forms, and the Week Three Inventory segment had a total of 60 queries.

Questions on premature suture synostosis were correctly answered only twice on 26 forms. Fifteen volunteers observed Skeleton 7, but only 26AY noted the anomaly; none of the eight participants observing Skeleton 9 correctly identified this trait; and of three volunteers assessing Skeleton 17, only 11JR was able to identify this trait (as was done by 11JR in Week One). Therefore out of 66 opportunities over the three weeks to correctly identify premature synostosis, only 12 successful observations were made, of which six were made by the same three adult amateur archaeologist participants: 03RC, 08MH, 11JR (each successful twice) and the other correct assessments were one-off correct assessments by six different students: 16WH, 20ND, 23MS, 25SH, and 27PF.

6.3.4 Comparing Apples to Apples

Between Week One and Week Two, by query, the SD remained high, but the overall success increased marginally from 67.1% to 70.6%. Between Week Two and Week Three, by query, the SD dropped somewhat and the success rate rose from 70.6% to 76.2%. But, the number of questions asked also increased per week and in addition, in Week Two, not all participants received the fully updated form. The query regarding the condition of the pelvic bones was only asked in Week Three. Therefore all seven new questions are removed to truly compare results between the weeks.

Week One results stay the same: By query, the range is 9 to 31.5, the average 22.8 out of 34 forms (67.1%) and the SD = 6.06. For Week Two, with the new queries removed (patella, clavicle, scapula inventory; hip socket morphology, sacral fusion), the query range is 5 to 31 and the average of correct answers is 21.8 out of 31 forms (70.3%). The average *participant score* has also increased now that the 8 volunteers with the bad forms have lost their disadvantage; and SD = 6.03.

For Week Three, with all extra questions removed, the average of *participants'* scores remains about the same (39.9 correct out of 53 queries or 75.3%) but the SD improves from 4.40 to 3.41. For *queries*, the range is 2 to 26, the average of correct responses is 19.5 of 26 (75.0%) and the SD = 5.54. To sum up, with the extra questions removed, the scores still increased from week to week (67.1% to 70.3% to 75.0%) and SD dropped slightly from 6.06 to 6.03 to 5.54. With all weeks combined, Inventory scores averaged 64.1 correct answers on 91 forms (70.4%).

6.4 Query Results for Paleopathology

The results of the Paleopathology queries for all three weeks are found on the CD: **All Skeletons All Volunteers All Weeks Paleopathology Only: Excel Sheet Eight** and are summarised below. **Figure 6.7, Figure 6.8**, and **Figure 6.9** illustrate results for each week. Queries are abbreviated in all figures; see **Table 5.8** for full descriptors.

6.4.1 Week One

Query scores trend with participant scores. Thirty-four forms were generated the first week. The *query* score average of 20.1 'correct' answers is 59.1%, the same success rate of *participant* scores for Week One, with an average participant score of 25.4 (59.1% of 43 questions). The range is 11.5 to 29.5 and the SD = 11.17. The median score of 20.0 is virtually the same as the mean.

The spread between Paleopathology scores is almost twice that of Inventory (SD= 6.06). The variation is due to many participants abandoning the form midway through the segment. The Inventory segment queried presence and absence of elements, but complicated about half of the queries by also requiring participants to judge the extent a morphological trait fell along an unknown continuum; some of these questions were not as successful as others. However, the Paleopathology segment introduced unfamiliar terminology and then also required volunteers to figure out where to record observations of abnormal bone. Even with supporting text and illustrations this was a struggle.

The gross appearance of each disease or disorder was first described in familiar language, followed by correct terminology. The first half of this segment focused on familiar disorders such as dental caries, tooth loss, healed bone fractures and osteoarthritis and enjoyed moderate success, but the second half, which introduced terms such as cortex, medullary canal, Schmorl's nodes and periosteal inflammation, fared poorly (see **Figure 6.7**). Dividing the 43 Paleopathology questions into two halves of 21 and 22 queries, the first half has an average score of 23.2 correct (68.2%), range 17.0 to 29.5, SD= 3.44; and the second set of 22 queries has an average of 17.2 correct (out of 34: 50.6%), range 11.5 to 22.0 and a similar standard deviation of 2.97. The ranges are similar, the spreads are similar; fewer people finished the second set of queries and thus the scores are lower.

Relatively successful queries focused on teeth and were correct an average of 22.9 times (67.4%): caries, post-mortem and ante-mortem tooth loss, and wear and chipping. The last two are Very Important Queries). Vertebral osteoarthritic (OA) changes (20.2 times: 59.4%) and mild, global synovial joint OA changes were also moderately successful (21.5, or 63.2%). Participants determined none of the specimens had evidence of localised or multiple OA (23.0, 27.0); but, as for multiple healed/healing fractures in limbs and ribs, also determined to not be present (27.0 or 79.4%), participants did not confront specimens with these issues (see Weeks Two and Three Inventory, above, for premature synostosis results). Identification of healed single fractures was not well recognised (17.5 times, or 51.5%). Recognising a roughened, noticeable line of muscle insertion sites enjoyed only moderate success: 19.5 (58.1%). The query on Schmorl's Nodes failed, with only 13.0 correct (38.2%); recognising bone deposits on inner and outer rib surfaces, and on long bones shafts (a Very Important Query), was simply beyond the ability or interest of many volunteers. Finally, the attempt to have novices investigate cortical thinning or abnormal cortical thickening was hampered by the (fortunate) lack of post-mortem midshaft transverse breaks in long bones; but imparting that set of investigative criteria was most difficult.

The lowest scores occurred when volunteers gave up and left 20 or more questions unanswered. A small set of participants did very well, either the first week or by subsequent improvement (02IC, 06PH, 07RH, 08MH, 09CS, 12EJ, 17CB, 25SH, 26AY, 28AP, 31CW, 34OM, 36DH), but for many volunteers, their efforts were expended in the Inventory segment.

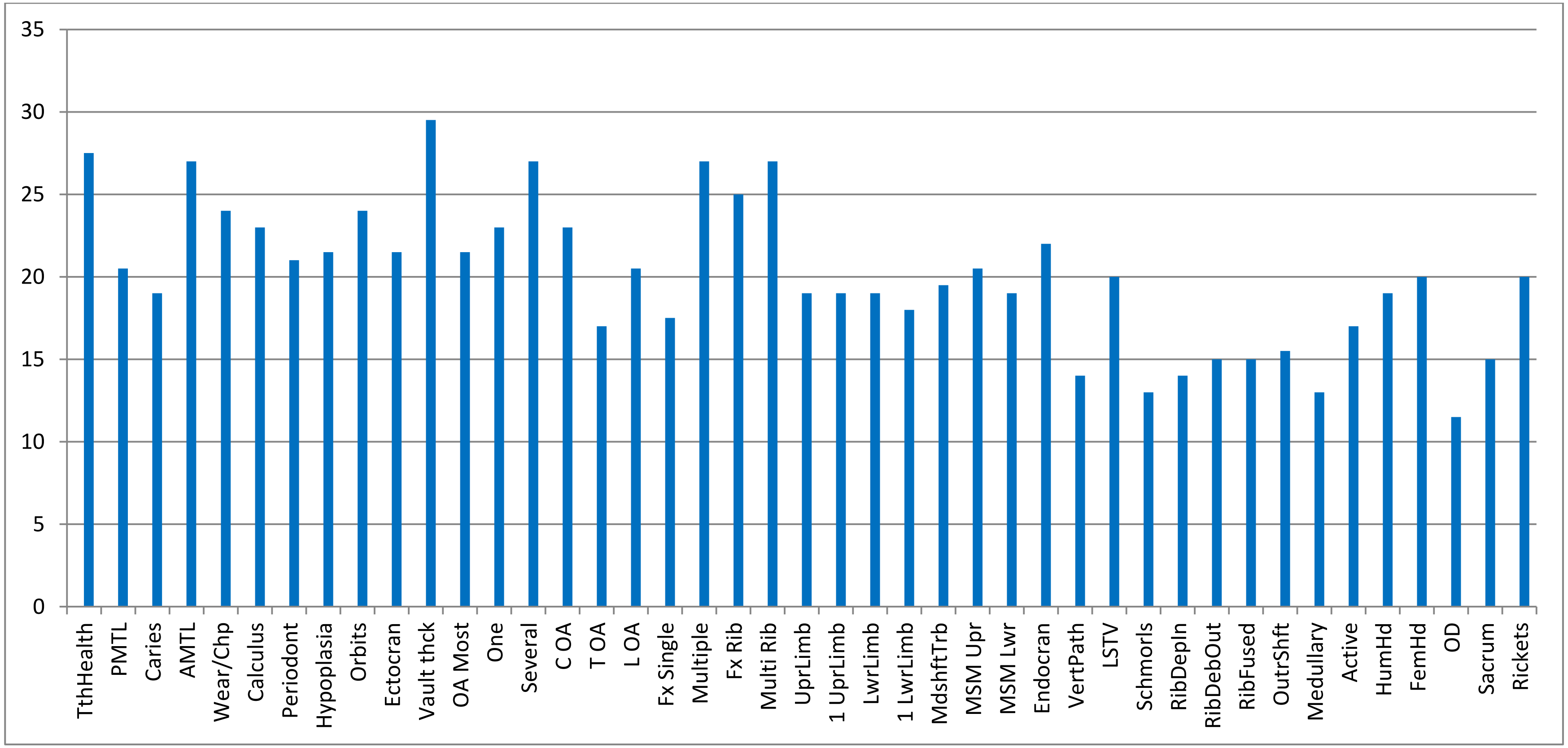


Figure 6.7 Week One Paleopathology. This figure illustrates the relative success of each query in the Paleopathology segment of Week One, which generated 34 forms. This segment had 43 queries for Week One.

6.4.2 Week Two

Thirty volunteers completed 31 forms and thus the maximum possible correct score is 31 per query. The *query* score average of 23.0 answers in agreement with the author is 74.2% or the same as that of *participant* scores (average 32.7 correct out of 44). Query scores ranged from 4.0 to 29.0, but the lowest score is an outlier, with the next lowest score 13.0. The mean was 23.0, the median 23.8, and the standard deviation was 4.80. With the outlier removed (unfortunately, assessment of abnormal periosteal bone, an Important Query), the range is 13.0 to 29.0, the mean is 23.5 (75.7%) and thus similar to the median, and SD = 3.85. The other two Important Queries found in this segment, antemortem tooth loss (AMTL) (21.0 or 67.7%) and wear and chipping 26.0 (or 83.8%) fared better. On average, dental queries were reasonably successful, with 22.9 out of 31.0 (73.9%).

Results are shown in **Figure 6.8**. 'Multiple healed long bone fractures' (27.0 correct, or 87.1%) was succesful, and one might presume this is because the specimens observed (Skeletons 2, 15 and 17) were generally free of multiple or extreme bone lesions. That ribs did not have abnormal bone deposits on inner curves or outer surfaces, and also were not abnormally fused to each other was correct (or fortuitously left blank) an average of 27.8 times (89.7%). Abnormal bone deposits (or loss) in the orbits was assessed in agreement with the author 20.5 times (66.1%); bone shaft, rib, and scapular shape deformities that suggest healed rickets were noted as present or absent 23.5 times (75.8%) in agreement with the author.

The success of assessing cranial vault plates for abnormal thickness (above 10 mm) can be considered a genuine positive result. A total of 12 Week One and Week Two volunteers assessed Skeleton 15, the only specimen with a fragmented skull and which thus affords an internal view of the plate breadth, and most correctly determined the vault thickness was normal (e.g, less than 10 mm), with 10.5 answers correct out of 12 opportunities to assess the vault (87.5%). All other specimens had complete skulls, participants either wrote N/A next to this option or left it blank; and almost every participant accurately noted a skull was 'complete' versus ‘shattered’: over all three weeks and out of 91 forms, 87.5 answers for skull condition were correct (96.2%).

Inability to observe bone shaft interiors due to few limbs having post-depositional damage, and thus inability to comment on cortical thickness was correctly realised an average of 24.4 out of 31 times (78.7%). Abnormal sacral shape or fusion with the lowest lumbar vertebrae was assessed correctly 28.5 times (91.9%). But many of these observations, whilst interesting to some researchers, are not as important as other lesions and conditions that were not accurately captured. Periosteal inflammation was poorly noted on specimens with mild to moderate bone changes. This is an Important Query, but was picked up only 4.0 times out of 31 and indeed was the lowest score of the week (12.9% success).

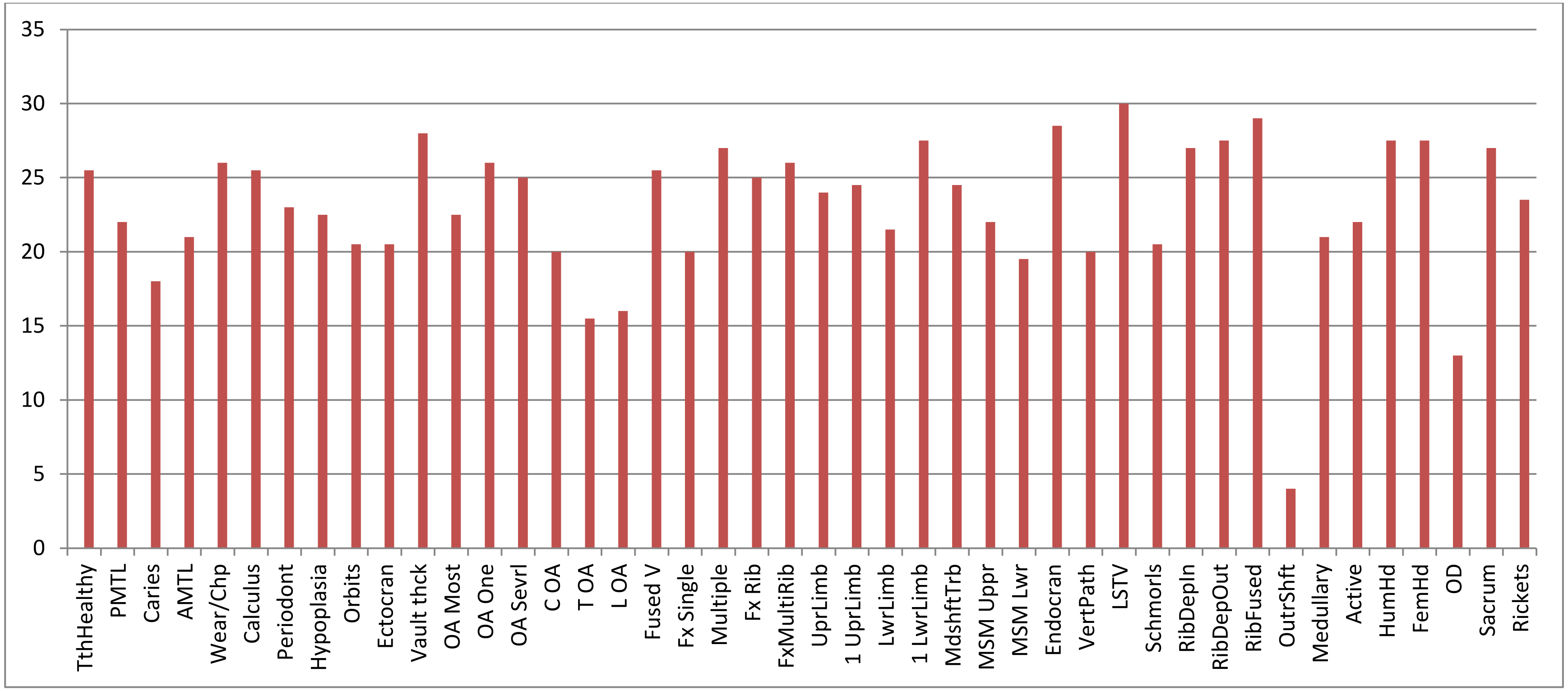


Figure 6.8 Week Two Paleopathology. This figure illustrates the relative success of each query in the Paleopathology segment of Week Two, which generated 31 forms. This segment had 44 queries for Week Two.

6.4.3 Week Three

With 26 analysed forms, the maximum possible correct score was 26 per query. The *query* score mean of 13.8 ‘correct’ answers is 53.1% or about the same as *participant* Paleopathology scores for Week Three, with 44 questions and a mean of 23.3 (53.0%). The range is 4.0 to 23.0, the standard deviation is 5.58, and the median score at 15.0 is higher than the mean (13.8). Twelve participants abandoned the form during the second half of the Paleopathology segment, thus nearly half were incomplete. Results are shown in **Figure 6.9**.

The first 22 queries were correct 16.5 out of 26 (63.5%); the remaining 22 queries effective 11 out of 26 times (42.3%). All but one of the first 22 queries scored 10.0 or more (except localised OA: 8.5), whereas 12 out of 22 queries in the second half scored less than 10.0: vertebral infection; abnormal rib deposits and fusion; bone shaft medullary infection (a complicated concept to impart); orthopaedic changes to femoral and humeral heads (slipped capital epiphyses); healed rachitic deformities; and most tellingly, joint damage (OD). This was conflated with localised OA.

The volunteers recognised abnormal periosteal bone 15.5 times out of 26 (59.6%), surprising in view of the prevalence of mild to moderate lesions in most specimens; but confusion regarding cortical bone as a shaft *thickness* (viewable only by post-mortem midshaft shaft breakage), and cortical bone as a *location of disease* caused several participants to record bone lesions in the section on cortical bone. In Skeleton 7 (**Photograph 6.1**) OA was conflated with OD: highly abnormal bone growth on both tibia and fibula, which extended into the ankle region (a joint) led to confusion about where to record OA (mild if at all) versus OD (some joint damage) versus distal limb joints most certainly affected by abnormal bone (infection). Interestingly, if the participants had not been forced to choose between the ‘correct’ and the ‘incorrect’ diagnosis (a requirement in direct violation to the study’s aims), and had been able to merely record ‘this joint has something wrong’, or ‘this long bone is abnormal’, the abnormal joints and limbs would likely have been flagged.

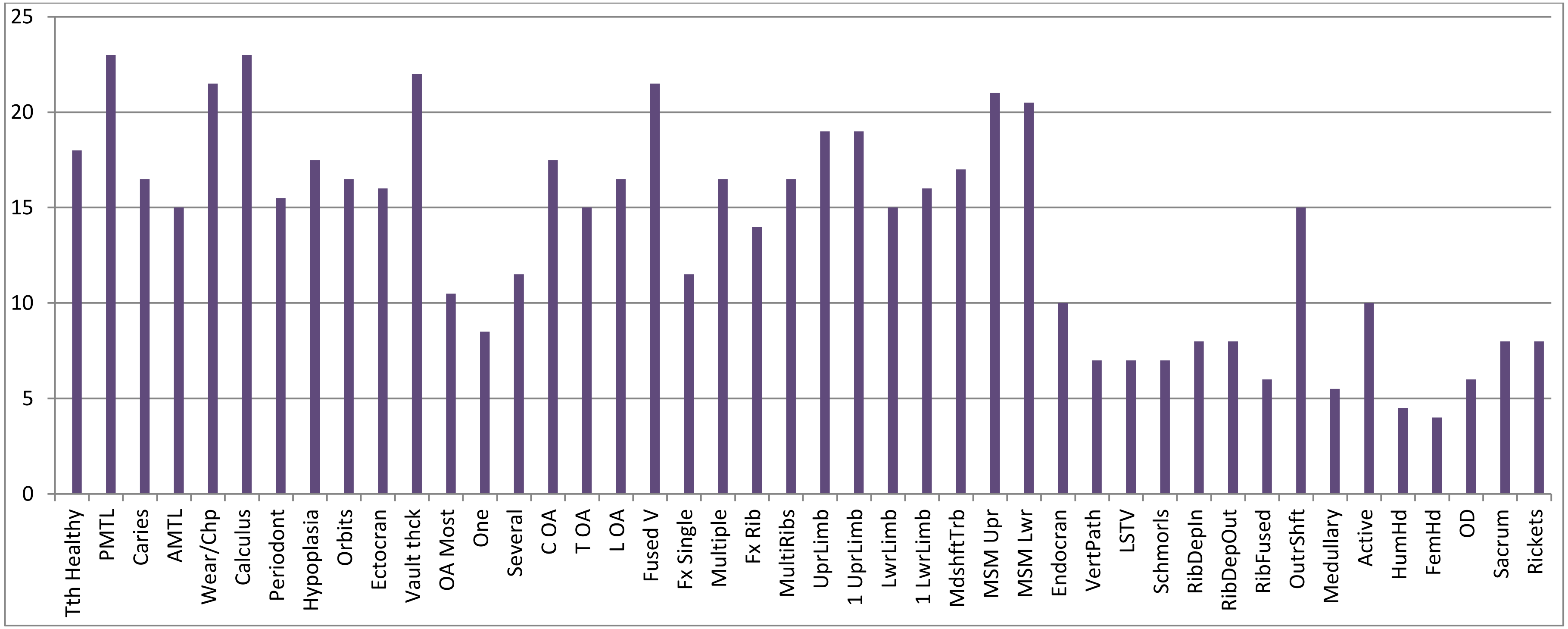


Figure 6.9 This figure illustrates the relative success of each query in the Paleopathology segment of Week Three, which had 24 participants and generated 26 forms. This segment had 44 queries for Week Three.

6.5 Twenty Important Queries; Comparing Results between WARG/NF and Students

The 100 or more questions asked on the form cover inventory, condition of the remains (fragmented, apparently complete), and enquire about relative appearance and shape variation: robust, gracile, pronounced, worn, edentulous, fused, firm, billowy, rough or ragged: all terms meant to elicit observations regarding age and sex-linked traits. In order to more easily compare results, and as an exercise in determining what are truly the most (or among the most) valuable questions, a subset of Twenty Important Queries was identified (**Table 5.6**). Inventory queries with a high degree of success, possibly aided by the excellent bagging system in use at Winchester, were not selected. Obscure traits or anomalies such as artificial cranial modification, premature suture synostosis, or lumbosacral transitional vertebrae were not selected; nor the controversial trait Schmorl's nodes (investigated to collect data on a trait of questionable diagnostic value: **4.4.6.4**). Criteria for selection included the tendency for an element to survive burial, its importance for sexing and ageing, or relevance regarding health, life history, and stature.

The 20 Important Queries (**Table 5.6**) include: completeness of the skull and two cranial traits that research indicates are strongly associated with accuracy in sexing (lateral orbits, torus); completeness and robusticity of mandible, and general dentition; presence, completeness and robusticity of long bones; completeness of joints; maturity of medial clavicle; presence of vertebrae; presence of pubic bones, and assessment of symphyseal face and margins; presence of sacrum; femur length and head diameter; ante-mortem tooth loss and wear / chipping of occlusal surfaces; abnormal periosteal bone on limbs. Volunteer scores for the 20 queries are in **Table 5.13**.

Table 6.1 compares results between WARG/New Forest volunteers and students and finds that the two sets of results that appear most markedly different (assessment of medial clavicle; measuring the diameter of the femoral head) are also the *only* two sets that differ with statistical significance ($x^2 = 6.608$, $p < 0.05$;

x^2 = 24.07, p<0.01 respectively). Chi square analyses were accomplished by comparing number of scored forms plus score between the two groups. For example, for the medial clavicle, 56 adult forms with an average correct score of 34.0 (60.7% correct) were compared to 35 student forms with 10.0 correct (28.6%). Unsurprisingly, x^2 was greater than 3.841 (95% confidence level, p = 0.05) at 6.608, proving the between-group variance of success at recognising billowing versus a flattened medial surface indicted a true difference in how the groups scored this trait.

No two percentages of correct answers match exactly between the groups, but many are within 1.0 to 2.0 percentage points. **Table 6.1,** derived from **Table 5.13** shows results for the 20 Important Queries separated by groups, as accumulative scores of correct answers, and as percentage of forms from each group. Examining the two columns of 'Averages' in the table, one observes modest variation between groups: eleven queries vary by as little as 1.0% between groups, whilst nine vary at 5.0% or more. As a baseline, the 2.3% between-group difference in assessing torus robusticity was examined, but x^2 = 0.022 (p = 0.05) and was not significant. The 5.0% between-group difference in 'Teeth: General' was investigated but again, x^2 = 0.075 (p = 0.05). The 11.4% between-group variation in assessing roundness of lateral orbits was investigated, but was not a significant difference: x^2 = 0.479 (p = 0.05). At this point, it was presumed no further significant differences would be found unless the spread between groups was above 10%; and indeed only Clavicle Fused and Left Femur Head Diameter had significant between-group differences and also have obviously different results. All results for all three weeks for 20 Important Queries, divided by group and with actual scores for each participant, can be found in the **CD Appendix** as Excel spreadsheet **Important Queries: WARG/NF versus STUDENTS, Sheet 10.**

Table 6.1. **Intergroup variation on 20 Important Queries**. Results for the 20 Important Queries are shown as separate scores for adult amateur archaeologists (‘WARG/NF’) and student volunteers (‘STUDENT’), derived from **Table 5.12**. Queries are listed by the common abbreviations used in all tables of results; the full name of each query is found in **Table 5.6**. WARG/NF volunteers completed 56 forms, STUDENT volunteers completed 35 forms, and thus the raw accumulative scores are also shown as averages based on the specific number of forms each type of volunteer completed. Chi square analyses were performed for five pair of results. Between-group differences of 5.0% or more are in bold; significant differences ($x^2 > 3.841$, $p = 0.05$) are in ***bold italics***.

Query	WARG/NF Scores	Average (56 forms)	STUDENT Scores	Average (35 forms)	Chi Sq
SkullCompl?	53.5	95.6	34.0	97.1	
Torus	35.5	63.4	23.0	65.7	0.022
LatOrbs	36.0	**64.3**	26.5	**75.7**	0.479
Mand Present	49.5	88.4	31.5	90.0	
RobvGrac	37.5	67.0	24.0	68.6	
Teeth Genrl	46.0	**82.1**	27.0	**77.1**	0.075
LB Present	52.5	93.8	34.0	97.1	
RobvGrac	46.5	**83.0**	26.0	**74.3**	
JointsCompl?	52.0	92.9	31.0	88.6	
ClavFuse	34.0	***60.7***	10.0	***28.6***	***6.608***
Vert Present	49.0	87.5	32.0	91.4	
PubePres	43.0	**76.8**	30.5	**87.1**	
SymphBil	40.5	**72.3**	23.0	**65.7**	
SymphSharp	22.0	39.3	15.0	42.9	
Sacr Present	52.5	93.8	33.5	95.7	
L Fem L	45.5	**81.3**	26.5	**75.7**	
L Fem Hd	39.0	***69.6***	4.0	***11.4***	***24.07***
AMTL	39.5	70.5	23.5	67.1	
Wear/Chip	45.5	**81.3**	26.0	**74.3**	
OutrShft	21.0	37.5	13.5	38.6	

6.6 Binary Queries

In the York trial, binary queries seemed more successful than other queries. For example, **Figure 3.6** shows that 75% of the participants recognised the presence or absence of calculus, compared to 38% scoring in agreement with author on presence *and* degree (mild, severe) of dental caries. Despite the small number of participants in this session (eight plus author: see **Table 3.8)** it was felt clearly defined, binary queries might be more readily comprehended and thus more reliably observed.

In the 2012 Winchester test, 31 of the 96-104 queries can be termed binary **(Table 6.2),** but in actuality only 23 are truly binary; and of these, six investigate obscure or (in this collection) non-existent traits; four require complex descriptions, prior osteological experience, or are not observable (e.g. endocranial lesions when only one skull was fragmented). One question was added during the test (‘Sacrum fused’) and appeared on 49 forms (with 42.5 correct: 86.7%). Thus, of the 23 binary queries, only 12 are commonly observed and provide useful information. Six of these 12 binary queries are also on the list of Twenty Important Queries (**Table 5.6**): mandibular robusticity; whether the mandible is endentulous; the presence of vertebrae and pubic bones; if overall dental health was ‘unremarkable’; and whether any long bones had lesions such as the new bone depositional growth associated with inflammation and infection.

These six binary queries that are also Important Queries have an average of 77.9% success across 91 forms, with a median of 76.0 and SD = 13.4. Regrettably, the lowest scoring query is on periosteal inflammation (49 correct, or 53.8% success), which if successfully observed, flags evidence consistent with trauma, chronic infection or other long-term conditions. Omitting this outlier, for the five remaining binary queries that are also ‘Important’, the mean is 84.9, the median score is 81.0 and SD = 8.92.

The average number of correct responses in the 23 binary queries is 62.4 (68.6%), but not all queries were on all 91 forms. Removing the less-tested query, the 22 remaining queries average 63.3 (69.6%), with a mean of 61.0, range of 41.0 to 83.5, and standard deviation of 13.80. Considering binary queries most commonly completed (Inventory, plus dental queries in Paleopathology), the average is 73.7 (80.9% out of 91), the range 57.0 to 83.5 and the standard deviation 9.22; but these are only 12 queries.

Comparing ratios of correct answers based on the number of times the queries showed up on a form permits consideration of all 23 queries, including the sacral fusion query added during the experiment (correctly assessed 86.7% of the 49 times this was asked), provides an average of 70.3% in agreement with the author, with a range of 45.1% to 91.8% correct, standard deviation of 15.30 and median of 67.6%.

The final seven queries in **Table 6.2** are from the Paleopathology segment and indeed from the last part of that segment: the portion most likely to have been abandoned by volunteers who were overwhelmed by the process in Week One or overwhelmed by the preponderance of abnormal bone in Week Three. These queries cover sacral morphology, abnormal bone deposits on or fusion of ribs, slipped femoral or humeral heads, infectious disease in long bones, and yet the scores are very similar: the average is 50.1, the range is 49 to 51.1 and the standard deviation is 0.94.

The eight queries that *seem* to be binary could indeed be so with some slight adjustment of the question. Two queries investigate presence or absence of a type of element but have a conditional aspect since the elements queried come in pairs (clavicles, patellae) and the query enquires if 'One or Both' are present. Three other questions can be binary but the state of the element is also queried: is sacrum (or os coxae; or pubic bones) present, yes or no, or present and fragmented. The problematic query on premature craniosynostosis is yes or no, but continues 'if yes, where'; the trait that can be associated with anaemia, cranial vault thickness is queried as to presence and absence but worded as 'less than 10mm or more than 10mm' (10mm thickness in cranial vault plates is taken to indicate abnormal diploe formation: **4.4.4.3**). Abnormal fusion between vertebrae is indeed phrased as 'If present' and thus can be viewed as binary, but the query then specifies number of abnormally fused vertebrae: 'three to five', or 'six or more'. Thus, as worded, these eight queries are not truly binary.

Therefore, the 31 queries in **Table 6.2** are listed as either binary (presence or absence), or not binary with the reasons why they are not; the table notes factors that may limit the utility of these queries on a form designed for use by novices with 'specialist' for rare traits and 'difficult' for those that are too complex for novices. However, the rarity of a trait may not negate the usefulness of the query, especially if the collection is from a region noted for this particular anomaly (e.g. cranial modification in South America); but since the traits termed 'specialist' are not found in this collection, the results may not reflect real-world conditions. The query used less than 91 times has score and percentage listed separately.

Table 6.2. Binary Queries and queries that appear to be binary. Queries are from both segments, listed in the order they appear in the protocol: the top 16 are from Inventory, the lower 15 are from Paleopathology. Queries are considered adequately described (supportive text, illustration) or in alignment with mainstream research, unless described as specialist or difficult. If query is not truly binary the reason is provided. Raw scores and percentage of correct answers (on 91 forms) are provided. One query (Sacrum fused) was not on all 91 forms and the raw score and percentage are separate.

Query	Query style	Binary	On 91 forms	Percent correct on 91 forms	On less than 91 forms	Percent correct
Cranial Modification (horizontal)	specialist	yes	79.5	87.4		
Cranial Modification (vertical)	specialist	yes	83.5	91.8		
Premature Suture Closure	specialist	No: where fused if Yes				
Mastoids misaligned	specialist	yes	74.5	81.9		
Mandible Robust v Gracile		yes	61.5	67.6		
Edentulous		yes	82.0	90.1		
L&R Patellae		No: one or both present				
L&R Clavicles		No: one or both present				
Vertebrae Present		yes	81.0	89.0		
Vertebrae Complete		yes	80.0	87.9		
Os Coxae Present		No: asks condition of bones				
Pubic bones Present		No: asks condition of bones				
L&R pubic bones present		Yes	81.0	89.0		
L&R Greater sciatic notch similar	specialist	Yes	57.0	62.6		

Sacrum Present		No: asks condition of sacrum				
Sacrum Fused		Yes: 49 forms			42.5	86.7
Healthy Teeth		Yes	71.0	78.0		
Calculus		Yes	71.5	78.6		
Hypoplasia	difficult	Yes	61.5	67.6		
Vault + 10 mm thick		No: two options: less than 10mm, more than 10 mm				
Fused Vertebrae		No: two options for number vertebrae fused				
Endocranial lesions	difficult	Yes	60.5	66.5		
Vertebral lesions		Yes	41.0	45.1		
LSTV	specialist	Yes	56.0	61.5		
Ribs Bone deposits inner surfaces		Yes	49.0	53.8		
Ribs bone deposits outer surfaces		Yes	50.5	55.5		
Ribs Fused		Yes	50.0	54.9		
Long bones: Active lesions		yes	49.0	53.8		
Humerus Head abnormal morphology	difficult	yes	51.0	56.0		
Femur head abnormal morphology	difficult	yes	51.5	56.6		
Atypical sacral morphology	specialist	yes	50.0	54.9		

6.7 Discussion

In 2008, a test of an early version of this protocol suggested a data collection system based on observation was possible. Uncertainties remained. The inventory aspect had not been properly tested. In addition every participant in York had previously worked or in some way studied with the author: was the test truly observation-based? Had the author 'trained' the volunteers and, if so, did this matter?

The Winchester 2012 test indicates that prior training did influence the ability to recognise abnormal bone. However, familiarity with concepts such as 'periosteal inflammation', 'osteoarthritis' and 'post-mortem tooth loss' did not guarantee perfect scores in the York trial. Indeed, a little training could be dangerous; the student who most identified as the author's assistant, self-identify as having Level Two training, missed more questions than those identifying as Level One. Similarly in Winchester, participants who came open minded and ready to pay attention sometimes did very well (08MH, 28AP, 31CW with scores around 85-95%); whilst those with 'some training' or with 'experience' (24AF, 33AB) scored in the range of 50-62% correct.

On the other hand, terminology and concepts that posed few problems for York volunteers proved difficult for truly naïve volunteers to comprehend, such as recognising cortical bone as a separate entity that could be scrutinised; considering skulls and long bones as having 'robust' or 'gracile' morphology; and grasping that immature elements have 'billowy' or 'furrowed' appearance. Postmortem breaks were often perceived as 'fractures'. The sheer novelty of handling an actual human skeleton, dealing with completely unfamiliar jargon and then trying to work out how to answer questions proved unexpectedly time-consuming and mentally exhausting for most, and completely untenable to some.

The author had presumed that novices with absolutely no prior knowledge of human skeletons at all could work through two or even three forms from the first session, based on high speed, efficient results of York students with formal and informal training for up to two years. This was unfortunate, and only three skeletons were observed by most volunteers; but in reality, due to time and access constraints, this would not have improved if the author had realised the volunteers would need more time per form. No more time was to be had beyond the three weeks available for data gathering, and obtaining two, often three and occasionally more forms per volunteer was all that would have ever occurred. The test juggled nearly 40 volunteers, many of whom were students doing coursework, in lab space also used for teaching. The biggest error consequential to inaccurate calculation of the pace of volunteers was not related to too small a sample viewed by each volunteer, but in failing to ensure the same three specimens were viewed by all the participants, thus enabling a range of inferential statistics to have been calculated. Even so, subjecting the same three skeletons to repeated handling would not have been optimal, and since two participants ended up viewing more than three, having additional specimens out would have led to a fresh one being an ‘attractive menace’, and perhaps being scored in lieu of the target core of three. Finally, offering a range of age cohorts and both biological sexes, as well as various disease states and conditions of remains was desired; presenting only 3 or 4 specimens would not have fulfilled this criteria.

6.7.1 Query Format: Binary, Graduated, Conditional.

6.7.1.1 Binary Queries

In 2008, binary queries on simple presence and absence of a trait enjoyed more success than complex or graduated questions judging presence of a trait as well as degree of the trait’s expression (mild, moderate, robust; mild, severe) (**Figure 3.6**). Therefore for 2012 it was decided to word as many queries as possible into an either/or format. One problem with graduated queries offering some format of ‘mild, moderate, extreme’ is the tendency for the less confident assessor to choose moderate (see below in Graduated Queries). With partial scores given for being off by only one degree, selecting the middle ground consistently can artificially inflate scores. On the other hand, even hesitant volunteers are eventually able to label an extremely large, robust or otherwise compelling trait as ‘robust’; after which time, a notably thin, small or smooth bone or brow can be potentially recognised as apposite and be assessed as ‘gracile’. Many Week One comments related to ‘how can I tell what ‘robust’ is?’ (**Appendix 5: Participant Comments**).

Discussion: Winchester 2012 Test of Protocol

In an attempt to force participants to think beyond the safe ‘moderate’ box, a false binary was trialed for an element with such sexual dimorphism it can be arguably used to ‘sex’ infant and young juvenile remains (Schutkowski 1993; Scheur 2002b; Lewis 2009): the mandible. Results were mixed. Binary queries on traits that are most readily described in graduated terms such as robust, moderate and gracile can suffer from chance: what one participant might view as gracile, another may see as robust or pronounced. However, with confidence gained from viewing several sets of remains with a range of robusticity, volunteers were able to assign a mandible to either gracile or robust assessment. For Week One, with specimens comprised of older remains, younger adults and middle age adults, 21 out of 34 volunteers were able to assign the bone to one or the other. For Week Two, with the specimens one middle-aged adult male and two younger adults of either sex, this became tricky, with only 17.5 out of 31 mandibles assessed in agreement with the author. The males were not so challenging but few assessors felt confident enough to assign the moderate mandible of a younger female to the robust category and thus only 2.5 of 13 volunteers were correct. The binary query was either correct or incorrect and thus scored 1.0 or 0.0 except for one memorable time: the assessor declined to circled either option and wrote ‘between the two’ above the choices. Author laughed and awarded a half point. By Week Three, the volunteers were able to confidently assign one of only two options to an element with graduated morphology, which suggests that it required experience with several sets of remains to be able to so: the respondents agreed with the author 23 out of 26 times. Despite most volunteers only assessing three skeletons, one to four other specimens were also on display, being studied by other volunteers, most of whom are friends, colleagues and on occasion, one’s spouse; it is presumed that casual exposure to more than three specimens added to a volunteer’s ability to discern slight variation and to make a ‘call’ on the mandibles.

Binary queries were successful 70% to 80% of the time, with the lower scored traits the mandible (overall, 67.6% successful); specialist or hard-to-define traits such as dental hypoplasias or asymmetry in greater sciatic notches between left and right hips; and the often-abandoned Paleopathology queries at the end of the form (**Table 6.2)**.

6.7.1.2 Graduated or Conditional Queries

Questions can be termed ‘graduated’ or conditional if they are not answered by a simple yes or no. Conditional queries are those that interrogate the presence of a skeletal element and its condition: ‘Complete? Fragmented?’ Some of the seemingly binary queries in **Table 6.2** request condition as well as confirmation of presence.

Most questions in Inventory pertaining to sexual dimorphism are graduated queries, offering an extreme at either end (robust / pronounced versus gracile / mild), with the option of ‘moderate’ for a trait that fits somewhere in-between. The scale is more correctly divided into five degrees, as depicted for pelvic and cranial traits in Phil Walker’s famous series of sketches for Buikstra and Ubelaker (1994: 18-20). In general, the more options offered to novices, the more room for confusion, as shown in the convoluted paleopathology assessments in York 2008 and indeed in Winchester 2012. The decision to limit cranial and postcranial morphology to three options was deemed adequate. The eventual success of the forced binary choices for the highly dimorphic mandible (**6.7.1.1**) suggests this was sound reasoning.

Many cranial and pelvic traits that were chosen as moderate were, indeed, neither robust nor gracile: the author agreed with these choices of ‘moderate’. ‘Moderate’ answers discussed here are those scored 0.5, as the trait was actually at one end of a continuum: these answers were one degree off of correct and scored as a half-point. Participants who overly relied on the mid-range safety of ‘moderate’ were perhaps the most unsure, for example 24AF. Even this participant reduced reliance on this choice week after week: Week One, moderate was chosen six times; Week Two, three times; Week Three, once. Other volunteers with high usage of ‘moderate’ in Week One gained confidence in later weeks, selecting it less often. Other participants hedged their bets on the same, hard to quantify trait skeleton after skeleton; several relied on ‘moderate’ both Week One (novel task) and Week Three (highly abnormal long bones: general panic). The young probable female Skeleton 17 garnered many ‘moderates’, perhaps due to her youthful mix of gracile and more robust traits. **Table 6.3 Reliance on Moderate for Graduated Queries** lists graduated queries, the participants who chose the middling answer, and the weeks that they did so. Not all 37 participants are on the table: a few students had abandoned the form in Week One, and also tended to share answers; the data for only one is included here for Week Two. Other participants were very confident of their answers, and were either absolutely wrong or were correct; or were awarded 0.5 points for selecting an extreme when a trait was actually deemed 'moderate' by the author. For ease of comparison only 'moderate' answers that were off by one degree for a trait that was actually mild or robust, or some different quality of completeness, are examined here.

The result of (incorrectly) choosing the safe bet of moderate is two-fold: if the volunteer genuinely could not select one extreme, then the choice of 'moderate' is defensible; but if the participant is not confident of their ability to judge the expression of a trait, or the query itself is requesting information they simply do not know how to provide, then the choice of 'moderate' masks the inadequacy of the query's wording by making the query seem more successful than it was. Perhaps a future version of the protocol might be improved by offering a range of five expressions for a dimorphic trait. As discussed in **6.3** *Query Results for Inventory*, in general the cranial sexually dimorphic traits averaged 62.9%, 69.0% and 61.5% for Weeks One to Three respectively and thus do not appear as successful as binary queries.

Considering the 20 graduated or conditional queries in **Table 6.3**, one sees that some were less straightforward to quantify than others: Torus (the supraorbital ridge over the eyes, more pronounced in males), Occipital (the rear of the skull, with pronounced muscle attachments in males – generally), Lateral orbits (rounder in males) and Mastoid processes (wider and/or larger in males) were judged to be moderate 16-20 times by the 30 participants listed. Ribs were deemed to be 'in large fragments' 22 times by these 30 participants, whereas the author reckoned most sets to be mostly complete; determining the greater sciatic notch in the pelvic bones was either deep and narrow, or wide and shallow was a tough call about half the time (16 times). Nasal completeness (ambiguous 18 of 30 times) may relate to the irregular contours of a typical nasal area, and paired maxillary bones (which combine to create the nasal orifice) may have been judged ‘partially complete’ as a result of the skeletonised individual having lost teeth and maxillary bone to leprosy, which afflicted most of the individuals thus far exhumed from Mary Magdalen Hospital (Roffey and Tucker 2012).

Examining the respondents, nine used ‘moderate’ in lieu of deciding firmly on one end of the spectrum 50% of the time or more, with counts of the middling option used 10-15 times out of 20 opportunities over three weeks. Some participants seemed to gain confidence over the weeks, based on a reduction in their (incorrect) use of moderate by Week Three, and with a presumption that choosing ‘safe’ moderate represents indecision; and indeed, 02IC and 09CS enjoyed score increases over the sessions. On the other hand, 06PH increased his reliance on ‘moderate’ and yet went from scoring 36.0 in Week One to 80.0 in Week Three. Outlier 24AF maintained low scores throughout all three weeks, but dropped from six near-misses in Week One to three in Week Two and one in the final week: he gained confidence but not comprehension; in some way the format failed him. 24AF is discussed briefly below in **6.7.6 Outliers.**

The low reliance on ‘moderate’ by 37IN is deceptive: this volunteer only attended one session (Week Two) and was so overwhelmed by options relating to the skull, he skipped the first 22 queries. 31CW and 09CS rarely used moderate and indeed 31CW used it only once. Her score was amazingly high for a novice in Week Two (90.5 out of 104 queries), and like many, in Week Three was utterly wrong-footed by the highly abnormal specimens; she was wrong, or right; rarely in between. Four volunteers in **Table 6.3** only appear for Week One (10SH, 18AK, 33AB, 35JD) or are evaluated for this aspect of the trials for one session for other reasons (20ND, 37IN). Thus of the remaining 24 volunteers in **Table 6.3**, ten relied markedly less on ‘moderate’ by Week Three, and eight used ‘moderate’ in Week Three more than in other weeks. The traits listed are either associated with sexual dimorphism, or relate to the completeness of skeletal elements. Dimorphic traits are expressed on a continuum and can be genuinely described as ‘moderate’ as well as some form of ‘mild’ or ‘robust’; groups of skeletal elements assessed for completeness could potentially be complete as well as partially complete or in fragments. The choices of ‘moderate’ highlighted below are those that seem to have been made as a result of participant indecision.

Table 6.3. Reliance on Moderate for Graduated Queries. This table lists 20 graduated or conditional queries, and 30 of the Winchester 2012 participants. Queries answered by selecting ‘moderate’ in partial error have the week in which this occurred listed by the participant’s identifier; ‘1’ signifies Week One, ‘2’ represents Week Two, and 3 for Week Three. The queries are designed to be answered by first identifying presence or absence of the skeletal element or region, and then determining the morphological characteristics, or state of preservation or completeness that best describe the element or region.

	Frontal	Glabella	Torus	Occipital	Zygomatics	Lateral Orbits	Mastoids	Supra EAM	Maxilla L Compl?	Maxilla R Compl?	Nasal Compl?	Mental Eminence	Gonials	Long Bones Present	LB Robust v Gracile	Joints Compl?	Ribs Compl?	Verts Compl?	Pubes Compl?	Gr Sciatic Notch
02IC	1		2	1	2	3	1, 3						1	1	3	2				
03RC							3						2	3			3			
05GL				3												3	3		3	
06PH	1, 2, 3		3	2, 3	3	3							1							1
07RH			3				2				2				2		2			2
08MH			3	2, 3												3	2			3
09CS			2				2						2							
10SH						1	1							1			1			
11JR				3			3													
12EJ	3		3		3	3							3			3	2			2
14YS			3	2		3			3		3		2				2			2
15BD			3			3					2, 3						2			
16WH				2	2	2					2		1		1		2			2
17CB				2					2	2	2	2	2				2			2
18AK				1		1			1	1	1									
19KM			2	1, 2	1, 2				1	1	1			2			2			
20ND							2		2	2					2	2	2			2
23MS						1			2, 3	2, 3	2, 3				1		2		3	2, 3
24AF			1, 2		2	1	1					3			1		1, 2			1
25SH					1, 3		2		2	2	2, 3		1		1		2	1	1	
26AY	3					1, 2	1		1, 3	3	1, 3				2	1	2			
28AP	1, 3			2		3	2, 3				3	3	1, 3		1, 2		2			1, 2
29MY					3	2, 3	3		1	1	3				1	2	2	2	2, 3	1
30JY			2, 3	1	3	1, 2, 3	1				2		1						2	1
32BB						2								2	2	2	2			
33AB				1, 1		1	1				1		1				1			
34OM			2													2				
35JD			2												2	2	2			
36DH	3		3																	3
37IN														2						

6.7.1.3 *Problem Queries: Ones that Simply Failed*

Some questions have issues that go beyond problematic form design. Some queries are simply too specialist; too reliant on at least a minimum level of comprehension as to how bone reacts to insults such as trauma and disease, and how age and sex can affect these reactions. The author was curious to see how absolute novices would interpret some of the questions, in much the same way that fairly complex, nested queries were asked in York. Both times, the author was interested in testing the limits of common knowledge and a participant's ability to undertake a novel task whilst simultaneously trying to comprehend unfamiliar terminology. In **Table 6.2**, some queries (generally those that seem like binary questions but are not) are described as 'specialist' or 'difficult'. Graduated queries (**Table 6.3)** also proved difficult for novices; many were successful only about 60% of the time. Participants juggling too much novel information may have been prone to leave a confusing question unanswered (Babbitt and Nystrom 1989: 77), or to skip sections of the form when both the query and the skeletal specimen were too difficult to comprehend.

Using the figures made for each session during the Winchester test (**5.5.1, 5.5.2, 5.5.3)**, queries that scored very low each week are summarised in **Table 6.4**. Over a three week period, four different groups, two comprised of WARG and New Forest members and two made up of undergraduate students, met weekly: thus adult amateur archaeologists had altogether six sessions (1A, 1D, 2A, 2D, 3A, 3D) as did the students (1B, 1C, 2B, 2C, 3B, 3C). **Table 6.4 Query Failures** lists the 26 queries that failed in at least one session over the testing period. For example, in session 1A, only 1.5 points were accumulated for recognising the pre-auricular sulcus (a sexing trait); thus out of 13 participants, the success of this query was 1.5 out of 13, or 11.5%. Some queries are related: four are associated with the pubic symphysis (margins, billowing on the symphyseal face) but were variably problematic. Some queries fail repeatedly: recognising age-related changes in the medial clavicles was scored correctly less than 20% of the time in five out of the 12 sessions; noting the presence of premature suture future failed 8 sessions out of 12 and the few sessions when this query was successfully scored are more than likely related to the *absence* of the anomaly in the specimens for those sessions (see **Section 6.3)**. Students failed to measure the diameter of the femur head correctly (often scoring 0) in five of their six sessions. Assessing the pubic symphyseal margins for age-related changes failed in seven sessions; recognising periosteal reactions was too difficult for half of the 12 sessions and this skeletal sample is comprised of individuals with molecular and hard tissue evidence of leprosy.

This problematic aspect raises the concern of applicability: whether this methodology is viable if parts of the protocol are too difficult for the target user. This is explored further in **Section 7.3.4**. Whilst problems are recognised with how questions were framed, the answer is yes: information on skeletal elements present, overall preservation of the remains, and that captured important paleodemographic data, had reasonable to high rate of success (**Table 5.13).**

Table 6.4. Query failures. Twelve sessions met over a three week period during which volunteers used a paper-based questionnaire to assess human skeletal remains. In every session, two to ten queries failed. The questions with less than 30% success rate are listed by session. The queries are abbreviated.

WEEK ONE			
1A WARG / NF	**1B STUDENT**	**1C STUDENT**	**1D WARG / NF**
sulcus, ribs	pubic symphysis (bevel, ragged margin), femur head, OA T vertebrae, periosteal reaction	frontal, medial clavicles, ramus, femur head, ectocranial lesions, vertebrae OA, orthopaedic disorder: femur head	pubic symphysis (sharp margin), sulcus
WEEK TWO			
2A WARG / NF	**2B STUDENT**	**2C STUDENT**	**2D WARG / NF**
premature suture, pubic symphysis (sharp, ragged margins), OD, periosteal reaction	premature suture, medial clavicles, pubic symphysis (sharp, ragged margin), periosteal reaction, vertebral infection	premature suture, medial clavicles, sulcus, femur head, orbit lesions, OA L vertebrae, periosteal reaction, OD	premature suture, medial clavicles, pubic symphysis (sharp margin), OA T vertebrae, fractures, periosteal reaction
WEEK THREE			
3A WARG / NF	**3B STUDENT**	**3C STUDENT**	**3D WARG / NF**
premature suture, pubic symphysis (ragged margin), OA and OD, periosteal reaction, LSTV	premature suture, zygomatics, medial clavicles, pubic symphysis (billowy; bevel and ragged margins), femur head, orbit lesions, OA, fractures	premature suture, ageing w ribs, pubic symphysis (ragged margin), femur head	premature suture, pubic symphysis (bevel, ragged margins), ageing with auricular, OA and OD

WARG/NF = WARG and New Forest adult amateur archaeologists; **OA** = osteoarthritis; **T** = thoracic, **L** = lumbar; **OD** = osteochondritis dissecans; **LSTV** = lumbosacral transitional vertebrae.

6.7.2 Differences Between York and Winchester Trials

6.7.2.1 Participant Incentives

In the 2008 York study, the participants were mostly students known to the author; most had studied skeletons; most had attended the author's weekly 'Bone Club' (nicknamed by these same students). There was a social aspect to the York study as it was considered a continuation of Monday evening Bone Club meetings. It was recognised that the volunteers were donating their time in order to further the author's research; even so, there were pre-existing friendships between the author and most participants. A fairly substantial supply of soft drinks, snacks and candies were offered as an incentive. Most volunteers lived within walking distance of the University.

In Winchester, a large time commitment was requested of student volunteers who had no previous acquaintance, excavation experience or tutor-student relationship with the author: the experiment was specifically to benefit a research project. A quantifiable carrot was needed and thus a small cash sum was offered to students as well as to WARG/New Forest volunteers, many of whom travelled some distances to participate. Stipends for volunteer participation are the norm in psychology studies and it was felt this would inspire consistent attendance. None of the adult amateur volunteers accepted the stipend, but most students did (as has this author when volunteering for other research students' studies).

6.7.2.2 Methodology

In York, the protocol was comprised of 40 different queries, split into four separate 'Trials', each comprised of a few queries. The Inventory segment, which developed into the most successful aspect of the 2012 protocol, had been recognised as a necessity but was not tested formally in York. The other four sections were tested within one Monday session or on contiguous Mondays. For example, Trial 1 took three sessions to complete; Trial 2, dental assessments was accomplished in one evening but required a revised version and thus was repeated the following Monday. The volunteer may have had 5 to 10 specimens to observe, and was asked to complete one short form per specimen; thus the same few queries were answered repeatedly in a single session. The separate sections took approximately 30 minutes, with some volunteers needing no more than 40 minutes even when assessing 4-6 skeletons, suggesting a volunteer 'up to speed' might need only 5-10 minutes per section per skeleton. With the full and expanded five sections assembled for the Winchester 2012 trial, the author optimistically presumed it would require 30 to 40 minutes per skeleton for a volunteer to complete a full form, possibly on the lower end of the estimate as the format had been 'streamlined', earlier errors had been 'repaired', and sections now flowed one into the next. This was not the reality. Most volunteers in Winchester used the full two hours to complete only one form.

It could be that the close relationship the author had enjoyed with York students, going over skeletons together during a year of casual 'Bone Club' meetings, was considerable training. It could be that shorter sections of just a few queries answered repeatedly on multiple skeletons is easier and less mentally exhausting than to pour over just ONE skeleton for up to 2 hours using an unfamiliar form. Several participants looked exhausted and others announced they were 'shattered' at the end of the session.

The aim for the Winchester test of the protocol was for most of the 30-40 potential participants to record observations on the same 10 skeletons, with five specimens available for each 2 hour session per group per week. It was hoped that most volunteers could assess two or three skeletons per session, possibly even four with some practice and that most participants would be able to attend more than one session. During the testing period, the author also assessed the specimens, recording her time to complete each form, with most forms taking 20 to 35 minutes to complete (minus any interruptions). Several volunteers managed to complete two forms per session, but none approached the 30 minute mark.

6.7.3 Overall Results All Weeks

6.7.3.1 Condition of Remains

This aspect of the protocol was extremely successful. At the top of every form were five multiple choice questions relating to overall condition of the remains: are the remains in a box (yes); are elements stored in separate bags; and three queries on overall impression of the remains ('good condition?' 'Fairly complete?'). These questions were answered at least in part on all but one form: 90 of 91 forms (98.9%) recorded these observations either in full (90.0%, 81/90) or partly (10.0%, 9/90). All answers on all forms have been recorded in Excel and are on the CD in folders labelled Week 1 Participants, Week 2 Participants and Week 3 participants.

It would be interesting to test these observations on other volunteers and on a collection not curated as well. The Mary Magdalen Hospital remains are comprehensively stored, with bags clearly marked as Right Hand, Left Leg, Vertebrae and so on. The excavators successfully collected even tiny elements such as sesamoid bones, and the specimens are impressively complete; the remains have survived well for over 1000 years.

6.7.3.2 Inventory

The spread sheet **All Skeletons All Queries All Volunteers Inventory Only (Sheet Seven on the CD)** shows pooled results from all three weeks for the 'Inventory' queries. Of the 20 'Important Queries' (**Table 5.6**), 17 are from the Inventory segment; in the Excel table, the Inventory queries that are also on the 20 Important Queries are identified on the far right side beyond the totals of correct answers, by underlining and **bold face**. **Figure 6.1** to **Figure 6.6** illustrate Inventory results by week.

Although 91 forms were collected, not every query is on each form: 7 were added during the trials to accommodate basic inventory questions regarding several paired elements, sacral fusion, and the morphology of the acetabular rim. The potential influence of these extra questions on scores is addressed in **Section 6.3.4**. Even removing the new questions (which were rather successful) the scores improve week on week: from 67.1% on average Week One, to 70.3% in Week Two and 75.0% in Week Three.

The queries added mid-experiment on the presence and preservation of scapulae, and presence of patellae and clavicles have high rates of success. Questions on these three elements were added at the start of Week Two, and thus appear on 57 forms (Week Two = 31 forms, Week Three = 26 forms). Correct assessment of presence of one, both or neither patella was accomplished 50.5 times out of 57 (88.6% success); clavicles were correctly inventoried 56.5 times out of 57 (99.1%); scapulae were identified as present in combination with the correct (or nearly correct) state of preservation 51.0 times out of 57 (89.5). Questions regarding sacral fusion and the hip socket were incompletely added in Week Two (printer issues) and thus were assessed a maximum of 49 times. These results were more subjective or certainly confusing and the language utilised in the form was to blame. The query regarding the top two sacral elements having a hiatus (gap), a remnant line (small gap of sorts) or no line at all, termed S1/S2 in the spread sheet, was successfully observed 36.5 times out of 49 (74.5%). Whether the sacrum was a single bone or not (indicating an age less than mid-adolescence if the sacral elements remained totally separate: Scheuer and Black 2004:217), which is a binary query was more successful: 42.5 out of 49 responses were correct (86.7%). Whether the rim of the hip socket was ‘round/oval with firm edges’, ‘irregular, ‘bumpy’, rough’ or ‘deteriorated’ was successfully observed 33 times out of 49 (67.3%). Lastly, in Week Three (26 forms), a general assessment of the pelvic bones was added, asking whether they were ‘Complete’, Fairly complete’ or ‘Shattered’. This question, with a maximum possible success rate of 26, was correctly observed 22 times (84.6%).

Problems abound with descriptive statistics, with questions about reliability, accuracy and possible influence of the volunteer pool. When assessing an archaeological ‘item’ as pre-loaded with controversy as the human skeleton (e.g. Alberti *et al.* 2009), it is difficult to envisage volunteers going out of their way to assess remains for a museum if they are offended by studying remains, or do not find them interesting and do not want to learn something. The two most conspicuous problems related to answer sharing, and personal issues. Some students shared answers; mostly, one student would measure the femoral dimensions and two or more would share the answers, perhaps as practiced in lab settings. A few perhaps did not view the trial too seriously and considered it an interesting social pastime, as all answers and even written comments between several students were identical. In these cases, answers would be compared, one by one, between volunteers; when two or more sets of answers matched exactly, only one form would be scored with the other(s) set aside. Further problems related to personal issues: one participant stated a young relative of his was very ill, and then refused to ever complete the paleopathology segment. One suspects he came out of scientific curiosity but also a personal desire to see 'mortality'. He may not have liked it. Another volunteer showed up once and never returned, declaring the test 'too difficult' for the average volunteer. Again, she is correct. The target user is a person who is not offended by the human skeleton and wants to help collect data. Therefore, target users will ideally be self-selecting, and perhaps have some prior experience with handling skeletons.

6.7.3.3 Paleopathology

The spread sheet **All Skeletons All Queries All Volunteers Paleopathology Only** (Sheet Eight on the CD) shows pooled results from all sessions for the 'Paleopathology' queries. **Figure 6.7**, **Figure 6.8**and **Figure 6.9** illustrate results by week. These results seemed especially influenced by several factors: alterations to the design of the form, with N/A or NONE either explicit options or implicitly offered; variation among the skeletal samples in relation to abnormal bone; and the unfortunate design decision to simplify data analysis at the cost of volunteer comprehension. The apparently arbitrary (to a novice) separation of some types of joint disease or trauma from other similar (to a novice) joint disorders, which are scored as 'incorrect' if an anomaly is recorded in the 'wrong' section of the form, will be removed in the next version of the protocol. Whilst it would be wonderful for scorers who are not the author to be able to say Query 72, 73, or 74 refers to Osteoarthritis (OA) and Query 102 refers to Osteochondritis Dissecans (OD), it does not necessarily have to be that segregated. Some volunteers thrived using the form even with these complexities in place; complexities that could be unravelled by an end-user who has taken an undergraduate class in basic paleopathology. It can be argued (see **Chapter 7**) that the Paleopathology segment is specialist and is designed for 1. attentive volunteers and 2. osteologists who do not wish to forget to observe one aspect or another of skeletal specimens analysed during a research visit.

Whilst enabling novices who have time to volunteer in museums, or archaeological field and lab technicians with samples to assess to collect paleopathology observations is an excellent idea, the average student and older adult volunteer simply lacks the interest to read and absorb the supportive text carefully. Indeed, nine out of 34 volunteers in the first week simply abandoned the form once it went beyond asking queries about familiar topics such as dental health. This tendency to quit the form once it became ‘too much like hard work’ occurred again in the third week, when two of the specimens had moderate to severe abnormal bone; thus for many participants, questions on osteoarthritis, OD, fractures, cortical bone thickness (confused with cortical appearance), rachitic deformities, and of course shaft and medullary canal abnormalities were either rarely viewed, or answered hastily. The fault lies with the author: by separating OA from OD (both of which affect a joint) novices were, essentially forced to *diagnose* in order to choose observations of abnormal bone in the ‘correct’ location in the form.

In addition to forcing a diagnosis in order to answer the ‘correct’ section, by splitting OA and OD, volunteers were asked to observe the same areas repeatedly: a complaint raised during the York trials. One recommendation is to merely request information on ‘abnormal’ joints, whether the abnormality is a subchondral defect, marginal osteophytes, eburnation, abnormally enlarged joint margins, or so on. By not limiting the observation to the ‘correct’ diagnosis, OD as well as inflammatory and infectious arthropathies may be flagged. If a simplified question is employed, the system can potentially flag infectious diseases such as tuberculosis (Ortner 2003: 228-229) and yaws (ibid: 316-317), both of which can damage joints.

Based on admittedly limited statistical testing which involves mostly descriptive observations of the Paleopathology segment, it is suggested that, for those volunteers with patience, the Paleopathology segment is no more than an intellectual challenge; and for such volunteers, the extended form can be completed with a high degree of accuracy. Despite some dreadful Paleopathology scores (20 forms averaging only 12.0%, range 3.0 to 19.5 correct out of 44) and some middling scores (29 forms at 60.0%, range 20.0 to 30.0 correct), a large number of forms, 42 completed by 27 people had scores ranging from 30.5 to 42.0 correct (70.9% to 97.7% correct, averaging 79.8%). Of these 27 high scoring volunteers, 15 maintained high scores on at least two separate occasions, suggesting there is some element of reproducibility in their success. The spread sheet **All Skeletons All Queries All Volunteers Paleopathology Only (Sheet Eight) Appendix 11** lists each volunteer, the skeletons they observed and their weekly scores.

6.7.4 Skeletal Specimens

An entire chapter could be devoted to exploring how variation among the skeletal specimens influenced the comprehension of the queries. For example, youthful robusticity in a young adult female as compared to gracility in an older adult male perhaps lead discerning participants to doggedly select robust or gracile in order to fit with expectations of ‘female’ and ‘male’. Paleopathological conditions were better observed if extreme, such as the highly abnormal bone in Skeleton 7 versus milder periosteal inflammation in Skeleton 2, 15 and 17. In addition, Skeleton 7 was observed in Week Three, by which time all remaining 26 participants had taken part in at least one previous session, or more. Thus experience with skeletons and with the form cannot be discounted.

All scores are shown per skeletal specimen in the **CD Appendix**, as **Sheet 11** in Excel, **Item 5.** The specimens are also separated by week, thus Skeleton 2, 15 and 17 are listed twice. **Photograph 6.1** shows the right femur, tibia and fibula of Skeleton 7. The distal fibula has evidence of a healed fracture; most of the shaft is expanded and the abnormal bone is speculated and unremodeled. Conversely, **Photograph 6.2** shows the articulated right foot and partial image of the right tibia and fibula of Skeleton 17. Periosteal inflammatory response on the tibia is very mild; the fibula looks normal compared to that in **Photograph 6.1**. The foot podials were assembled in anatomical position by a volunteer.

Photograph 6.1. Right femur (top of image), tibia (middle) and fibula (bottom of image), Skeleton 7. Anterior aspects. Photograph by Rose Drew.

Photograph 6.2. Right articulated foot, fibula and tibia, Skeleton 17. Anterior aspects. Image taken during Session 2A. Photograph by Rose Drew.

As summarised in **Table 5.5**, young to middle adult specimens, and those without disease were more straightforward to analyse; easily recognised elements and traits were correctly recorded: but **Table 5.5** includes all 100 or so queries. When results per specimen are compared for just the 20 Important Queries, the same observations are missed repeatedly, despite the specimen: the few successes amongst ones commonly missed relate to extreme expression, or lack of the trait (see below). **Table 6.5 Failed Queries by Specimen** summarises the 20 Important Queries that were missed per skeleton and per week. As Skeletons 2, 15 and 17 were each viewed in two weeks, they are each listed twice.

Table 6.5. Failed Queries by Specimen. The 20 Important Queries assessed per skeleton per week, listed by specimen, estimated age and sex, and the queries with less than 60% success, based on query score average and number of volunteers per session.

Specimen	Age and Sex	Queries with less than 60% success
Week One		
Skeleton 01	Older Adult Male	Pubes billowy; Femur head; Outer shaft
Skeleton 02	Adult Male	Torus; Mandible and LB robust; Clavicles; Pubes: present, billowy, sharp; Femur head; Outer shaft
Skeleton 15	Young Adult Male	Clavicles; Pubes: present, sharp; Sacrum present; Femur Length; Outer shaft
Skeleton 20	Adult Female	Torus; Teeth general; Pubes sharp; Femur head; AMTL; Outer shaft
Skeleton 21	Adolescent, probably male	LB robust; Clavicles; Femur head and length
Week Two		
Skeleton 02	Adult Male	Torus; Pubes: present, sharp; Outer shaft
Skeleton 15	Young Adult Male	Lateral orbits*; Clavicles; Pubes sharp; Outer shaft
Skeleton 17	Young Adult Female	Clavicles; Pubes sharp; Femur head; AMTL; Outer shaft
Week Three		
Skeleton 07	Older Adult Male	Torus; Pubes billowy; Femur head; AMTL
Skeleton 09	Adult Male	Torus; Pubes sharp; Femur head; Outer shaft
Skeleton 17	Young Adult Female	Lateral orbits; Mandible robust; Clavicles; Pubes sharp; AMTL; Outer shaft

LB = Long bones; **AMTL** = Antemortem tooth loss. *This skull was shattered.

The torus, or supraorbital ridge is more pronounced in males (Krogman 1962; Meindl *et al.* 1985b; Buikstra and Ubelaker 1994; Brickley and McKinley 2004; Ramsthaler *et al*. 2010), but this trait is affected by age (Walker 1995). The query was unsuccessfully observed for most specimens; for example, the combined scores from eight volunteers observing Skeleton 20, an adult female were 3.0 (37.5%), whereas Skeleton 21, an adolescent (probably male) was correctly assessed for a score of 8.0 by 10 participants (80.0%). Skeleton 15 has a shattered skull and thus the torus is not readily observable. The trait was assessed successfully for Skeleton 1, Skeleton 17 and Skeleton 21; all of these specimens are very old, very young or a young female, and have a gracile brow.

The medial clavicles were correctly assessed as having lost the youthful furrows and billowing due to epiphyseal development for mature specimens: Skeletons 1 (64.3%), 2 (66.7% the second week), 7 (66.7%), 9 (87.5%) and 20 (62.5%). However, during the first week, Skeleton 2 was poorly assessed for clavicle maturity (a score of 1.0 from six participants). Youthful clavicles were virtually unrecognised in either Skeleton 15 (only 1.0 from a total of 15 participants) or Skeleton 17 (accumulative scores of 2.0 from 16 participants).

Periosteal inflammation, referred to as 'Outer shaft' in **Table 6.5** and 'Periosteal' in **Table 6.6** was observed by the author on Skeletons 2, 7, 9, 15 and 17. Skeletons 1, 20 and 21 did not have observable abnormal bone on the outer shaft and indeed Skeleton 1 was interred in the chapel, dates from the 17^{th} century and did not have molecular evidence of Hansen's disease (Roffey and Tucker 2012; Taylor *et al.* 2013). However, only the extremely abnormal long bone deposits in Skeleton 7 and the apparently normal long bones in Skeleton 21 were assessed with moderate success, with scores of 10.0 from 15 volunteers (66.7%) and 6.0 from 10 volunteers (60.0%) respectively.

Table 6.6 outlines traits and paleopathologies for the eight specimens, the number of volunteers to view each specimen and associated scores. When variations in traits, age, sex and disease, as well as condition of each specimen are considered, the relative successes and failures of queries can be better understood. For example, volunteers 'successfully' scored the torus in Skeleton 15 because the skull is shattered; this trait is not assessable.

Table 6.6. Observed traits and pathologies in the eight specimens. The number of volunteers ('Vols') to view a specimen each week as well as the average ('Avg') scores, overall and by segment (Inventory and Paleopathology) are included.

Specimen	Age and Sex	Observed Paleo-pathology	Vols	Avg score (raw, %)	Inv. Score	Paleo Score
WEEK ONE: 96 Queries						
Skel 01	O A M	No teeth; gracile skull. Mild OA, no other disease	7	59.4 (61.8%)	70.4%	51.1%
Skel 02	A M	Obvious: bad teeth, greenstick fracture. Mild periosteal	6	67.9 (70.8%)	68.2%	73.8%
Skel 15	Y A M	Skull in fragments. Mild dental and periosteal	3	57.8 (70.2%)	61.0%	59.3%
Skel 20	A F	Mod/Sev OA in spine	8	54.4 (56.6%)	65.9%	45.3%
Skel 21	Adol. M?	Gracile skull. Unfused femur interpreted as disease; no obvious disease	10	64.6 (67.3%)	67.5%	67.1%
WEEK TWO: 103 Queries						
Skel 02	A M	See Week One	9	77.2 (75.0%)	72.8%	77.9%
Skel 15	Y A M	See Week One	9	75.5 (73.3%)	72.3%	74.7%
Skel 17	Y A F	Gracile skull. One severe caries; mild periosteal	13	71.6 (69.5%)	68.2%	71.4%
WEEK THREE: 104 Queries						
Skel 07	O A M	Obvious dental and periosteal disease	15	69.4 (66.8%)	75.2%	55.2%
Skel 09	A M	Mild/mod disease, missed.	8	71.8 (69.0%)	78.8%	55.6%
Skel 17	Y A F	See Week Two	3	59.3 (57.0%)	74.0%	34.0%

O = Older; **A** = Adult; **M** = Male; **F** = Female; **Y** = Younger; **OA** = Osteoarthritis; **Mod** = Moderate; **Sev** = Severe; **Adol** = Adolescent.

Most volunteers to examine Skeleton 15 recognised that the skull had been shattered (10.5 out of 12, or 87.5%), similarly, almost all observations of the other seven, unshattered crania were accurately documented (77.0 out of 79, or 97.5%). Considering the 20 Important Queries across all specimens, answers were in agreement with the author 73.3% of the time, even counting the dismal results of assessing age-related traits in the medial clavicles or the pubic symphyses, accurately taking the maximum diameter of the femoral head, or recognising periosteal inflammation on long bones. If these queries are excluded, the 15 remaining 20 Important Queries average 81.4% agreement with the author.

Therefore, easily recognised aspects, such as overall condition of remains; and whether limbs, skull and pelvic bones appear mostly complete (to the untrained eye) were consistently answered in agreement with the author over 80% of the time. Even these basic observations provide information not visible from outside an archival box, shelved in a storage room.

Accurately recording sexually dimorphic traits as robust, moderate or gracile was accomplished 64.8% of the time (all 91 forms); trauma, disease and orthopaedic disorders were only 58.5% in agreement with the author; and chronic periosteal inflammation and active infection recognised only 45.1% (91 forms) from a sample of individuals who had suffered from leprosy (Roffey and Tucker 2012). Clearly, assessment at this level by average volunteers is not promising; but question wording and how the queries were segregated by 'type' caused much of the confusion.

The results per skeleton for each the 20 Important Queries were examined to identify if any particular queries were a struggle dependent on the specimen. This was investigated in **5.6.2, (Table 5.11)** when intragroup variation for two skeletons observed by the same nine volunteers (both students and adult amateur archaeologist) was tested question by question using paired samples t-tests. Skeleton 7, an older male and Skeleton 17 a young female were compared. Scores were either similarly good (skull condition; correctly assessing presence and condition of mandible, teeth, long bones, joints and sacrum) or similarly poor (femur head diameter). The significant differences were for assessing the torus, more difficult for older male Skeleton 7 ($t = 4.24$, $p = .003$, two-tailed); robusticity of the mandible and recognising periosteal inflammation, both significantly more difficult for younger female Skeleton 17 ($t = 5.29$, $p = .001$ and $t = 4.00$, $p = .004$ respectively, two-tailed). Results for the paired samples t-tests are found in the **CD Appendix, Item 7.**

6.7.5 Weekly sessions

6.7.5.1 Week 1: Problems with Forms

The protocol aims to be straightforward to comprehend, with questions adequately explained via supporting text and illustrations. The answer options should be easily matched to both the query at hand, and recognizable aspects of the human skeleton: ('Trait X is') mild, moderate, robust; 'both elements present'; 'teeth generally in good condition'; 'most joints fairly complete'; and so on. However, problems were identified during the first week, and were noted during the scoring. Specifically, textual descriptions alone were inadequate for participants to identify and appraise morphological traits, specific regions of elements such as the pre-auricular sulcus; nor was the methodology for measuring the femoral head understood by many. Therefore the imbedded explanatory materials were expanded to include illustrations of almost every element, as well as the sexually dimorphic regions of the skull, and collected as a separate 'Information Booklet'. This booklet was available for each participant for Week Two onward. Participants were vocal in their opinions and indeed were encouraged to be (**Appendix 5: Volunteer Comments**). No intervention was offered to correct errors, for example, no advice was offered to help volunteers with difficulty in measuring the femur head diameter, but the additional clarifying text added to the subsequent Information Booklet would prove to be adequate for the two groups of adult amateur archaeologists. Most supportive text was removed from the answer sheet.

Queries most often left blank, or answered almost uniformly in error are in **Table 6.4**. These queries mostly related to sexually dimorphic cranial and postcranial traits; heavily parsed traits in the pubic bones; obscure anomalies (such as premature cranial synostosis); or lesions that are difficult to describe in lay terms, such as periosteal reactions or bone infections that had spread to the medullary canal. One could wonder why novices would be asked to assess such features. However, a skull that is misshapen as compared to what is widely recognised as a 'normal' skull shape could reasonably be identifiable: the skull is a common symbol in Western Culture, an icon appearing on children's backpacks and so on;

long bones that look ‘lumpy’, ‘moth eaten’ or of unusual shape would presumably be recognised by novices familiar with typical human appearance in which legs and arms are generally straight, and based on skeletons in museums, television shows and magazine articles. To an extent this was true. Extreme expressions of abnormality were identified, such as profuse abnormal bone on Skeleton 7; but milder conditions were not detected, and complicated concepts such as multiple fractures or regional (but not general) OA were not transmittable. Importantly, Inventory queries relating only to *inventory* and broad queries on overall specimen condition were successful.

Other problems related Paleopathology segment form design. Students expressed the opinion that two columns for answers (‘Present’ and ‘None / NA’) was somehow onerous; indeed, one creative response to multiple empty boxes was to fill in unused options. Several respondents were uncomfortable with merely marking their choice of Mild, Moderate or Severe as ‘Present’, and wrote in ‘None’ or ‘N/A’ for all other choices in that section. This solution was independently used by 10SH in 1A, two participants not working together in session 1C (24AF, 26AY), and a volunteer in 1D (28AP).

6.7.5.2 Unrealistic time estimations

It was unexpected that participants in the student sessions, even with (limited) exposure to human skeletal remains, would require the full two hours of each session to complete one single form. This same result carried on throughout the week, with only one exception from the adult amateur archaeologists (33AB).

6.7.5.3 Week Two: Altering the form

Seven queries were added to the form: 6 in Inventory and one in Paleopathology, increasing the total queries from 96 to 103. Altering an experiment already in progress can undermine comparisons; this was recognised. However, the complex arrangements required to gather nearly 40 volunteers and a suitable lab would not easily be recreated, and it was decided to forge ahead. In any case, the existing pool of data generated from just Week One, whilst based on very few skeletons, provided 34 tests of the format (compared to four or five from York). Finally, results from Weeks Two and Three show most respondents did very well on identifying the new elements (knee cap, shoulder blade, collar bone) and delineating differences between *unfused* S1 and S2 sacral elements versus *recently fused* elements retaining a fusion scar.

6.7.5.4 Problems

However, the new questions were not on every Week Two form, due to a printing issue in the first session of the week (2A). Consequently, most participants in 2A received forms with only 3 of the 6 new Inventory questions. One participant (09CS) completed two forms, one faulty and one correct: therefore, of ten forms completed, eight were defective. 04AH received the other correct form with all seven of the new queries.

Examining the three new queries completed by only 04AH and 09CS in 2A, it is interesting that these particular volunteers agree five times of the six, since 09CS was one of the more careful volunteers and 04AH one of the least involved. Over three weeks, 04AH scored 46.5, 59.5 and 46.5; and 09CS scored 68.0, 85.5, 82.5, 88.0, and 89.5 (he managed to complete five forms in total).

6.7.5.5 Successes

One cannot presume other participants in Session 2A would have enjoyed similar success but it seems possible. Overall scores for the four sessions in Week Two are moderate to good for these three questions, with 16 of 23 forms (31 forms reduced by 8 without these questions) correctly identifying the state of the hip socket rim (69.6%), 16.5 correct answers for total fusion of the sacrum (71.7%), and 19.5 correct answers (84.8%) regarding the presence or absence of a hiatus, or scar line between S1 and S2. Overall scores for all queries for Week Two, based on 31 volunteers average 22.3 with most participants answering these three queries; with the missing queries dropped in order to facilitate comparison, the average success of queries (maximum 31 opportunities) is 22.5.

It had been hoped participants might complete more than one form due to increased familiarity with the protocol. One participant did complete two forms (09CS) but was alone of the 31 participants.

Throughout the four sessions, paleopathology observations were about as successful as inventory queries when compared across the participants. When choices of specific volunteers are compared between the two segments, poor scores in one half are occasionally disguised by stronger scores in the second half; or overall weak performance across all queries belies very careful work in one segment. For example the low score from 04AH (57.5 from 100 queries) is due to abandoning the second segment, but in 'Inventory' this volunteer shared the second highest score of 46 correct out of 56 (82.1%) with 08MH; only 09CS was marginally higher with 47 of 56 queries correct (83.9% for Skeleton 02). In future analyses, one-way ANOVA can examine within-group differences for repeated measures of the same Paleopathology queries for two skeletons as observed by the same ten (or more) volunteers. Between-group variation was examined using independent samples t-tests (**Table 5.10** and below).

Differences between the two types of participants, adult amateur WARG / New Forest volunteers and University undergraduates were tested with independent samples t-tests, based on 8 WARG/NF members and 8 students assessing Skeleton 17 (**Table 5.10).** Scores for both groups were either good (skull condition and morphology, presence and condition of mandible, teeth, long bones, joints, vertebrae, pubic bones, sacrum) or equally poor (mandible robusticity, clavicle maturity, recognising sharpened margins in the pubic symphysis, AMTL, periosteal inflammation). The single significant difference between the groups was the inability of most students to accurately measure the femur head diameter ($t = 4.59$, $p = .003$. two-tailed). Widespread agreement (accuracy, or errors) between groups suggests the fault lies with the questions, not the participants.

6.7.5.6 Week Three: Problems

Results for this week are initially disappointing. About half of the volunteers who had gained what appeared to be confidence in the protocol and enjoyed increases in scores lost these gains. **Table 5.4** is a summary of each volunteer's performance. By Week Two, overall scores for eleven participants had risen, at times dramatically from the Week One results. For example, 03RC increased his score from 43.5 to 69.0, 06PH from 36.0 to 78.5, and 29MY went from 56.5 to 80.5. And yet of the eleven large score increases, and including ten other volunteers whose scores increased from 1.0 to 5.0 points, eight participants had overall decreases of up to 20.0 points, with half of these losing 18.0 to 20.0 points (03RC, 29MY, 30JY, 31CW).

6.7.5.7 Successes

Reasons for the downturn have been discussed above, and mostly relate to a combination of a poorly laid out Paleopathology Segment and the weekly specimens having moderate to highly abnormal lesions, or perceived ambiguous dimorphism. But several aspects of the week's results are very positive: for one, poor scores in the Paleopathology section mask rather good results in Inventory; and two: despite the problems, four participants improved their scores anyway (06PH, 08MH, 09CS, 17CB) and others maintained similar results to the previous week or dropped by about 5.0 points. Nine volunteers scored in agreement with the author an average of 80.0% or better in the Inventory segment, including 31CW, who had dropped 19.0 points from Week Two (90.5 correct answers out of 103 queries) to 71.0 correct answers in Week Three. Sixteen participants had scores of 45.0 or above in this segment (75.0% to 86.7%). Indeed, *only three* participants for the entire week agreed with the author less than 70% of the time: 14YS and 30JY at 65.0% (39.0 out of 60), and 24AF with 33.5 correct out of 60 Inventory queries, or 55.8%.

Problems with Week Three forms are thus found in the Paleopathology segment. Queries to assess OA were worded such that volunteers would consider any evidence of OD to fulfil the OA description. Due to abnormal bone in the joints of both Skeleton 7 and 9, and OD in several specimens, this section was often scored incorrectly. The volunteers have indeed recognised an abnormality in the correct region: the synovial joint. The scores are only 'incorrect' in that novices are supposed to somehow know that one abnormality is OA whilst another, apparently similar in description, is OD. The fault lies entirely with the form design. That almost every participant recognises *something* abnormal in the joints is adequate and indeed admirable.

6.7.6 Outliers

Across all three weeks, one or two outliers do influence score averages. Several participants struggled mightily to comprehend the protocol; at times, the fault is due to form design and the unfortunate decision to create paleopathology divisions when most novice volunteers only recognise something is wrong in X region, not whether its Disease Y or Disease Z. And yet, many volunteers improved their scores week upon week and by the third (or more) attempt to use the form enjoyed successful identification of traits and anomalies 80% to even 90% of the time.

For a few workers, though, there were few improvements. When such outliers are removed, average scores improve and scores are more consistent: standard deviations drop slightly. To an extent the ability to comprehend the form improves or fades randomly for the handful who struggle with the protocol: they have their successful scores. For the most part, however, those who miss more questions than others do not consistently improve. Some participants maintain similar scores throughout the trial. Some improve quite dramatically. Overall, the Inventory segment works well for most people and for the two or three who just do not quite understand, it is uncertain this will change. In a real-life scenario, such a well-meaning volunteer will quite simply miss some queries; but on crucial aspects such as completeness of skull, hips, or long bones, the information they do capture will be useful for a visiting scholar attempting to maximise data with limited time, energy and funds.

6.7.7 Statistical Analysis: Descriptive versus Inferential

Inferental statistical testing was hampered due to the limited number of volunteers to assess the same specimens (see **Section 5.7**). However, the question that the author set out to answer with this project has been in the main answered, namely would it be possible for novices to glean any useful information from examining a human skeleton.

Inventory assessments work for most volunteers, drawn from a disparate pool: students with deep interest in skeletal analysis and who applied great effort; students who worked less hard and indeed copied each other's answers; older adults who rose to the challenge; older adults who balked at filing in forms and routinely quit after the first half.

The paleopathology section worked less well, except for those who carefully read each question and did their best to make sense of akwardly designed queries. By requiring volunteers answer osteoarthritis OA queries in the 'OA' section and osteochondritis dissecans (OD) queries in the 'OD' section, the author was demanding they, as novices, recognise each section and therefore recognise (diagnose) the disease. This was a mistake made in York, and that the author managed to make again in an attempt the desire to subdivide the form for easier analysis. It is suggested the Paleopathology segment only be attempted by volunteers who feel comfortable with the Inventory portion; or as a tool for experienced researchers who plan to collect metric data and wish to have a checklist aide memoire. The stand-alone Inventory form captures 12 of the 17 Important Queries at about 75% success. Less effective queries relate to ageing and sexing, and will benefit from additional illustrations.

The aim was to test this method on a mixed pool of volunteers assessing a range of human skeletons. During the course of analysis it became apparent that expected statistical tests were not useable based on the data collected, a problem that can only be solved by repeating the trial. The 2012 test of this assessment system was not designed and executed with multivariate tests in mind, and the data cannot be used in most multivariate statistical tests. For example, out of 37 volunteers, only 22 completed three (or more) questionnaires and of those, very few studied the same skeletons. The aim had been to test the reliability of the form as used by novices. Out of 96 to 104 queries, broad statements can be made about one query with only a few correct answers, versus a different one that was scored correctly on 87 of the 91 forms. But groups of the same volunteers looking at the same skeleton did not organically occur nor were people assigned skeletons to examine.

In the end, the random nature of both volunteers and human skeletal remains fit real-world scenarios. Potential volunteers are unlikely to wander into museums and offer to assess only the ‘easy’ skeletons with few bone abnormalities; volunteers, museum technicians and archaeological workers will assess what they have before them. Similarly, museums with no funding but a few hundred skeletons that require a basic evaluation will hardly quiz enthusiastic volunteers regarding their ability to carefully read every word. Institutions will vet volunteers to ensure poignant, non-renewable resources are treated with care, but will be delighted with whoever shows up: they will work with who they get. When considering questions that were asked 91 times based on 8 different human skeletons and that were correctly answered 87 of 91 times by students both dedicated and disinterested, and by older volunteers both nervous or enthused, one can only conclude that something about that question worked across a wide range of human skeletons and a wide range of volunteers. Therefore, statistical calculations are based on percentages and standard deviations, with a few comparative statistical tests that can infer future successes with these questions.

Chapter 7: Conclusion

In 2004 a short research visit to a large and well-known collection led to an early attempt to standardise observations, in order to assess socioeconomic status (SES) in undocumented and understudied medieval individuals (Brash *et al.* 1935; Goodman and Morant 1940). This was refined over several years and became the basis for a first set of experimental trials using volunteers in York 2008, which identified a range of problems and opportunities. In 2012 a larger test of the protocol was undertaken, using 37 Winchester-area residents comprised of undergraduate students and older, semi-retired members of historical societies. The York trials were treated as an extended focus group (Babitt and Nystrom, 1989) from which the Winchester trials were derived. The Winchester experiment and its results were presented in Chapter 5, and discussed in Chapters 6.

Based on using median scores and standard deviations from the Winchester 2012 experiment, minimum and maximum average scores can be calculated for all three weeks. These results indicate the protocol can successfully capture basic paleodemographic information (the Inventory Segment) 60-83% of the time, based on the results from all three weeks, and from *all* participants, including those who balked at completing the full protocol or who answered the queries casually. The participants who approached the task with rigour captured 80-87% of Inventory observations in agreement with the author; and 99% of all 91 forms correctly assessed the overall condition of the remains and the state of bone preservation. The last result alone would have saved the author one full working day during the 2004 research visit: and for that trip, the author had an assistant.

7.1 Examining Human Remains

Early approaches to studying skeletal human remains were often aimed to support notions of evolution; curiosity in human variation gave way to systematic typologies of human 'types' with the explicit goal to justify African chattel slavery, eugenics, and seizing land from indigenous inhabitants in the Americas, Australia and smaller islands in Oceania (Trigger 1989). Following the horrors of Nazi

Germany's attempt to ethnically cleanse Europe of 'undesirables', which included those with physical imperfections, or who were homosexual, non-White, non-Christian and non-Westernised, explicit eugenic practices faded away and anthropology settled into a method of identifying war dead, designing comfortable and safe military equipment and uniforms, and establishing forensic applications for anthropometry (Baker and Eveleth 1982; Brace 1982; Thompson 1982).

7.1.1 Concerns over examining human remains

The study of human skeletal remains can be contentious. In addition to limitations on the study of indigenous remains, some religious and political organisations are against all study of any remains aside from forensic investigation and autopsy, which may also be under limitations (Zimmerman 1987; Alberti *et al.* 2009). With anthropology's abysmal record of grave-robbing indigenous and African-American graves in the Americas and Australia until just a few decades ago, the poor reputation of anthropologists can be perhaps understood (Cook-Lynn 1996; Blakey 1997). One solution, as defined by Walker (2000) is to recognise that both scientists, and those against research on ancient remains are working within "competing value systems", and attempts to gain the moral 'upper hand' are better replaced by communication and respect (ibid: 13).

7.1.2 Documented Collections

Large collections of documented remains such as the Hamann-Todd collection are often (but not always) comprised of late 19th to early 20th century abandoned bodies uncollected by family members, or from indigent individuals who had lived very harsh lives (Meindl *et al*. 1990; Mays 2010). However, documented remains in Coimbra and Lisbon Portugal are drawn from abandoned *graves*, with the individuals representing a wide range of socioeconomic status (SES) levels (Cardoso 2006). The crypt from Christ Church Spitalfields, London yielded 968 18th and 19th century burials, of which 387 retained coffin plates providing name, age and date of death; the individuals had been considered ‘middle class’ and thus not impoverished (Cox and Scott 1992).

7.1.3 Archaeological Collections: Benefits of Analyses

There are important reasons for examining archaeologically obtained remains as well as documented individuals of recorded sex, age at death and recent medical history. Despite potential uncertainty as to an individual’s biological sex, and difficulty estimating age at death once growth has ended, the study of archaeological remains can inform on the history of disease in a region, for example exploring the debate about the origin of syphilis (Powell and Cook 2005). Lesions in 1500 year old Native American remains that suggest multiple myeloma are conjectured to be due to radon exposure; when the skeletal evidence is compared with the dangers of modern exposure to radon in the same region, the ancient remains became part of what is essentially an extremely long-term epidemiological study (Whitely and Boyer 2012). Tracking early appearance of disease can inform on migration and changing health issues; or can suggest that postmenopausal females have faced age-related osteoporosis since medieval times (Mays 1996).

Examining skeletal collections is more efficient when searchable databases permit a potential visitor to screen holdings for their research value prior to arrival. Online catalogues are rare, but even on-site databases are not common (Giesen *et al.* 2013). Over half of English institutions that responded to a survey of their holdings were aware of their exact number, or were correct regarding the number and condition of curated remains (White 2011). Having basic assessments of the condition and level of completeness of their holdings would benefit research.

7.1.4 Growth in One-Off Osteology Courses

The Stockwood Discovery Centre in Luton has been promoting periodic 2-day ‘short courses’ in human osteology, for which interested members of the public pay just under £100 per day, with lunch and ‘materials’ included. The purpose of the course is two-fold: to satisfy genuine public interest in human skeletal remains; and for the Stockwood Discovery Centre to earn money whilst also amassing data on the collection (David Klingle, personal communication 2012). The participants pay to collect data for the underfunded Centre; but the data they collect is mostly metric, with limited paleopathological observations. The latter are based on how the organisers interpret conditions such as ‘anaemia’ and tuberculosis to be recognised in the skeleton.

In a similar manner, Sheffield, Exeter and Bournemouth Universities have occasionally offered human osteology ‘taster courses’. It is unknown if a side attraction is the collection of data on an under-studied assemblage, but the schools introduce their programmes and instructors to potential students, satisfy the interest of people with no desire to enter formal education, and inject much-needed cash into their programmes. Postgraduates working as instructors in such courses gain valuable teaching experience.

There can be dangers in assigning a disease to a bone anomaly and instructing novices to record the presumed disease rather than to record an unbiased description as may be occurring in Stockwood. Recorded descriptions of lesion appearance can be interrogated at a later date whereas a blunt diagnosis of a specific disease cannot. Whilst less successful than the Inventory segment, the Winchester 2012 Paleopathology Segment queries bone *appearance.* The descriptions are collected in an unbiased fashion and are intended to document bone anomalies, not to diagnose disease. The principal failing in the Winchester 2012 test of the protocol was the misguided attempt to guide observations into certain categories for ease of scoring, and because the author felt that the supportive descriptive text enabled the participants to differentiate between joint damage due to osteoarthritis and small defects related to impact trauma in youth. Slight alterations to the protocol are detailed in **7.3.5.**

7.2 *What was discovered during first test: York*

Several important lessons were learnt during the York 2008 trials. It was clearly too difficult to ask volunteers to determine age at death cohort in order to diagnose which degree of disease expression to select. This level of interdependent analysis is accomplished readily and subconsciously by any experienced osteologist. The mistake was in presuming a similar level of comprehension could be obtained by including some supportive text.

However, also realised was that, despite the difficulty in determining the ‘correct’ degree of trait expression (mild, moderate, extreme; gracile, moderate, robust), novices tasked with creating a basic assessment still need to select a gradation. Sexually dimorphic traits and indeed most disease states run along a continuum, and although requesting the participants to choose a gradation was difficult for some, most aspects of human variation are not binary. The decision to accept answers as partially correct when off by one degree from the author’s (perhaps subjective) assessment was a defensible one. Cranial robusticity varies between populations (Đjurić *et al.* 2005). Indeed the author has traveled from the UK to the USA to view indigenous remains and has been required to reset her own expectations as to what constitutes ‘gracile’: native American females are as robust in cranial aspects as many European white males.

Including the actual scores on the recording form proved intimidating to volunteers: the numbers were just one more piece of overwhelming information and, if a researcher were to refer to the answers, the scores could easily be added later. In addition, the scores themselves were not irrevocably associated with a disease or condition. Different populations would have had different scores for the same pathological condition and would need adjustment for the circumstances; for example a society based on war and conquest would not view multiple healed fractures as a negative and indeed battle scars may be associated with a successful ruler (Price *et al.* 2010). As a consequence it was determined that the ‘scoring’ aspect to the form was untenable. In the end it was simpler to remove the scores and complex ‘nested’ queries, and to remove the requirement for participants to assign an age at death cohort. The protocol became a system for data capture based on participants selecting the 'best fit' answer to describe a skeletal trait.

7.2.1 How the protocol changed

Problems with form design and volunteer comprehension highlighted during the York experiment led to appropriate modifications being incorporated into the Winchester 2012 trials. Complex queries were broken down into separate questions or were not asked at all (such as age at death). The Inventory was enlarged and indeed became a central aspect of the form. Jargon and technical language was toned down.

Several problems remained. Despite dark, bold outlined boxes to separate queries and to highlight that one of a set of conditions was possible (mild, or moderate, or extreme) volunteers at times checked more than one. This could be silent protest against being forced to select from only three options (such as the objection by 16HK in York 2008 when not offered the combination that was observed) but in several cases there seemed to be a genuine misunderstanding of how the format was designed. An electronic version of the form would be ideal to solve this dilemma by offering one Select Button option only; selecting a second answer would move the checkmark, not add a second one. Deciphering results would be far easier.

7.2.2 Early Positive Reception for York Results

Despite the identified issues, several notable anthropologists expressed support for the RAS following York. In July 2009, Robert Jurmain, noted for his seminal work on osteoarthritis and other joint disease (Jurmain 1999) offered to publish the project once finished, as he was pleased the RAS requires users to "observe rather than diagnose" (Robert Jurmain, personal communication, 4 July 2009). Regarding the RAS project, he later wrote, “I can tell quickly it has obvious merit”, (Jurmain

13 July 2009, personal correspondence). Don Brothwell, Professor Emeritus at York University, had expressed this opinion of the RAS during a meeting in March 2009: "There are really several phases to an excavation. First, removing the skeleton. Then, cataloguing the remains: washing, india-inking the bones, and so on. After that, there is analysis… your project is a sort of third step, an offshoot of cataloguing." (Don Brothwell, personal communication, March 2009).

7.3 Winchester

7.3.1 Inventory: Condition of Remains

Assessing the condition of the remains was extremely successful. At the top of every form were five multiple choice questions relating to overall condition of the remains: are the remains in a box (yes); are elements stored in separate bags; and three queries on overall impression of the remains ('good condition?' 'Fairly complete?'). These questions were answered at least in part on all but one form: 90 of 91 forms (98.9% recorded these observations either in full (90.0%, 81/90) or partly (10.0%, 9/90). All answers on all forms have been recorded in Excel and are on the CD in folders labelled Week 1 Participants, Week 2 Participants and Week 3 participants.

It would be very interesting to test these observations on other volunteers and on a collection that is not so well curated: for example, remains that are bagged less precisely. The Winchester 2012 trials used the Mary Magdalen Hospital remains, which are comprehensively stored, with bags clearly marked as Right Hand, Left Leg, Vertebrae and so on. The excavations successfully collected even very small elements, such as sesamoid bones, and the specimens are impressively complete; the remains survived very well for over 1000 years.

7.3.2 Paleopathology

A few Winchester volunteers comprehended the Paleopathology segment very well (even in Week Three), notably 09CS: but this participant completed five forms. Experience and careful reading do make the difference in the level of success achieved by a novice. The Paleopathology segment was too difficult for at least 50% of the volunteers (**Section 5.5.3**).

Three types of volunteers failed to complete the protocol: those who lost too much time (and energy) identifying and counting the podials and vertebrae; participants who became too involved with critiquing the format and recording lengthy suggestions; and those for whom the procedure was simply too complicated. The last category of volunteer became frustrated by the more complex queries. As a result they were unsure of what answer to provide. Despite time spent on assessing smaller bones, the identification and counts of hand and foot bones proved fascinating for many volunteers.

7.3.3 Twenty Important Queries

Identifying the 20 Important Queries permitted results between volunteers, and skeletons to be more easily compared. The goal in selecting queries to represent 'the most important' was to encompass information that the author would be delighted to have to hand prior to deciding which boxes to pull during a research visit. Whilst it was recognised that eliciting accurate or even somewhat accurate descriptions of the pubic symphysis was a long shot, the results were disappointing. Similarly poor (60-65%) were assessments of sexually dimorphic features such as cranial robusticity. The supra-orbital region (torus) is considered highly indicative (Meindl *et al*. 1985b; Walker 1995 with caveats; Ramsthaler *et al.* 2010) yet did not do well in Winchester, even when illustrations were provided. In 2012, the torus was mostly reliably identified in absentia: that is, when the brow ridge was gracile.

7.3.4 New Format: Only Inventory; Target End-users

Analyses of the results indicate the protocol should be rendered into two separate forms; an inventory segment and a paleopathology segment. The Inventory aspect of the trials was the most successful portion of the protocol, with very few participants (03RC, 24AF, 33AB) scoring poorly, and even for these participants most poor scores occurred in the first week, when the form was completely novel.

After becoming familiar with the format, most participants completed the Inventory segment with a high degree of success. By the third week all 26 participants had taken part in both previous sessions; for 23 of the volunteers, the average score was 46.8 out of the 60 queries (78.0%), with a median score of 46.5 and a standard deviation of 3.14.
The participants were undergraduate students as well as middle-aged to older individuals, from non-professional to academic or medical backgrounds, with an interest in archaeology. The wide range of ages and life experiences supports the protocol as useable by potential end users as identified in **Section 3.1.4**, specifically students, trusted museum volunteers, archaeological technicians and museum curatorial staff: non-osteologists.

By separating the Paleopathology segment from the Inventory, the confidence of the average volunteer could be maintained due to overall comprehension of the queries as well as a shorter amount of time spent on the protocol: lengthy questionnaires provoke volunteer fatigue and result in queries ignored or answered hastily (Babbitt and Nystrom 1989).

The Paleopathology segments could be completed at another time by confident participants (perhaps self-selected after one try at the form: either a volunteer understands the format or they do not). Those who might feel intimidated by the complexity of the second segment can decline to use it. Even volunteers who feel comfortable with the second half of the protocol should return to the section on another day. A steady routine of assessing remains using Inventory segments can be achieved with ideally one set of remains an hour (to start) being assessed. Returning to an individual on a different day permits one to look at the skeleton with ‘fresh eyes’.

But is a successful Inventory form alone worth all this fuss? Should institutions simply advertise for short course participants, and charge them £50-£100 a day to collect this information under supervision, with a professional at hand to answer any questions regarding terminology? This notion is rejected. The hypothesis that novice volunteers armed only with paper-based questions, most with supportive text and illustrations can never collect data as well as trained osteologists is rejected. The volunteer pool in Winchester was comprised of undergraduates some of whom had previously handled skeletal elements following excavation; and older adults with some interest in local history and archaeology. The ability to focus on complex, novel tasks whilst examining archaeological materials that are notoriously contentious, and undeniably, poignantly ‘human’, was neither universally embraced, nor universally overwhelming. Some volunteers never returned; some refused to ever work the second half of the form; a very few never quite got the hang of it. But considering the range of skills, ages and interest levels, the average result of 77.5% agreement with the author for the final week (including all ability levels) in a format that can still benefit from some adjustments is encouraging.

The temptation for cash-strapped museums and universities to embrace short courses to amass data whilst offering instruction will prove to be more hands-on than utilising well-meaning volunteers. One presumes a museum cannot merely open its stores to anyone who answers an advert; seeking volunteers from members of Archaeological and Historical Societies is sensible and, based on results here, will be well-received. Ten such volunteers can be supervised by one professional, as opposed to a group of novices expecting training (as paying customers). Ideally the protocol can be used by museum curatorial staff and museum members independent of supervision; or by archaeological lab technicians as part of their job.

The perfect form must be short and clear; the paleopathology assessment can be more complex but is not recommended for the same audience. Roger Colten of the Yale Peabody Museum concurs: “The paleopathology form probably requires someone with more experience to complete” (personal correspondence, 4 May 2014).

7.3.5 Alterations to the Winchester 2012 Protocol

Following the Winchester 2012 test, protocol queries that proved very difficult for novices to assess, and that also have limited research impact were removed. In the Inventory segment, this included three questions in the first section: assessments of cranial modification and evidence of premature suture fusion, which both result in an atypical skull shape; and misalignment of mastoid processes which can indicate scoliosis, torticollis and premature fusion. Time-consuming tasks were minimized. Identification of the different types of vertebrae and taking detailed counts of hand and foot bones was made explicitly optional.

Confusing, terminology-laden assessment of the pubic symphysis was simplified to a choice of billowy, flattened or ragged, with rims either sharp/distinct or also irregular. Whereas detailed description can serve as method for estimating age, variability between age ranges is so vast that even a perfect assessment cannot necessarily differentiate much beyond ‘youthful’, ‘adult’ and ‘older adult’.

In the Paleopathology segment, checkbox columns were made consistent: Options for all traits, anomalies and disorders were ‘Present’, ‘Not Present’ and ‘N/A’. Despite some Week One volunteers finding too many columns confusing, other volunteers preferred to select a trait as observed and then to *also* select ‘N/A’ for all other options in the same section (or to pencil in ‘None’ if this option was not offered). The option of ‘Unremarkable’ was available for some elements and, if selected, both ‘Present’ and ‘N/A’ were crossed off or otherwise unavailable. Finally, joint disorders were no longer separated by what the *author* would identify as different categories, such as osteoarthritis, joint infection, or cartilage trauma: flagging a joint that is abnormal for any reason will be adequate.

The basic format has now reached its final format. Novice volunteers achieved almost 100% agreement with the author on key observations, such as overall condition of the remains, and on specific elements such as the skull. This information could indeed be viewed as a ‘third step’ in dealing with a human skeleton, enabling future research to proceed more efficiently.

7.3.6 Survey to Investigate if Protocol would be taken up

As a follow-up to the design and testing of the protocol, it was decided to investigate the level of interest that might exist among potential end-users. A short series of questions were devised, a simple online survey created on Survey Monkey, and a letter of introduction was written. The letter and links to the survey (as revised in **7.3.6.1)** were posted on the Facebook page for British Archaeological Jobs and Resources (BAJR) on 26 March 2014, and sent to the Society of Museum Archaeologists (SMA); the letter primarily addressed museum curators due to the recognized need for English museums to have an improved idea of their holdings (White 2011; Giesen *et al.* 2013), but the BAJR posting made clear that input would be appreciated from anyone who manages, excavates or in any way deals with human skeletal remains. Results are summarised in Table 7.1.

7.3.6.1 Letter Describing Project

> Dear Museum Curator,
>
> I am completing a PhD and it has been suggested I enquire about the utility of my project. Put simply, I have devised a user-friendly, deskilled assessment protocol for non-experts to use in creating a basic assessment of any skeletal remains that are being curated and that have not, for whatever reason, been previously assessed. Many museums with skeletal holdings are unaware of exactly how many they have, and/or unaware of their condition, e.g. fragmented, fairly complete, commingled, weathered, etc. (Giesen *et al.* 2013).

This system, called the Rapid Assessment System (RAS) collects data on the condition (completeness) of the remains and a few demographic factors (age at death, sex) in the Inventory Segment; and data on possible disease/trauma/disorders in the Paleopathology Segment. I have tested this protocol with 17 non-experts (York: 2008) and with 37 non-experts (Winchester: 2012). Over the years, using non-expert volunteers, I have had 99% success, certainly as far as identifying condition of remains (99%), whether the skull is shattered or complete (87%), and so on. I first presented on this protocol in March 2009 to a small regional conference of PhD students, and in April 2009, in Chicago IL, to the annual meeting of the Paleopathology Association.

The Museum Survey questions can be found on Survey Monkey, here:
https://www.surveymonkey.com/s/96RLWJ5. Within the Survey are link to the two segments of the protocol (Draft Form). The volunteers have also had access to a separate Information Booklet, which illustrates each skeletal element or trait to be observed, but this is not included here.

Also needed are any comments, positive or negative, which can be provided via Survey Monkey.

Thank you for your help!

Rose Drew
Dept of Archaeology
University of Winchester, UK

rose.drew@unimail.winchester.ac.uk

Giesen M., McCarrison K. and Park V. 2013. Dead and Forgotten? Some Observations on Human Remains Documentation in the UK. In: Giesen M (ed.), *Curating Human Remains: Caring for the Dead in the United Kingdom*. Woodbridge UK: The Boydell Press, 53-64.

7.3.6.2 Survey Questions

1. Does you institution curate Human Remains?
yes
no
I don’t know.

2. If so, are you aware of how many sets of remains your
institution curates, and the condition of the remains, for example
if they are commingled, fragmented, fairly complete?
yes
no

3. If not fully aware of number and/or condition of Human
Remains is this because (choose one)
a. Too few staff to document
b. Staff lack expertise
c. Institute lacks funds to outsource
d. Any combination of above

4. I have designed an observational based, user-friendly questionnaire. The system is designed to collect a basic inventory of each set of remains and is comprised of an Inventory segment and separate Paleopathology segment; the links below lead to each segment in draft form. The end-users will also have access to an Information Booklet that illustrates each skeletal element or aspect to be queried, but this is not supplied in this survey.

Link to Inventory Only here
http://www.rdgassociates.co.uk/html/inventory.html
Link to Paleopathology Only here
http://www.rdgassociates.co.uk/html/paleopathology.html

5. Would you be interested in using
a. Inventory only
b. Paleopathology Only
c . Both segments

6. If this is not considered useful, why not?

7. Any other comments?

Thank you for your time.

Rose Drew
rose.drew@unimail.winchester.ac.uk

7.3.6.3 Results

There were 12 responses to the Museum Survey 2014 (**Table. 7.1**), with all respondents stating their insititution curates human remains. Seven survey respondents agreed their institutions may not be fully aware of their holdings; reasons given for included ‘Staff lack expertise’ (one respondent); ‘Institution lacks funds to outsource' (one respondent); or 'Any combination of above' (five respondents). Eight respondents said they would consider using the RAS; four said they would not. Of these four, three provide reasons: 1. "I can use our estblaished in-house system"; 2. "sorry, I think they are a really good idea, but every skeleton we curate has already been fully analysed and cataloged (by me...we only have 56 plus some disartic)"; 3. "We already do have fully adequate forms for both in our inventory database." All typos and grammatical errors are reproduced exactly as they appear in the Survey Monkey comments.

Interestingly, although eight respondents (of 12: 67%) claim to be aware of their holdings, seven respondents (58%) admitted that they are not 'fully aware' of their holdings due to a lack of staff expertise or sufficient funds. Upon interrogating the survey results, three respondents to claim familiarity of their holdings (Question 2) *also* supply reasons that their institution is not 'fully aware'. This suggests that, while they have a broad awareness of their holdings, they are reluctant to claim to know the condition of each set with complete confidence.

Positive comments included 1. "Seems straightforward. Be interested to know if it's reliable"; 2. "At last a protocol that can be undertaken by motivated volunteers. Sorting shards or fish bones can be mind numbingly disincentivising Work on the human remains is always attractive until volunteers face the uncertainty and complexity of filling out the forms and the drop off rate is high: the clear definitions of what is needed would allow us to motivate and encourage our volunteers"; 3. "The inventory form looks useful for the basic inventory of human remains and might be used by people with basic knowledge of skeletal anatomy. I suspect that the paleopathology form would be too complex for people with basic knowledge of the skeleton. That type of assessment might require a different, perhaps more detailed form"; 4. "Good idea to provide concise, user (and time) friendly forms for a basic curatorial recording. However, I think that these forms should be used by staff or students with an at least a certain level of knowledge of human osteology to minimise observer error. In addition, we should create more jobs for qualified osteologists and palaeopathologists, not encourage non-specialists to think they can replace us! We devoted many years of our life and precious funds to specialise, and I find it disturbing when people at BAJR for example hail the 'generalist' and happily perpetuate the stereotype that to get a job you need to know sby (British) to get you into an excavation as a digger (forget your specialisation) and IF they like you, then MAYBE they will consider you for a small osteology project, because 'they stick to their own' ”.

The author would enjoy assuring the fourth respondent with a ‘positive’ comment, above, that a lack of paleodemographic information for holdings is actually detrimental to research; and that 23 of the 26 Winchester volunteers to complete at least three forms selected answers 80% to 87% in agreement with the author in the Inventory segment, but were far less successful with the Paleopathology segment: thus guaranteeing that experienced osteologists will continue to be required. If institutions have a minimum of information in place, such as the condition and completeness of remains as suggested by English Heritage (English Heritage and Church of England 2005: 43), research visits can actually be more productive.

One respondent who states they would use ‘both segments’, and that their holdings might be unexamined due to ‘Any combination of above’ left this comment: “I am skeptical regarding the long-term value of databases given the rate at which the questions in our field change and the difficulties of preserving digital data.” Perhaps this project would overcome such issues, since observations of presence, absence and abnormal bone are not biased by diagnoses that indeed do ‘change’ with continued research.

“Done! I really think your project is absolutely essential, Rose. Filling out such a simple form for human remains really would elevate them above other finds just enough to bridge the gap between 'artefact' and 'person'... I'm expecting that whenever I manage to start a career, your form will be industry standard,” (Bethany Dean, 3rd Year student, B SC Archaeological Practice at Winchester University, 27 March 2014 posted on BAJR Facebook page).

Table 7.1. Responses to Museum Survey 2014. Numerical responses only. Question 3 was not answered by all respondents; Question 4 provided links to websites with the Inventory and Paleopathology segments; and Questions 6 and 7 requested comments from respondents. **Section 7.3.6.2**. provides the full list of questions found in the online survey.

1. Does your institution curate Human Remains?

Yes	12
No	0
I don't know	0

2. If so, are you aware of number and condition of remains?

Yes	8
No	4

3. If not fully aware, is this due to

Too few staff	0
Staff lack expertise	1
Institution lacks funds	1
Any combination of above	5

5. Would you be interested in

Inventory only	2
Paleopathology only	0
Both segments	6
Neither	4

Whilst few people responded to the Museum Survey, the response was mostly positive and indeed, one positive remark which concluded with concerns about novice assessors taking work away from osteologists in actuality supports the project. Remains that are unassessed or that languish in relative obscurity impede research (Giesen *et al.* 2013). The three respondents who elaborated on why they would not use the protocol did not find fault with the project, but stated they already had a different protocol in place.

7.4 Concluding Remarks

> *"Perhaps with a novice the first few results could be discarded, but form a valuable part of the learning process."*
> Winchester Volunteer 06PH, 13 March 2012.

The project demonstrates the potential of an observation based recording system. Human osteology hovers between being a science and a humanity, but its success must be based on scientific principles, the foundation of which is observation. Forensic anthropologists make observations that are used to support testimony given in court and which must satisfy legal requirements for scientific rigour in accordance with the Daubert Rule (or Daubert Challenge) (Daubert v Merrell Dow Pharmaceuticals, 1993; Morris 2012); the process of building a differential diagnosis is based on comparing different possible diagnoses of a pathological lesion supported by observation. An anthropologist developing a new hypothesis will search the literature for supporting data expressed both statistically, and descriptively in order to build a library of supporting examples. Expressions of 'cribra orbitalia' routinely identified in European collections and diagnosed as anaemia would be considered just mild pitting in Native American populations (compare **Figure 2.1**and **Figure 2.2**).

The wide variability of the human form has led researchers to create equally variable protocols by which to record this complexity. Despite the recommended suite of observations for fairly complete specimens which comprise up to 20 different Attachments in order to capture the most important information, the editors of *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994) nonetheless warn, "We recognise that the standards presented here are only a limited set of those necessary to meet the needs of contemporary and future researchers." (ibid: 4). To be fair, the authors laboured under the pending repatriation of thousands and thousands of skeletal remains and were attempting to fulfil current wish lists as well as to guess, over 25 years ago, what future workers might need to know. Despite their best intentions, the book, created by committee, requests so much information that arguably one of the most important elements, dispassionate descriptive observation of anomalies and disorders, is rarely captured. Searches of PubMed and Google Scholar have yet to return references to literature that explicitly cite these observations.

Osteology has not, like other disciplines, created a hierarchical architecture or theory, to capture the common essence of human expression upon which further analysis and observation can build. While it might to too early to suggest that this protocol (both halves) is sufficient to provide this base module, it does meet with a number of essential needs.

7.4.1 Reduced Handling

The Inventory segment creates a database of essential basic observations, which can be established using a methodology in which individuals are laid out on the laboratory bench for one hour or so, and whereby the description of each element requires limited handling. Once created, such a database reduces the need for boxes to be pulled by researchers just to establish what is inside. One valuable aspect of this process is how successful volunteers were in judging the overall condition of the contents of a box.

7.4.2 Increased documentation of existing holdings

If both halves of the protocol are used, the resultant database is fairly comprehensive and relatively quick to perform. In a given period of time, with less qualified analysts, more individuals can be documented and published. Lack of time, funding and knowledgeable staff are identified reasons that archaeologically obtained human remains are not comprehensively catalogued by the majority of English museums, as discovered in several detailed surveys (White 2011; Giesen *et al.* 2013) as well as in the informal survey from March 2014 (**Section 7.3.6**).

7.4.3 Consistent base for further research

The protocol provides a straightforward baseline for recording individuals, ensures that the observations are consistent and unambiguously described, and does not require the observer to make decisions (or guesses) as to where a measurement should be taken (Jantz *et al.* 1995; Smith and Boaks 2013) or to rely on traits such as the tibial nutrient foramen which presents randomly within a given region (Andermann 1976).

If the entire protocol is applied, a useful set of observations becomes available for researchers. Admittedly several issues with placement of observations have been addressed, with observations related to osteoarthritis and osteochondritis dissecans potentially combined into a general ‘joint disorder’ segment; however for volunteers who applied themselves with zeal to this task, the 2012 incarnation was not impossible to understand.

7.4.4 A basis for teaching

Students need to learn how to observe, and the protocol provides a consistent universal system with which to train students in observing human bone. Despite the simplified language, proper terminology is also supplied. This protocol has been successful in teaching many of the participating volunteers, students and adult amateur archaeologists alike, stimulating their interest. A number of York student volunteers who worked with the earlier iterations of the protocol have gone on to obtain Masters Degrees and PhDs in human skeletal analysis and are becoming established in the profession.

7.4.5 Further work

Further work is needed to move the present version of the protocol forward. Most importantly, a field evaluation of novices using a skeletal diagram to lay out a specimen is needed. The author attempted to trial this crucial element both in York and in Winchester, but simply ran out of time. Setting up experiments that require human subjects as volunteers becomes logistally difficult when coordinating schedules and testing locations; the additional complexity of sourcing human skeletal remains and obtaining the appropriate location for assessing these remains placed further limitations on time. In the end, the most optimal way to test this aspect is to find small museums willing to trial the protocol with (vetted) volunteers.

Volunteers dealing with commingled remains would face additional challenges. In these situations, archaeologists will do the best they can. In shifting the approximately 10,000 commingled medieval individuals that will be disturbed by the London Crossrail project in late 2014 (Doyle 2014), teams of archaeologists will attempt to estimate the number of individuals, but without additional context (e.g. the *Mary Rose* remains, whilst commingled, are from a specific source population, with a known date of death, and a documented cause and manner of death), information from the Crossrail remains will be extremely limited.

The current forms and supporting material described in this project presently have the potential to serve as a research tool; one Winchester student volunteer has expressed interest in applying this protocol to a small assemblage of remains that have not previously been examined. Further work includes other researchers using this system and providing feedback on their experiences. During the York experiment, 16HK expressed the opinion that the protocol “could be really useful” (16HK, personal communication 3 Dec 2007). Suggestions from other professionals can lead to improvements. However, the danger of the 'academic' model undergoing further development is that what begins as a simple rapid protocol balloons into yet another onerous tool. An electronic format is in process of development and other improvements are sure to find their way into the system, but the simple, direct nature must remain in place.

This protocol, however, achieves what it set out to do: to provide museums and other institutions a method by which to affordably document their collections and thus increase the number of collections available for further research; and to offer archaeological firms a simple method for technicians to capture information. The format has been tested, discussed and examined by almost 60 volunteers with even early results on an imperfect form capturing 60-70% of observations. Remains can sit in boxes for decades, awaiting a researcher (Drew 2006a) and, until observations reach the grey literature (at minimum) the information offered by the unique individual stays untapped. This method serves as an alternative.

Bibliography

Abitbol M.M. 1987. Evolution of the Sacrum in Hominoids. *American Journal of Physical Anthropology*. 74: 65-81.

Adams B.J. and Byrd J.E. 2002. Inter-observer variation of selected postcranial skeletal measurements. *Journal of Forensic Science* 47: 1193-1202.

Agarwal S.C. and Grynpas M.D. 1996. Bone Quantity and Quality in Past Populations. *The Anatomical Record* 246: 423-432.

Albanese J. 2003. A metric method of sex determination using the hip bone and the femur. *Journal of Forensic Science* 48: 263-273.

Alberti S., Bienkowsi P., Chapman M. J. and Drew R. 2009. Should we display the dead? *Museum and society* 7: 133-149.

Alves Cardoso F. and Henderson C.Y. 2010. Enthesopathy Formation in the Humerus: Data from Known Age-at-Death and Known Occupation Skeletal Collections. *American Journal of Physical Anthropology* 141: 550-560.

Alves Cardoso F. and Henderson C.Y. 2012. The Categorisation of Occupation in Identified Skeletal Collections: A Source of Bias? *International Journal of Osteoarchaeology* 23: 186-196

Andermann S. 1976. The Cnemic Index: A Critique. *American Journal of Physical Anthropology* 44: 369-370.

Anderson D.D, Finnegan M., Hottop J. and Fisher A. 1978 The Lewis Central School Site (13PW5): A Resolution of Ideological Conflicts at an Archaic Ossuary in Western Iowa. *Plains Anthropologist* 23: 193-219.

Angel J.L. 1976. Colonial to modern skeletal change in the USA. *American Journal of Physical Anthropology* 45: 723-735.

Anonymous 1954. Memorium: Earnest Albert Hooton. *American Journal of Physical Anthropology* 12: 445-454

Apley, A. G. 1970. Fractures of the spine. *Annals of the Royal College of Surgeons of England* 46: 210-223.

Armelagos G.J., Carlson D.S. and Van Gerven D.P. 1982. The Theoretical Foundations and Development of Skeletal Biology. In: Spencer F (ed) *A History of American Physical Anthropology 1930-1980*. 305-328.

Arts Council England. 2011. Accreditation Scheme for Museums and Galleries in the United Kingdom: Accreditation Standard. http://www.artscouncil.org.uk/media/uploads/pdf/Accreditation_standard_print_friendly.pdf (accessed 13 February 2014).

Auerbach B.M. and Ruff C.B. 2006. Limb bone bilateral asymmetry: variability and commonality among modern humans. *Journal of Human Evolution* 50: 203-218.

Aufderheide A.C. and Rodriguez-Martin C. 1998. *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge UK: Cambridge University Press

Aykroyd R.G., Lucy D., Pollard A.M. and Roberts CA. 1999. Nasty, brutish, but not necessarily short: A reconsideration of the statistical methods used to calculate age at death from adult human skeletal and dental age indicators. *American Antiquity* 64: 55-70.

Babbitt B.A. and Nystrom C.O. 1989. *Questionnaire Construction Manual. Research Product 89-20*. Virginia, USA: US Army Research Institute for the Behavioral and Social Sciences.

Baker T.S. and Eveleth P.B. 1982. The Effects of Funding Patterns on the Development of Physical Anthropology In: Spencer F (ed). *A History of American Physical Anthropology 1930-1980* New York: Academic Press. 31-48.

Barnes E. 1994. *Developmental Defects of the Axial Skeleton in Palepathology*. Colorado USA: University Press of Colorado.

Bass W. 2005. *Human Osteology: A Laboratory and Field Manual. 5th Ed*. Columbia MO: Missouri Archaeological Society.

Bates B. 1989. "Archaeological Ethics and the Treatment of the Dead." Paper presented at World Archaeological Congress, University of Southampton UK.

Bauman L.J. and Adair E.G. 1992. The Use of Ethnographic Interviewing to Inform Questionnaire Construction *Health Education and Behavior* 19: 9-23. DOI: 10.1177/109019819201900102

Bendyshe T. (translator, editor). 1865. *The Anthropological Treatises of Johann Friedrich Blumenbach.* London: The Anthropological Society

Bergland RM. 1965. New information concerning the Irish Giant. *Journal of Neurosurgery* 23: 265-269

Bilezikian J.P. 2006. Editorial: What's Good for the Goose's Skeleton is Good for the Gander's Skeleton. *The Journal of Clinical Endocrinology and Metabolism* 91**:** 1223-1225.

Bingham A.M. 2000. *Explorer of Machu Picchu: Portrait of Hiram Bingham*. Greenwich CT: Triune Books.

Blakey M.L. 1997. Past Is Present: Comments on "In the Realm of Politics: Prospects for Public Participation in African-American Plantation Archaeology" *Historical Archaeology* 31: 140-145.

Blumenbach J.F. 1775, transl by Bendyshe, T In: Bendyshe T (ed, transl) *The Anthropological Treatises of Johann Friedrich Blumenbach* (1865). London: The Anthropological Society. 64-143

Blumenschine R. J. and Selvaggio M M. 1988. Percussion marks on bone surfaces as a new diagnostic of hominid behavior. *Nature* 333: 763-765.

Boas F. 1896. The Limitations of the Comparative Method of Anthropology. *Science* 4: No. 103

Boas F. 1905. The horizontal plane of the skull and the general problem of the comparison of variable forms. *Science* 21: 862-863.

Boas F. 1909. Race Problems in America. *Science* 29: No. 752 839-849

Boix C. and Rosenbluth F.M. 2007. Bone of Contention: The Political Economy of Height Inequality. Available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1352626 or http://dx.doi.org/10.2139/ssrn.1352626. Date accessed: 25/10/2011.

Boldsen J.L., Milner G.R., Konigsberg L.W. and Wood J.W. 2002. Transition analysis: a new method for estimating age from skeletons. In: Hoppa RD, Vaupel JW (eds), *Paleodemography: Age distributions from skeletal samples. Camb*ridge: Cambridge University Press. 73-106.

Booth N. 2009. Modern Paganism and UK Museums. *Museum Archaeologists News No 46* Society of Museum Archaeologists, pp 2-3.

Bouvier M. 1985. Application of In Vivo Bone Strain Measurement Techniques to Problems of Skeletal Adaptations. *Yearbook of Physical Anthropology* 28: 237-248.

Bowron E.L. 2003. A New Approach to the Storage of Human Skeletal Remains. *The Conservator*, Issue 27. United Kingdom Institute for Conservation of Historic and Artistic Works.

Boylston A. 2004. Recording of weapon trauma. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 40-42.

Brace C.L, Russell N.A., Noriko S., Hiroaki O., Leslie S., Qifeng P, Yongyi L. and Dashtseveg T. 2001. Old World sources of the first New World human inhabitants: A comparative craniofacial view *Proceedings of the National Academy of the Sciences* 98: 10017–10022

Brace C.L. 1982. The Roots of the Race Concept in American Physical Anthropology. in: Spencer F (ed). *A History of American Physical Anthropology 1930-1980,* New York: Academic Press. 11-29

Brash J.C., Layard D. andYoung M. 1935. The Anglo-Saxon Skulls from Bidford-On-Avon, Warwickshire, and Burwell, Cambridgeshire, with a comparison of their principal characteristics and those of the Anglo-Saxon skulls in London Museums, Part II. *Biometrika* 27: 388-408.

Brickley M. 2004. Compiling a skeletal inventory: articulated human bone. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 6-7.

Brickley M. 2004. Guidance on recording age at death in juvenile skeletons. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 21-22.

Brickley M. 2004. Determination of sex from archaeological skeletal material and assessment of parturition. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 23-25.

Brickley M. and McKinley J.I., editors. 2004. *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7.

Brickley M, and Ives R. 2008. *The Bioarchaeology of Metabolic Bone Disease.* New York: Academic Press.

Bridges P.S. 1995. Skeletal Biology and Behavior in Ancient Humans. *Evolutionary Anthropology* 4: 112-120.

Brooks S.T. 1955. Skeletal age at death: the reliability of cranial and pubic age indicators. *American Journal of Physical Anthropology* 13: 567-589.

Brooks S.T. and Suchey J.M. 1990. Skeletal age determination based on the os pubis: a comparison of the Ascadi-Nemeskeri and Suchey-Brooks methods. *Human Biology* 5: 227-238.

Brothwell D.R. 1981. *Digging Up Bones 3rd Ed*. London: British Museum

Brothwell D.R. 2004. Bring Out Your Dead: People, Pots and Politics. *Antiquity.* 78: 414-418.

Brothwell D. R. and Zakrzewski S. 2004. Metric and non-metric studies of archaeological bone. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 27-33.

Brown M. 2007. All Quiet on the Western Front? Excavating Human Remains from the Great War 1914-1918. Presented at 29th annual Theoretical Archaeology Group Conference 2007, York UK.

Brown M. 2011 Whose Heritage? Archaeology, Heritage and the Miltary. In: Stone PG (ed) *Cultural Heritage, Ethics and the Military*. Woodbridge: Boydell Press. 129-138.

Bruzek J. 2002. A Method for Visual Determination of Sex, Using the Human Hip Bone. *American Journal of Physical Anthropology* 117:157–168

Buckberry J.L. and Chamberlain A.T. 2002. Age estimation from the auricular surface of the ilium: A revised method. *American Journal of Physical Anthropology* 119: 231–239. doi: 10.1002/ajpa.10130

Buikstra J.E. 1981 A specialist in ancient cemetery studies looks at the reburial issue. *Early Man* 3: 26-27.

Buikstra J.E and Beck L.A eds. 2006 Bioarchaeology: *The Contextual Analysis of Human Remains.* Oxford UK: Elsevier

Buikstra J.E. and Ubelaker D.H. 1994. *Standards for Data Collection from Human Skeletal Remains*. Fayetteville Arkansas: Arkansas Archaeological Survey, Research Series No. 44.

Bullough P.G. 1992. *Atlas of Orthopedic Pathology with Clinical and Radiologic Correlations, 2nd Ed.* New York: Gower Medical Publishing.

Burstein H.J., Janicek M.J., and Skarin A.T. 1997. Hypertrophic Osteoarthropathy. *Journal of Clinical Oncology.* 15:2759-60.

Byers S.N. 2002. *Introduction to Forensic Anthropology: A Textbook.* Boston: Allyn & Bacon.

Carani C, Qin K, Simoni M, Faustini-Fustini M, Serpente S, Boyd J, Korach KS and Simpson ER. 1997. Effect of Testosterone and Estradiol in a Man with Aromatase Deficiency. *New England Journal of Medicine* **337**: 91-95.

Cardoso H.F.V. 2006. Brief Communication: The Collection of Identified Human Skeletons Housed at the Bocage Museum (National Museum of Natural History), Lisbon, Portugal. *American Journal of Physical Anthropology* 129:173–176

Chahal HS, Stals K, Unterländer M, Balding DJ, Thomas MG, Kumar AV, Besser GM, Atkinson AB, Morrison PJ, Howlett TA, Levy MJ, Orme SM, Akker SA, Abel RL, Grossman AB, Burger J, Ellard S and Korbonits M. 2011. AIP Mutations in Pituitary Adenomas in the 18th Century and Today. *New England Journal of Medicine* 364: 43-50.

Chamberlain A.T. 2006. *Demography in Archaeology.* Cambridge University Press.

Chapman R, editor. 2009 *Culture Wars: An Encyclopedia of Issues, Voices, and Viewpoints.* Armonk NY: Sharpe Reference

Churchill SE, Formicola V. 1997. A Case of Marked Bilateral Asymmetry in the Upper Limbs of an Upper Palaeolithic Male from Barma Grande (Liguria), Italy. *International Journal of Osteoarchaeology* 7:18–38.

Cohen J. 1960. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement* 20: 37-46.

Cole T.M. 1996. Historical note: Early anthropological contributions to “geometric morphometrics”. *American Journal of Physical Anthropology* 101:291–296.

Colman A.M. and Pulford B.D. 2008. *A Crash Course in SPSS for Windows, 4th ed.* Chichester: John Wiley & Sons.

Comas J. 1960. *Manual of Physical Anthropology*. Illinois: CC Thomas
Connell B. 2004. Compiling a dental inventory. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 8.
Cook D. C. 1976. Pathological States and Disease Process in Illinois Woodland Populations: An Epidemiological Approach. Thesis for Doctor of Philosophy, University of Chicago, Chicago Ill.
Cook D.C. 2006. The Old Physical Anthropology and the New World. In: Buikstra JE, Beck LA, (eds), *Bioarchaeology: The Contextual Analysis of Human Remains*. Oxford: Elsevier: 27-71.
Cook-Lynn E. 1996. American Indian Intellectualism and the New Indian Story. *American Indian Quarterly* Vol. 20: 57-76
Cowin S.C, (ed). 2001. *Bone Mechanics Handbook*, 2nd ed. Boca Raton FL: CRC Press.
Cox M. 1995. A Dangerous Assumption: Anyone Can Be A Historian! The Lessons From Christ Church Spitalfields. In: Saunders SR, Herring A, eds. *Grave Reflections: Portraying the Past Through Cemetery Studies*. Toronto: Canadian Scholar’s Press. 19-29
Cox M. and Mays S. (eds). 2000. *Human Osteology In Archaeology and Forensic Science*. Cambridge: Cambridge University Press.
Cox M. and Scott A. 1992. Evaluation of the obstetric significance of some pelvic characters in an 18th century British sample of known parity status. *American Journal of Physical Anthropology* 89: 431–440.
Currey J.D. 1984 *The Mechanical Adaptations of Bones*. Princeton NJ: Princeton University Press
Currey J.D 2002 *Bones: Structure and Mechanics*. Princeton NJ: Princeton University Press
Dar G., Masharawi Y., Peleg S., Steinberg N., May H., Medlej B., Peled N. and Hershkovitz I. 2010. Schmorl’s nodes distribution in the human spine and its possible etiology. *European Spine Journal*. 19: 670-675.
Daubert v Merrell Dow Pharmaceuticals, Inc. 1993. Supreme Court of the United States. 579.
Deloria V. 1968. *Custer Died for Your Sins: An Indian Manifesto*. University of Oklahoma Press
Deloria V. 1992. Indians, Archaeologists and the Future. *American Antiquity* **57**: 595-598.
Department for Culture, Media and Sport. 2005. Guidance for the Care of Human Remains in Museums. http://webarchive.nationalarchives.gov.uk/+/http:/www.culture.gov.uk/images/publications/GuidanceHumanRemains11Oct.pdf, accessed on 23 August 2012.
Dirkmaat D.C, compiler. 2001. *Laboratory Methods in the Documentation, Analysis, and Interpretation of Human Remains from Forensic Contexts*. Forensic Anthropology Laboratory Short Course, Mercyhurst Archaeological Institute, Mercyhurst College PA.
Đjurić M. 2004. Anthropological Data in Individualization of Skeletal Remains from a Forensic Context in Kosovo—A Case History. *Journal of Forensic Science* Vol. 49, No. 3 Paper ID JFS2003168 www.astm.org Accessed 24 August 2012.

Đjurić M, Đjonić D, Nikolić S, Popović D and Marinković J. 2007. Evaluation of the Suchey–Brooks Method for Aging Skeletons in the Balkans. *Journal of Forensic Sciences* 52: 21-23.

Đjurić M, Rakočević Z and Đjonić, D 2005. The reliability of sex determination of skeletons from forensic context in the Balkans. *Forensic Science International* 147: 159-164.

Dongoske KE. 2000. A New Beginning, Not the End for Osteological Analysis—A Hopi Perspective. in: Mihesuah DA, ed. *Repatriation Reader: Who Owns American Indian Remains?* Lincoln: University of Nebraska Press. 282-293

Doyal L and Muinzer T. 2011. Should the skeleton of "the Irish giant" be buried at sea? *British Medical Journal* 343 (electronic article: no page numbers). Accessed online August 17 2012.

Doyle J. The challenge of building on sites containing human remains. Presented at Community of the Dead Conference, Anglia Law School, Cambridge UK, 30 January 2014.

Drew R. 2002. Oral Histories: Ours for the Taking. A Brief Exploration Of Tapping Natural Resources Found In A Population, With A Focus On The New Haven Area. *Yale Graduate Journal of Anthropology*, Issue 2. (No longer available online. Never published in hard copy).

Drew R. 2003. A Preliminary Survey of Pre-Columbian Puerto Ricans. Unpublished Masters Thesis, Yale University, Yale New Haven.

Drew R. 2005a. 8DA11 MDM Development tracts B and D. January 6 2005. Prepared for the Florida State Archaeologist and Archaeological and Historical Conservancy, Ltd, Davie Florida.

Drew R. 2005b. Miami One Parcel D. March 7 2005. Prepared for the Florida State Archaeologist and Archaeological and Historical Conservancy, Ltd, Davie Florida.

Drew R. 2005c. The Toothless Woman of Choquequirau. Presented at the First Annual Paleopathology Association Meeting in South America (PAMinSA), Rio de Janeiro, Brasil.

Drew R. 2006a. Medieval Life and Death in Coppergate: The Case of the Differential Diagnoses. *Yorkshire Archaeology Today, No. 10.* York: Yorkshire Archaeological Trust.(Out of print).

Drew R. 2006b. Cranial Suture Closure: useful guide or distraction? *Current World Archaeology* 3: 45-46.

Drew R. 2009a. From Saladoid to Taíno: Human Behavior from Human Remains in the Greater Antilles**.** *Bulletin of Peabody Museum of Natural History* 50:167–185

Drew R. 2009b. An Alternative Approach to Preliminary Assessment of Skeletal Remains. Presented at the 36th Annual meeting of the Paleopathology Association, Chicago IL USA

Drew R. 2013. A Review of the Ischium-Pubis Index: Accuracy, Reliability, and Common Errors. *Human Biology*: 85: 579-596

Duggan J. 1999. "Last Call on Pine Ridge". *The Lincoln Journal Star,* Thursday August 5

Echazabal C. 2010. Life in the Florida Everglades*:* Bioarchaeology of the Miami One site. Masters Thesis, Department of Anthropology, University of South Florida. *Theses and Dissertations.* Paper 1624. http://scholarcommons.usf.edu/etd/1624, accessed May 22, 2011.

English Heritage and Church of England, compiled by Simon Mays. 2005. *Guidance for best practice for treatment of human remains excavated from Christian burial grounds in England*. Available at: http://www.english-heritage.org.uk/publications/human-remains-excavated-from-christian-burial-grounds-in-england/16602humanremains1.pdf, accessed Feb 13 2014.

Ferguson T.J. 1996. Native Americans and the Practice of Archaeology. *Annual Review of Anthropology*. 25: 63-79.

Ferguson T.J., Anyon R. and Ladd E.J. 2000. Repatriation at the Pueblo Zuni: Diverse Solutions to Complex Problems. in: *Repatriation Reader: Who Owns American Indian Remains?* Mihesuah DA (ed.) Lincoln: University of Nebraska. 239-265.

Fforde C. 2004. *Collecting the Dead: Archaeology and the Reburial Issue*. London: Duckworth.

Fiorato V, Boylston A and Knüsel C. (eds.) 2000. *Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461*. Oxford: Oxbow Books

Fiorato V, Boylston A and Knüsel C. (eds.). 2007. *Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461*. Oxford: Oxbow Books.

Fitzgerald C.M. and Rose J.C. Reading Between the Lines: Dental Development and Subadult Age Assessment using the Microstructural Growth Markers of Teeth. In: Katzenberg MA, Saunders SR (eds). *Biological Anthropology of the Human Skeleton*. Wiley-Liss. 163-186.

Fleiss J.L and Cohen J. 1973. The Equivalence of Weighted Kappa and the Intraclass Correlation Coefficient as Measures of Reliability. *Educational and Psychological Measurement* 33: 613-619.

Frost H.M. 1973. *Bone Remodeling and its Relationship to Metabolic Bone Diseases. Orthopedic Lectures Volume III*. Springfield Illinois: Charles C Thomas.

Frost H.M. 1987. Bone “Mass” and the “Mechanostat”: A Proposal. *The Anatomical Record* **219:** 1-9.

Geber J. and Murphy E. 2012. Scurvy in the Great Irish Famine: Evidence of Vitamin C Deficiency From a Mid-19th Century Skeletal Population. *American Journal of Physical Anthropology.*148: 512–524. doi: 10.1002/ajpa.22066

Giesen M. (editor). 2013. *Curating Human Remains: Caring for the Dead in the United Kingdom*. Woodbridge UK: The Boydell Press.

Giesen M., McCarrison K. and Park V. 2013. Dead and Forgotten? Some Observations on Human Remains Documentation in the UK. In: Giesen M (ed.), *Curating Human Remains: Caring for the Dead in the United Kingdom*. Woodbridge UK: The Boydell Press, 53-64.

Gilchrist R. and Sloane B. 2005. *Requiem: The Medieval Monastic Cemetery in Britain*. London: Museum of London Archaeology Service

Gill G.W. 1998. Craniofacial Criteria in the Skeletal Attribution of Race. in: Reichs KJ (ed) *Forensic Osteology: Advances in the Identification of Human Remains, 2nd Ed*. Illinois: C.C. Thomas 293-317.

Godfrey L.R. 2008. From the shoulders of a Giant: Persepctives on the Legacy of William White Howells (1908-2005). *Yearbook of Physical Anthropology* 51: 118-126

Goodman A. H. and Rose J.C. 1990. Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Associated Histological Structures. *Yearbook of Physical Anthropology* 33: 59-110.

Goodman C.N. and Morant. G.M. 1940. "The Human Remains of the Iron Age and Other Periods from Maiden Castle, Dorset." in: *Biometrika*, Vol. XXXI, Parts III and IV, March issue. UK: University Press Cambridge

Grauer A.L, ed. 1995. *Bodies of Evidence: Reconstructing History through Skeletal Analysis* New York: Wiley-Liss

Gray H. and Robinson S.O.L. 1928. Auricular head height technique. With a comparison of OH by Todd's head spanner and Hrdlička's compass, held up, on one hundred skulls. *American Journal of Physical Anthropology* 11: 321–342

Groning F., Fagan M.J. and O'Higgins P. 2011. The effects of the periodontal ligament on mandibular stiffness: a study combining finite element analysis and geometric morphometrics. *Journal of Biomechanics* doi:10.1016/j.jbiomech.2011.01.008

Hackett C. J. 1976. Diagnostic criteria of syphilis, yaws and treponarid (treponematoses) and of some other diseases in dry bones (for use in osteoarchaeology). Berlin: Springer-Verlag.

Hadley D.M. 2001. *Death in Medieval England: An Archaeology*. Stroud: Tempus Publishing Ltd.

Hawkey D.E. 1998. Disability, Compassion, and the Skeletal Record: Using Musculoskeletal Stress Markers (MSM) to Construct an Osteobiography from Early New Mexico. *International Journal of Osteoarchaeology* 8: 326-340.

Hawkey D.E. and Merbs C.F. 1995. Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology* 5:324-338.

Henderson C.Y. and Gallant A.J. 2006. Quantitative Recording of Entheses. Poster presented at the 16th European Meeting of the Paleopathology Association, Fira, Santorini, Greece.

Hero M, Ankarberg-Lindgren C, Taskinen M-R and Dunkel L. 2006. Blockade of oestrogen biosynthesis in peripubertal boys: effects on lipid metabolism, insulin sensitivity, and body composition. *European Journal of Endocrinology* 155: 453-460.

Hill J.D. 1992. Overview: Contested Pasts and the Practice of Archaeology. *American Anthropologist.* 94: 809-815.

Hillson S. 2000. Dental Pathology. In: Katzenberg MA, Saunders SR (eds). *Biological Anthropology of the Human Skeleton*. Wiley-Liss. 249-286.

Hillson S. 2005. *Teeth.* Second Edition. Cambridge: Cambridge University Press.

Holm S. 2001. The Privacy of Tutankhamen – Utilising the Genetic Information in Stored Tissue Samples *Theoretical Medicine* 22: 437–449.

Hope J.W, Spitz E.B and Slade H.W. 1955. The Early Recognition of Premature Cranial Synostosis. *Radiology* 65: 183-193.
Hoppa R.D and FitzGerald CM. 1999. *Human Growth in the Past: Studies from Bones and Teeth.* Cambridge UK: Cambridge University Press
Hoppa RD, Vaupel JW. 2002. *Paleodemography: Age Distributions from Skeletal Samples.* Cambridge UK: Cambridge University Press
Howells W.W. 1938. The techniques of measuring auricular height in the living. *American Journal of Physical Anthropology* 24 185 198
Howells W.W. 1973. *Cranial Variation in Man*. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 67. Cambridge MA: Harvard University.
Hrdlička A. 1900. *Hrdlicka's Practical Anthropometry* Philadelphia: Wistar Institute of Anatomy and Biology
Hrdlička A. 1914. *Anthropological Work in Peru in 1913*. Smithsonian Misc. Collections Vol 61, No 18. Washington DC: Smithsonian Institute.
Hrdlička A. 1919a. Anthropometry. *American Journal of Physical Anthropology* 2: 43–60.
Hrdlička A. 1919b. Anthropometry. B. Introduction to anthropometry. *American Journal of Physical Anthropology* 2: 175–194.
Hrdlička A. 1919c. Anthropometry. C. Anthropometry on the living instruments. *American Journal of Physical Anthropology* 2: 283–319.
Hrdlička A. 1919d. Anthropometry. D. Skeletal parts: the skull. *American Journal of Physical Anthropology* 2: 401–428.
Hrdlička A. 1919e. Anthropometry. E. Osteometry. *American Journal of Physical Anthropology* 3: 147–173
Hrdlička A. 1920. Shovel-Shaped Teeth. *American Journal of Physical Anthropology* 3**:**429-465.
Hrdlička A. 1935. Ear Exostoses. *Smithsonian Misc. Collections* 93: 1-100. Washington DC: Smithsonian Institute.
Hrdlička A. 1939 *Hrdlicka's Practical Anthropometry 2nd Ed.* Philadelphia: Wistar Institute of Anatomy and Biology
Hrdlička A, Stewart TD. 1952. *Hrdlicka's Practical Anthropometry 4th ed* Philadelphia: Wistar Institute of Anatomy and Biology
Isçan M.Y. 1988. The rise of forensic anthropology. *Yearbook of Physical Anthropology* 31: 203-230.
Isçan M.Y. and Kennedy K.A.R, eds. 1989. *Reconstruction of Life from the Skeleton.* New York: Alan R Liss.
Isçan M.Y., Loth S.R. and Wright R.K. (1984), Metamorphosis at the sternal rib end: A new method to estimate age at death in white males. *American Journal of Physical Anthropology* 65: 147–156. doi: 10.1002/ajpa.1330650206
Isçan M.Y. and Miller-Shaivitz P. 1985. Prehistoric Syphilis in Florida. *Florida Medical Annals* 72: 109-113.
Ives R. and Brickley M. A Procedural Guide to Metacarpal Radiogrammetry in Archaeology. *International Journal of Osteoarchaeology* 14: 7-17.
Jantz R.L., Hunt D.R. and Meadows L. 1995. The measure and mismeasure of the tibia: implications for stature estimation. *Journal of forensic sciences* 40: 758-761.

Jones E.B. and Ousley S.D. 2008. The Repatriation Osteology Laboratory, National Museum of Natural History, Smithsonian Institution. In: Warren MW, Walsh-Haney HA, Freas LE (eds). *The Forensic Anthropology Laboratory.* Boca Raton FL: CRC Press. 117-147.

Judd, M.A. 2000 Trauma and Interpersonal Violence in Ancient Nubia during the Kerma Period (ca 2500-1500 BC). Thesis for Doctor of Philosophy, University of Alberta.

Judd M. 2002. Ancient Injury Recidivism: An Example from the Kerma Period of Ancient Nubia. *International Journal of Osteoarchaeology* 12: 89-106.

Jupp P.C. and Gittings C., editors. 1999. *Death in England: An Illustrated History.* Manchester: Manchester University Press.

Jurmain R. 1999. *Stories from the Skeleton: Behavioral Reconstruction in Human Osteology*. Amsterdam: Gordon and Breach.

Juzda E. 2009. Skulls, science and the spoils of war: craniological studies at the United States Army Medical Museum, 1868-1900. *Studies in History and Philosophy of Biological and Biomedical Sciences* 40: 156-167.

Kaestle F.A. and Smith D. G. 2001. Ancient Mitochondrial DNA Evidence for Prehistoric Population Movement: The Numic Expansion *American Journal of Physical Anthropology* 115: 1-12.

Katzenberg M.A. and Saunders S.R., eds. 2000. *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss.

Keith A. 1911 An inquiry into the nature of skeletal changes in acromegaly. *The Lancet* 177: 993-1002

Keith A. 1931. *The Place of Prejudice in Modern Civilization*. London: Williams & Norgate

Kent J. 2012. "Accounting for Pine Ridge killings", *Rapid City Journal,* June 21 2012. http://rapidcityjournal.com/news/opinion/kent-accounting-for-pine-ridge-killings/article_5895a507-5a7b-5526-82cc-f13253bd2a54.html. Accessed 16 Aug 2012.

Key C.A., Aiello L.C. and Molleson T. 1994. Cranial suture closure and its implications for age estimation. *International Journal of Osteoarchaeology* 4: 193-207

King T.F. 1998 *Cultural Resource Laws & Practice: an introductory guide*. Walnut Creek, California: AltaMira Press.

Kjellström A. 2005. A 16th Century Warrior Grave from Uppsala Sweden: The Battle of Good Friday. *International Journal of Osteoarchaeology*. 15: 23-50.

Knüsel C. 2000. Bone Adaptation and its Relationship to Physical Activity in the Past. In: Cox M, Mays S (eds). *Human Osteology: In Archaeology and Forensic Science.* Cambridge: Cambridge University Press. 381-401

Konigsberg, L.W. 2006. A post-Neumann history of biological and genetic distance studies in bioarchaeology. In: Buikstra JE, Beck LA, (eds), *Bioarchaeology: The Contextual Analysis of Human Remains*. New York: Academic Press. p (2006): 263-279.

Kontulainen S., Sievanen H., Kannus P., Pasanen M. and Vuori I. 2003. Effect of long-term impact-loading on mass, size, and estimated strength of humerus and radius of female racquet-sports players: a peripheral quantitative computed tomography study between young and old starters and controls. *Journal of Bone and Mineral Research* 18:352-9.

Kranzler G. and Moursund J. 1999. *Statistics for the Terrified, 2nd ed*. New Jersey: Prentice Hall.
Krogman W.M. 1962. *The Human Skeleton in Forensic Medicine.* Springfield Ill: Charles C Thomas.
Kuba C. L. 2012. Deadly Borders: The Role of Forensic Anthropology in Homeland Security in the Southwestern United States. *The Homeland Security Review* 6: 137-156.
Laird G. 2009. American Indian Movement. in Chapman R, ed: *Culture Wars An Encyclopedia of Issues, Voices, and Viewpoints.* Armonk NY: Sharpe Reference. 22-23.
Landau P.M. and Steele D.G. 1996. Why Anthropologists Study Human Remains. *American Indian Quarterly*. 20: 209-228.
Landolt A.M. and Zachmann M. 1980. The Irish Giant: new observations concerning the nature of his ailment. *The Lancet* 315: 1311-1312.
Langsjoen O. 1998. Diseases of dentition. In: Aufderheide, A.C. and Rodriguez-Martin, C. *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge UK: Cambridge University Press. 393-412.
LaRoche C.J. and Blakey M.L. 1997. Seizing Intellectual Power: The Dialogue at the New York African Burial Ground *Historical Archaeology* 31:84-106.
Larsen C.S. 1994. In the wake of Columbus: native population biology in the postcontact Americas. *Yearbook of Physical Anthropology* 37: 109-154.
Larsen C.S. 1997. *Bioarchaeology: Interpreting Behavior from the Human Skeleton.* Cambridge UK: Cambridge University Press
Larsen C. S. 2002. Bioarchaeology: The Lives and Lifestyles of Past People. *Journal of Archaeological Research.* 10: 119-166.
Layard D. and Young M. 1935. The Burwell Skulls, Including A Comparison with Those of Certain Other Anglo-Saxon Series *Biometrika* 27: 388-408
Lazenby R.A. 2002. Population Variation in Second Metacarpal Sexual Size Dimorphism. *American Journal of Physical Anthropology* 118: 378-384.
Lewis M. E. 2009. *The Bioarchaeology of Children: Perspectives from Biological and Forensic Anthropology*. Cambridge UK: Cambridge University Press.
Lilley J. M., Stroud G., Brothwell D. R. and Williamson M. H. 1994. *The Jewish Burial Ground at Jewbury*. York: Council for British Archaeology.
Loftus, E.F., and Marburger W. 1983. Since the eruption of Mt. St. Helens, has anyone beaten you up? Improving the accuracy of retrospective reports with landmark events. *Memory & Cognition* 11: 114-120.
Lovejoy C.O. 1985. Dental wear in the Libben Population: Its functional pattern and role in the determination of adult skeletal age at death. *American Journal of Physical Anthropology* 68: 47-56.
Lovejoy C.O., Meindl R.S., Pryzbeck T.R., Mensforth R.P. 1985a.Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age at death. *American Journal of Physical Anthropology* 68: 15-28.
Lovejoy C.O., Meindl R.S., Mensforth R.M. and Barton T.J. 1985b. Multifactorial determination of skeletal age at death: A method and blind tests of its accuracy. *American Journal of Physical Anthropology* 68: 1-14.

Lovell N. 1997. Trauma Analysis in Paleopathology. *Yearbook of Physical Anthropology* 40: 139-170.

Lovell N.C. 2000. Paleopathological description and diagnosis. In: Katzenberg M.A. and Saunders S.R., eds. *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss. 217–248

Luce R.H. 1979. *The History of the Abbey and Town of Malmesbury* 2nd ed. Malmesbury: The Friends of Malmesbury Abbey.

Mack M.E. and Blakey M.L. 2004. The New York African Burial Ground Project: Past Biases, Current Dilemmas, and Future Research Opportunities *Historical Archaeology* 38: 10-17.

Magilton J., Lee F. and Boylston A. (eds). 2008. *Lepers outside the gate: Excavations at the cemetery of the Hospital of St James and St Mary Magdalene, Chichester, 1986–93* York: Council for British Archaeology.

Mahany C,M. 1965 "Grafton Regis: First Draft of a Report of the Excavation of the Graveyard of the Curch of All Saints-Ad-Castra, Castle Hill, Cambridge" (unpublished report)

Mall G., Graw M., Gehring K-D., and Hubig M. 2000. Determination of sex from femora. *Forensic Science International* 113: 315-321.

Mann R.W. and Hunt D.R. 2005. *Photographic Regional Atlas of Bone Disease*. Springfield Ill: Charles C Thomas.

Martin R.B., Burr D.B. and Sharkey N.A. 2004. *Skeletal Tissue Mechanics.* New York: Springer.

Mastrangelo P, De Luca S, Alemán I, and Botella M C. 2011. Sex assessment from the carpals bones: Discriminant function analysis in a 20th century Spanish sample. *Forensic Science International*. 206: 216.e1 – 216.e10.

Matos V. and Santos A.L. 2006. On the trail of pulmonary tuberculosis based on rib lesions: results from the Human Identified Skeletal Collection from the Museu Bocage (Lisbon Portugal). *American Journal of Physical Anthropology.* 130: 190-200.

Mays S.A. 1996. Age-dependent cortical bone loss in a medieval population. *International Journal of Osteoarchaeology* 6: 144–154.

Mays S. 1998. *The Archaeology of Human Bones*. London: Routledge.

Mays S. 2000. Biodistance Studies Using Craniometric Variation in British Archaeological Skeletal Material. In Cox M, Mays S eds. *Human Osteology in Archaeology and Forensic Science*. Cambridge University Press 277-288.

Mays S. 2010. *The Archaeology of Human Bones* 2nd Ed. London: Routledge.

Mays S., Brickley M., and Ives R. 2006. Skeletal Manifestations of Rickets in Infants and Young Children in a Historic Population from England. *American Journal of Physical Anthropology* 129: 362-374.

McKern T.W. and Stewart T.D. 1957. *Skeletal Age Changes in Young American Males, Analyzed from the Standpoint of Identification.* Headq QM Res and Dev Command, Tech Rep EP-45. Natick Mass USA.

McKinley J. I. 2004. Compiling a skeletal inventory: cremated human bone. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 9-13.

McKinley J. I. 2004. Disarticulated and co-mingled remains. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 14-17.

McLuham M. 1964. *Understanding Media: The Extensions of Man.* New York: McGraw Hill.

McNulty S.L. 2009. Pattern and Distribution of Fractures in the William M. Bass and Hamann-Todd Osteological Collections, Masters Thesis, University of Tennessee.

Meindl R.S. and Lovejoy C.O. 1985. Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral-anterior sutures. *American Journal of Physical Anthropology* 68: 57-66.

Meindl R.S., Lovejoy C.O., Mensforth R.M. and Walker R.A. 1985a. A revised method of age determination using the os pubis, with a review and tests of accuracy of other current methods of pubic symphyseal ageing. *American Journal of Physical Anthropology* 68: 29-45.

Meindl R.S, Lovejoy C.O., Mensforth R.M. and Carlos LD. 1985b. Accuracy and Direction of Error in the Sexing of the Skeleton: Implications for Paleodemography. *American Journal of Physical Anthropology* 68: 79-85

Meindl R.S., Russell K.F. and Lovejoy C.O. 1990. Reliability of Age at Death in the Hamann-Todd Collection: Validity of Sub-selection Procedures Used in Blind Tests of the Summary Age Technique. *American Journal of Physical Anthropology* 83: 349-357.

Mihesuah D.A. editor. 2000. *Repatriation Reader: Who Owns American Indian Remains?* Lincoln: University of Nebraska Press

Molleson T. 1995. Rates of Ageing in the Eighteenth Century. In: Saunders SR, Herring A (eds). *Grave Reflections: Portraying the past through cemetery studies*. Toronto: Canadian Scholar’s Press. 199-222.

Montagu A. 1960. *A Handbook of Anthropometry*. Springfield Ill: Charles C Thomas

Montagu, M.F.A. 1944. Alěs Hrdlička, 1869-1943 *American Anthropologist*, New Series 46: 113-117

Moore W. 2005. *The Knife Man: Blood, Body-snatching and the Birth of Modern Surgery.* London: Bantam Books.

Moore-Jansen P.H. and Jantz R.L. 1986. *A Computerized Skeletal Data Bank for Forensic Anthropology.* Knoxville Tennessee: Dept of Anthropology, University of Tennessee

Moore-Jansen P.H., Ousley S.D. and Jantz R.L. 1994. *Data Collection Procedures for Forensic Skeletal Material.* Report of Investigations No. 48. Knoxville Tennessee: Dept of Anthropology, University of Tennessee

Morris A. G. 2012. *Missing and Murdered: A Personal Adventure in Forensic Anthropology*. Struik Publishing.

Morton S G. 1839 *Crania Americana. Or, a Comparative View of the Skulls of Various Aboriginal Nations of North and South America; to Which Is Prefixed and Essay on the Varieties of the Human Species* (J. Dobson, Philadelphia).

Murphy C., Syahizul Nuhairy Mohd Sharial M., Brennan N., Lee G., Moylan E., and O'Reilly S. 2008. Hypertrophic osteoarthropathy leading to the diagnosis of primitive neuroectodermal tumour (PNET). *Acta Oncologica*, *47*: 983-986.

Neumann, G.K. 1942. Types of artificial cranial deformation in the Eastern US. *American Antiquity* 7: 306-310.
North Carolina State University Policies, Regulations and Rules 2006 Website of NCSU http://www.ncsu.edu http://www.ncsu.edu/policies/homepage.php
O'Connell L. 2004. Guidance on recording age at death in adults. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7, 18-20.
O'Higgins P. 2000. The study of morphological variation in the hominid fossil record, biology, landmarks and geometry. *Journal of Anatomy* 197:103–120.
O'Higgins P and Cohn M.J. 2000. *Development, Growth, and Evolution: Implications for the Study of the Hominid Skeleton.* London: Academic Press.
O'Higgins P, Cobb S.N, Fitton L.C., Gröning F., Phillips R, Liu J and Fagan M.J. 2011. Combining geometric morphometrics and functional simulation: an emerging toolkit for virtual functional analyses. *Journal of Anatomy* 218: 3-15.
Olivier G., 1969. Practical Anthropometry. Springfield, Illinois: Charles C. Thomas Publishers
Orr E.R. 2009. Consultation on the Request for Reburial of Human Remains, Avebury *Museum Archaeologists News No 46* Society of Museum Archaeologists. 1-2.
Ortner D. 2003 *Identification of Pathological Conditions in Human Skeletal Remains,* 2nd Ed. London: Academic Press.
Ortner D.J. and Aufderheide A.C. (eds). 1991. *Human Paleopathology: Current Syntheses And Future Options.* Washington, D.C.: Smithsonian Institution Press.
Ousley S.D, Billeck W.T. and Hollinger RE. 2005. Federal Repatriation Legislation and the Role of Physical Anthropology in Repatriation. *American Journal of Physical Anthropology* 128: 2-32
Pearson, M.P., Schadla-Hall, T and Moshenska, G. 2011. Resolving the Human Remains Crisis in British Archaeology. *Papers from the Institute of Archaeology* 21:5-9.
Perizonius W.R.K. 1984. Closing and non-closing sutures in 256 crania of known age and sex from Amsterdam (AD 1883-1909). *Journal of Human Evolution* 13: 201-216
Peterson J. 2002. *Sexual Revolutions: Gender and Labor at the Dawn of Agriculture.* Walnut Creek CA: AltaMira Press.
Phenice T.W. 1969. A newly developed visual method of sexing the os pubis. *American Journal of Physical Anthropology* 30: 297-301.
Pietrusewsky M. 2000. Metric Analysis of Skeletal Remains: Methods and Applications. In: Katzenberg MA, Saunders SR (eds). *Biological Anthropology of the Human Skeleton*. Wiley-Liss. 375-415.
Powell M.L. and Cook D.C. 2005 *The Myth of Syphilis*. University Press of Florida, Gainesville.
Powers R. 1962. The disparity between known age and age as estimated by cranial suture closure. *Man* 83: 52-55

Price T.D., Burton J.H., Sharer R.J., Buikstra J.E., Wright L.E., Traxler L.P. and Miller K.A. 2010. Kings and commoners at Copan: Isotopic evidence for origins and movement in the Classic Maya period. *Journal of Anthropological Archaeology* 29: 15-32.

Radosavljevich P.R. 1911. Professor Boas' New Theory of the Form of the Head—A Critical Contribution To School Anthropology. *American Anthropologist* 13: 394-436.

Raisor M.J. 1993. Old Socorro Mission: An Osteobiological Analysis of the Skeletal Remains from the 1982-1985 Field Excavations. Submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of Masters of Arts.

Ramsthaler, F., Kettner, M., Gehl, A., and Verhoff, M. A. 2010. Digital Forensic Osteology: Morphological Sexing of Skeletal Remains Using Volume-Rendered Cranial CT Scans. *Forensic Science International* 195: 148-152.

Redfern M, Keeling J.W. and Powell E. 2001. *The Royal Liverpool Children's Inquiry Report.* House of Commons.

Redfern R. and Bekvalac J. 2013. The Museum of London: An Overview of Policies and Practice. In: Giesen M (ed.), *Curating Human Remains: Caring for the Dead in the United Kingdom*. Woodbridge UK: The Boydell Press, 87-98.

Reichs K ed.. 1998. *Forensic Osteology: Advances in the Identification of Human Remains,* 2nd Ed. Illinois: Charles C Thomas.

Rhine S. 1998. *Bone Voyage: A Journey in Forensic Anthropology*. Albequerque: University of Mexico Press.

Riding In J. 2000. Repatriation: A Pawnee's Perspective. in: Mihesuah DA editor. *Repatriation Reader: Who Owns American Indian Remains?* Lincoln: University of Nebraska Press. 106-120.

Rissech, C., Estabrook G. F., Cunha E., and Malgosa A. 2006. Using the Acetabulum to Estimate Age at Death of Adult Males. *Journal of Forensic Science* 51: 213-229

Robb J. 2000. Analysing Human Skeletal Data. In: Cox M, and Mays S (eds). *Human Osteology In Archaeology and Forensic Science.* Cambridge: Cambridge University Press 475-489.

Roberts C. and Connell B. 2004. Guidance on Recording Paleopathology. In: Brickley M. and McKinley J.I. (editors) *Guidelines to the Standards for Recording Human Remains.* Reading: Institute of Field Archaeologists Paper No. 7. 34-39.

Roberts C. and Cox M. 2003. *Health and Disease in Britain.* Gloucestershire: Sutton Publishing Ltd.

Roberts C. and Manchester K. 2005. *The Archaeology of Disease,* 3rd ed. Gloucestershire: Sutton Publishing.

Roberts C. and Mays S. 2011. Study and restudy of curated skeletal collections in bioarchaeology: A perspective on the UK and the implications for future curation of human remains. *International Journal of Osteoarchaeology* 21: 626-630.

Roffey S. 2012. Medieval Leper Hospitals in England: An Archaeological Perspective. M*edieval Archaeology* 56: 203-233.

Roffey S. and Tucker K. 2012. A contextual study of the medieval hospital and cemetery of St Mary Magdalen, Winchester, England. *International Journal of Paleopathology* 2: 170-180.

Rogers J. and Waldron T. 1995. *A Field Guide to Joint Disease in Archaeology*. Chichester: John Wiley & Sons.

Romanes G.J. 1976. *Cunningham's Manual of Practical Anatomy 14th ed. Volume One: Upper and Lower Limbs*. London: Oxford University Press.

Rose J.C., Green T.J. and Green V.D. 1996. NAGPRA is Forever: Osteologists and the Repatriation of Skeletons. *Annual Review of Anthropology* 25: 81-103.

Rouse I. 1992. *The Taínos: Rise and Decline of the People Who Greeted Columbus*. New Haven: Yale University Press.

Ruff C.B. 2000. Biomechanical Analyses of Archaeological Human Skeletons. In: Katzenberg MA, Saunders SR (eds). *Biological Anthropology of the Human Skeleton*. Wiley-Liss. 71-103

Ruff C.B. 2005. Mechanical determinants of bone form: Insights from skeletal remains. *Journal of Musculoskeletal Neuronal Interactions* 5: 202-212.

Ruff C.B, Holt B. and Trinkaus E. 2006. Who's Afraid of the Big Bad Wolff? "Wolff's Law" and Bone Functional Adaptation. *American Journal of Physical Anthropology* 129: 484-498.

Ruff C.B, Trinkaus E., Walker A. and Larsen C.S. 1993. Postcranial Robusticity in *Homo*, I: Temporal Trends and Mechanical Interpretation. *American Journal of Physical Anthropology*. 91**:**21-53

Ruff C.B., Walker A, Trinkaus E. 1994. Postcranial robusticity in *Homo*. III: Ontogeny. *American Journal of Physical Anthropology* 93: 35-54

Saenger P. 1996. Turner's Syndrome. *New England Journal of Medicine* 335: 1749-1754.

Santos A.L. and Roberts C.A. 2001. A picture of tuberculosis in young Portuguese people in the early 20th century: a multidisciplinary study of the skeletal and historical evidence. *American Journal of Physical Anthropology*. 115: 38-49.

Saunders S.R., Herring A, Sawchuk L.A. and Boyce G. 1995. The Nineteenth Century Cemetery at St Thomas' Anglican Church, Belleville: Skeletal Remains, Parish Records and Censuses. In: Saunders SR, Herring A (eds). *Grave Reflections: Portraying the past through cemetery studies*. Toronto: Canadian Scholar's Press. 93-117.

Saunders S.R., Herring A. 1995. *Grave Reflections: Portraying the past through cemetery studies*. Toronto: Canadian Scholar's Press

Scheuer L. 2002a Application of Osteology to Forensic Medicine. *Clinical Anatomy* 15: 297-312.

Scheuer L. 2002b. Brief Communication: A Blind Test of Mandibular Morphology for Sexing Mandibles in the First Few Years of Life. *American Journal of Physical Anthropology* 119: 189-191.

Scheuer L and Black S. 2004. *Juvenile Osteology*. New York: Academic Press, Elsevier Science Publishing

Scheuer J.L and Bowman J.E. 1995. Correlation of Documentary and Skeletal Evidence in the St Bride's Crypt Population. In: Saunders SR, Herring A. *Grave Reflections: Portraying the past through cemetery studies*. 49-70.

Schmid E. 1972. *Atlas of Animal Bones.* New York and Amsterdam: Elsevier Science

Schultz A.H. 1930. The skeleton of the trunk and limbs of higher primates. *Human Biology* 2: 303-456.

Schutkowski H. 1993. Sex determination of infant and juvenile skeletons: I. Morphognostic features. *American Journal of Physical Anthropology* 90:199–205. doi:10.1002/ajpa.1330900206

Schwarz N. and Oyserman D. 2001. Asking Questions About Behavior: Cognition, Communication, and Questionnaire Construction *American Journal of Evaluation* 22: 127-160. DOI: 10.1177/109821400102200202

Segebarth-Orban R. 1980. An evaluation of the sexual dimorphism of the human innominate bone. *Journal of Human Evolution* 9: 601-607.

Seidler H. 1980. Sex-diagnosis of isolated os coxae by discriminant functions. *Journal of Human Evolution* 9: 597-600.

Selvaggio M. M. and Wilder J. 2001. Identifying the Involvement of Multiple Carnivore Taxa with Archaeological Bone Assemblages. *Journal of Archaeological Science* 28: 465-470.

Sim J. and Wright C.C. 2005. The Kappa Statistic in Reliability Studies: Use, Interpretation, and Sample Size Requirements. *Physical Therapy* 85: 257-268.

Singer R. 1953. Estimation of age from cranial suture closure: a report on its unreliability. *Journal of Forensic Medicine* 1: 52-59.

Sirianni J.E. and Higgins R.L. 1995. A Comparison of |Death Records from the Monroe County Almshouse with Skeletal Remains from the Associated Highland Park Cemetery. In: Saunders SR and Herring A (eds) *Grave Reflections: Portraying the past through cemetery studies*. Toronto: Canadian Scholar’s Press. 71-92.

Smith A.C. and Boaks A. 2013. Point Differences in Modern Osteometrics: A Validation of Postcranial Measurement Landmarks. Practical Session, 82nd Meeting of American Association of Physical Anthropologists, Knoxville TN USA.

Smith D.G., Malhi R.S., Eshleman J., Lorenz J.G. and Kaestle F.A. 1999. Distribution of mtDNA haplogroup X among Native North Americans. *American Journal of Physical Anthropology* 110:271–284.

Smith L. 2004. The Repatriation of Human Remains—Problem or Opportunity? *Antiquity*. 78:404-413

Smith M, Knüsel C, Chamberlain A, Mitchell PD. 2012. We cannot change the past, but we can learn from it. *British Medical Journal* 344:e556. Accessed online August 17 2012.

Spencer F. (ed). 1982. Introduction. In: Spencer F (ed) *A History of American Physical Anthropology 1930-1980*, New York: Academic Press. 1-10.

Steckel R.H., Larsen C.S., Sciulli P.W. and Walker P.L. 2006. *The Global History of Health Project Data Collection Codebook*. Cambridge UK: Cambridge University Press. http://global.sbs.ohio-state.edu/new_docs/Codebook-06-28-06.pdf (accessed 23 Aug 2012).

Steckel R.H. and Rose J.C. 2002. The Backbone of History: Health and Nutrition in the Western Hemisphere. Cambridge UK: Cambridge University Press.

Steele D.G., Bramblett C.A. 1988. *The Anatomy and Biology of the Human Skeleton.* College Station, Texas: Texas A&M University Press.

Steele J. and Mays S. 1997. Handedness and directional asymmetry in the long bones of the human upper limb. *International Journal of Osteoarchaeology* 5:39–49.
Stewart T.D. 1954. Sex Determination of the Skeleton by Guess and by Measurement. *American Journal of Physical Anthropology* 12: 385-389.
Steyn M. and Isçan M.Y. 2008. Metric sex determination from the pelvis in modern Greeks. *Forensic Science International*. 179: 86-e1.
Stirland A. J. 1992. Asymmetry and Activity-Related Change in Selected Bones of the Human Male Skeleton. Thesis for Doctor of Philosophy, Department of Archaeology, University College of London, UK.
Stirland A.J. 1998. Musculoskeletal Evidence for Activity: Problems of Evaluation. *International Journal of Osteoarchaeology* 8: 354-362.
Stirland A.J. 2005 *The Men of the **Mary Rose:** Raising the Dead*. Gloucestershire: Sutton Publishing Ltd.
Stojanowski C.M. and Euber J.K. 2011. Technical note: Comparability of Hrdlička's *Catalog of crania* data based on measurement landmark definitions. *American Journal of Physical Anthropology* 146: 143-149
Stroud G. and Kemp R.L. 1993. *Cemeteries of St Andrew, Fishergate*. York: York Archaeological Trust.
Stuart-Macadam P.L. 1987. New Evidence to Support the Anaemia Theory. *American Journal of Physical Anthropology* 74: 521-526
Stuart-Macadam P.L. 1989. Nutritional deficiency diseases: a survey of scurvy, rickets, and iron-deficiency anemia. In: Isçan MY, Kennedy KAR, editors. *Reconstruction of life from the skeleton*. New York: Alan R. Liss Inc. 201–222.
Suchey J.M. and Katz D. 1998. Applications of Pubic Age Determination in a Forensic Setting. In: Reichs K. ed. *Forensic Osteology: Advances in the Identification of Human Remains,* 2nd Ed. Illinois: Charles C Thomas. 204-236.
Sutton M.Q. and Arkush B.S. 1998. *Archaeological Laboratory Methods: An Introduction,* 2nd Ed. Iowa: Kendall/Hunt.
Taylor G. M., Tucker K., Butler R., Pike A.W.G., Lewis J., Roffey S., Marter P., Lee O.Y-C., Wu H.H.T., Minnikin D.E., Besra G.S, Singh P., Cole S.T. and Stewart G.R. 2013. Detection and Strain Typing of Ancient Mycobacterium leprae from a Medieval Leprosy Hospital. *PLoS ONE* 8(4): e62406. doi:10.1371/journal.pone.0062406.
Taylor R.H. 1959. Age Determination in Wild Rabbits. *Nature* 184: 1158 – 1159
Thieme F.P. and Schull W.J. 1957. Sex determination from the skeleton. *Human Biology* 29: 242-274
Thomas C. 2004. *Life and Death in London's East End: 2000 years at Spitalfields*. London: Museum of London Archaeology Service.
Thompson D.D. 1982. Forensic anthropology. In: Spencer F. (ed). *A history of American physical anthropology 1930-1980.* New York: Academic Press. 357-369.
Todd T.W. 1920. Age changes in the pubic bones. I. The male white pubis. *American Journal of Physical Anthropology* 3: 285-334.

Todd T.W. 1921. Age changes in the pubic bones. II. The pubis of the male Negro-white hybrid. III. The pubis of the white female. IV. The pubis of the female Negro-white hybrid. *American Journal of Physical Anthropology* 4: 4-70.

Todd T.W. and Lyon D.W. 1924. Cranial suture closure. I. Adult males of white stock. *American Journal of Physical Anthropology* 7: 325-384.

Todd T.W. and Lyon D.W. 1925a. Cranial suture closure. II. Ectocranial closure in adult males of white stock. *American Journal of Physical Anthropology* 8: 23-43.

Todd T.W. and Lyon D.W. 1925b. Cranial suture closure. III. Endocranial suture closure in adult males of Negro stock. *American Journal of Physical Anthropology* 8: 44-71

Todd T.W and Lyon D.W. 1925c. Cranial suture closure. IV. Ectocranial suture closure in adult males of Negro stock. *American Journal of Physical Anthropology* 8:149-168.

Todd T.W and Russell M. 1923. Cranial capacity and linear dimensions, in White and Negro. *American Journal of Physical Anthropology* 6: 97-194.

Topinard P. 1876. *L'Anthropologie*. Paris: Libraire Schleicher Freres. Trigger BG 1989 *A History of Archaeological Thought.* Cambridge UK: Cambridge University Press.

Trigger B.G. 1980. Archaeology and the Image of the American Indian. *American Antiquity* 45: 662-676.

Trigger B.G. 1989 *A History of Archaeological Thought.* Cambridge UK: Cambridge University Press.

Trope J.E., Echo-Hawk W.R. 2000. NAGPRA: Background and Legislative History. In: Mihesuah DA ed. *Repatriation Reader: Who Owns American Indian Remains?* Lincoln: University of Nebraska Press. 123-168.

Trotter M. and Gleser G.C. 1951. The effects of ageing on stature. *American Journal of Physical Anthropology* 9:311-324

Trotter M. and Gleser G.C 1952. Estimation of stature from long bones of American Whites and Negroes. *American Journal of Physical Anthropology* 10: 463–514.

Turnbull P. 1997. Ancestors, not Specimens: Reflections on the Controversy over the Remains of Aboriginal People in European Scientific Collections. *The Electronic Journal of Australian and New Zealand History* 1-18. http://www.jcu.edu.au/aff/history/articles/turnbull

Tucker K. 2012. 'Whence this Severance of the Head?' The Osteology and Archaeology of Human Decapitation in Britain. Thesis for Doctor of Philosophy, Department of Archaeology, University of Winchester, UK

Ubelaker D.H. 1974. *Reconstruction of Demographic Profiles from Ossuary Skeletal Samples: A Case Study from the Tidewater Potomac*. Washington DC: Smithsonian Contributions to Anthropology No. 18

Ubelaker D. H. 1989. *Human Skeletal Remains,* 2nd ed. Washington DC: Taraxacum Press.

Ubelaker D.H. 1990. Positive identification of American Indian skeletal remains from radiograph comparison. *Journal of Forensic Sciences* 35: 466-472

Ubelaker D. H. 2000. Methodological Considerations in the Forensic Applications of Human Skeletal Biology. In: Katzenberg MA, Saunders SR (eds), *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss. 41-67.

Ubelaker D.H. and Jones E.B., eds. 2003. *Human Remains from Voegtly Cemetery, Pittsburgh, Pennsylvania* Smithsonian Contributions to Anthropology No. 46.

Ubelaker D.H. and Landers D.B. 2003. Introduction. In: Ubelaker D.H. and Jones E.B. eds. *Human Remains from Voegtly Cemetery, Pittsburgh, Pennsylvania*. 1-7.

UCL Human Remains Working Group. 2007. *Policy, Principles and Procedures For the Care and Treatment of Human Remains at UCL*. London: University College of London.

United States Department of the Interior 2004 Future Applicability Proposed Rule 43 CFR 10. Federal Register 69 (202) 61613-61615 http://www.gpoaccess.gov/

United States Department of the Interior National Park Service 2006 National NAGPRA: Website of the DOI with information on grants, the text of the Law, and common questions about NAGPRA http://www.cr.nps.gov/nagpra/INDEX.HTM . Accessed October 9 2007.

University of Minnesota 2005 Guidelines for the preparation of candidate dossiers http://www.ahceducation.umn.edu/OofE/Faculty/PandT/guidelines.html

Utermohle C.J. and Zegura S.L. 1982. Intra- and lnterobserver Error in Craniometry: A Cautionary Tale. *American Journal of Physical Anthropology* 57:303-310

Ved N. and Haller J.O. 2002. Periosteal Reaction with normal-appearing underlying bone: a child abuse mimicker. *Emergency Radiology* 9: 278-282.

Waldron T. 2009. *Paleopathology*. Cambridge UK: Cambridge University Press.

Walker P.L. 1995. Problems of Preservation and Sexism in Sexing: Some Lessons from Historical Collections for Palaeodemographers. In: Saunders SR, Herring A (eds) *Grave Reflections: Portraying the Past Through Cemetery Studies.* Toronto: Canadian Scholar's Press. 31-47.

Walker P.L. 2000. Bioarchaeological Ethics: A Historical Perspective on the Value of Human Skeletal Remains. In: Katzenberg MA, Saunders SR (eds). *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss. 3-39.

Walker P.L. 2005 Greater Sciatic Notch Morphology: Sex, Age, and Population Differences. *American Journal of Physical Anthropology* 127: 385-391.

Walker P.L. and Cook D.C. 1998. Brief communication: gender and sex: vive la difference. *American Journal of Physical Anthropology* 106: 255-9.

Walker P.L., Johnson J. and Lambert P. 1988. Age and sex biases in the preservation of human skeletal remains. *American Journal of Physical Anthropology* 76: 183-188

Walker R.A. and Lovejoy O.C. 1985. Radiographic changes in the clavicle and proximal femur and their use in the determination in skeletal age at death. *American Journal of Physical Anthropology* 68: 67-78.

Warren M.W., Walsh-Haney H.A. and Freas L.E. (eds.) 2008. *The Forensic Anthropology Laboratory*. Boca Raton Florida: CRC Press.

Washburn S.L. 1948. Sex Differences in the Pubic Bone. *American Journal of Physical Anthropology*. 6: 199-207.

Washburn S.L. 1949. Sex differences in the Pubic Bone of Bantu and Bushman. *American Journal of Physical Anthropology* 7: 425-432.

Webb S. 1987. Reburying Australian skeletons. *Antiquity* 61:292-296

White L. 2011. Giving Up the Dead: The Impact and Effectiveness of the *Human Tissue Act* and the *Guidance for the Care of Human Remains in English Museums*. Thesis submitted for the degree of Doctor of Philosophy, School of Arts and Cultures, Newcastle University, Newcastle upon Tyne, UK. Available at https://theses.ncl.ac.uk/dspace/bitstream/10443/1344/1/White%20%2011.pdf, accessed Feb 12 2014.

White L. 2013. The Impact and Effectiveness of the *Human Tissue Act* 2004 and the *Guidance for the Care of Human Remains in Museums* in England. In: Giesen M (ed.), *Curating Human Remains: Caring for the Dead in the United Kingdom*. Woodbridge UK: The Boydell Press, 43-52.

White T.D. and Folkens P.A. 2000 *Human Osteology*, 2nd Ed. San Diego: Academic Press.

White T.D. and Folkens P.A. 2005 *The Human Bone Manual*. San Diego: Elsevier Academic Press.

Whitley C.B. and Boyer J.L. 2012. Investigation into Radiation Exposure of Pre-Columbian Pueblo People in Northern New Mexico: Results of the Initial Study. *Newsletter of the New Mexico Archaeological Council* (no volume) 2-20.

Wilczak C.A. 1998. Consideration of Sexual Dimorphism, Age, and Asymmetry in Quantitative Measurements of Muscle Insertion Sites. *International Journal of Osteoarchaeology* 8: 311-325.

Wilkie A.O.M. 1997. Craniosynostosis: Genes and Mechanisms. *Human Molecular Genetics* 6: 1647-1656. doi: 10.1093/hmg/6.10.1647

Wolff J. 1869. Uber die Bedeutung der Architektur der spongiosen Substanz. *Zentralblatt fur die medizinische Wissenschaft* VI: 223-234.

Zelditch M.L., Swiderski D.L., Sheets H.D. and Fink W.L. 2004. *Geometric Morphometrics for Biologists: A Primer*. San Diego: Elsevier

Zimmerman L.J. 1981 How the Crow Creek archeologists view the question of reburial. *Early Man* 3: 25-26.

Zimmerman L.J. 1987 Webb on Reburial: A North American Perspective. *Antiquity* 61: 462- 463.

Appendix 1A: The ethics of studying human remains

On November 16 1990, President Bush approved Public Law 101-601, the Native American Graves Protection and Repatriation Act, more familiarly known as NAGPRA. The law directs all federally-funded museums, laboratories and university collections in the United States to inventory their human skeletal collections, determine cultural affiliations, and contact relevant Tribal communities. At the request of a (federally recognised) Tribe, these remains must become available for repatriation, which means to 'return to one's own country' (Websters, Encarta). A year earlier, Public Law 101-185 had been enacted specifically to bring the Smithsonian Institution of Washington DC into similar compliance, and which appropriated funds for the Institute to cover associated costs. However, NAGPRA as it applies to all other facilities in the States is an unfunded mandate. Grants and technical advice may be available, but must be actively sought; compliance is compulsory. In this section, viewpoints of skeletal biologists who regard reburial as a loss to scientific study are compared with those of Native groups who regard excavation as desecrating burials and 'grave robbing' (Webb 1987: 294). NAGPRA is discussed because it represents the success of indigenous Americans in reclaiming culturally vital remains, a process that has been also used to claim indigenous Australian remains.

> "….Common Ground….recently published an article on a new Boy Scout merit badge for archeology. In this example of political correctness run amok, one of the "ethical responsibilities" of Boy Scout counselors under this program is described as follows: The counselor 'avoids all osteological research (in the field and in the lab)'(Skinner *et al.* 1998)."
> From *Human Osteology, 2nd Edition*. (White and Folkens 2000: 327-328)

> "NAGPRA was enacted in 1989 to correct a long-standing injustice. Since the eighteenth century at least, and particularly in the late nineteenth and twentieth, the bones, grave goods, and religious objects of American Indians….have been treated….as objects of curiosity and scientific specimens. They have been dug up, stored, handled, analysed, displayed and discarded with little or no consideration for their sanctity….They have been treated, in a word, with disrespect—for

themselves and for those who ascribe cultural and spiritual value to them."
From *Cultural Resource Laws and Practice: an introductory guide*. (King 1998)

Mortui Viventes Docent : "The Dead Teach The Living"
Motto of the Paleopathology Association of the American Association of Physical Anthropologists

A.1. Colonization of North America; Collecting Indigenous Burials; AIM and Civil Rights Movement.

The history of American Physical Anthropology as a field of study and as a profession is an epic tale of redemption. Along with the heyday of dynamite paleontology and the search for Thunder Lizards, physical anthropology of the 1850s was often a study bent on proving the 'differences' between the so-called races. Pioneers such as Hrdlička, who founded the American Association of Physical Anthropology (AAPA) may or may not have been an ardent believer in the equality of Earth's various populations (Montagu 1943; Brace 1982; LaRoche and Blakey 1997), but his idol Broca firmly believed in the superiority of the so-called White race.

Many nineteenth century researchers such as Samuel Morton, working in America, and Paul Broca of the French School would fill various skulls with various substances and measure (or weigh) the results. These included the water method; the sand method, the mercury, mustard seed, pepper or buckshot method, and the water balloon method which ultimately failed when the balloon burst against the posterior clinoid process (Todd 1923: 100). In 1861 the Paris Anthropological Society held a "long and vigorous discussion" (ibid: 101) on the assumed differences in brain volume and intelligence between the races; this was a direct response to America's recent passage of a law forbidding consanguineous marriage. Indeed, work by Philadelphia-based Morton was used to defend the American practice African chattel slavery (Brace 1982: 18). Todd explicitly linked the off-times ridiculous attempts on the part of Broca to quantify brain capacity to the American preoccupation of the effect of slavery on the "African brain" (Todd 1923: 101). Followers of Broca and the French School remained firm proponents of racially linked differences, influencing both Hooton, who taught Coon, and Coon who in turn continued to teach at Harvard (Brace 1982: 15).

Franz Boas, a more admirable character, measured crania to determine the effect of immigrating to America (Trigger 1987), and yet was not above ransacking indigenous graves, albeit with reservations (Trope and Echo-Hawk 2000). Hrdlička roamed both American continents collecting only skulls (Hrdlička 1914, 1920, 1935); early anthropometry was often referred to as 'craniometry' (Brace 1982). Archaeologists collected pottery sherds and 'arrowheads', assembled them into typologies and traditions, and assumed that Native culture had remained static for the bulk of its duration (Trigger 1989; Deloria 1992; Ferguson 1996). Indeed, physical anthropology has utilised seriation, typology and the 'descriptive' method of analysis from its earliest attempts to place 'Man' and even the different 'races' into a proper chronology (Topinard 1876; Armelagos *et al.* 1982; Brace 1982; Chamberlain 2006). As the Wild West surrendered Native lands to homesteaders, ranchers and farmers, the bones and the possessions of displaced and eliminated Natives became exploitable plunder.

Until quite recently Native American arts, photographs and cultural artifacts such as costumes, canoes, baskets and weapons have been displayed primarily in natural history museums, considered analogous to the dioramas of stuffed extinct mastodon, rather than showcased in fine art museums displaying Greco-Roman and European antiquities (Trigger 1989; Ferguson 1996; King 1998). The skeletal remains of Native Americans, associated funerary objects, and sacred tribal possessions were also collected with abandon for decades, bought and sold, photographed, analysed, and displayed in museums as relics and curiosities of a vanquished past (Rose *et al.* 1996; King 1998; White and Folkens 2000).

Native American groups enjoyed several victories in the 1970s regarding the scope of the control that the United States federal government could wield over their beliefs and their everyday lives. The Indian Self-Determination and Education Act in 1975 restored some civil rights and was followed by the American Indian Religious Freedom Act in 1978 (Rose *et al.* 1996; King 1998). Native cultural and religious practices began to revert to Native control, and there was acknowledgment that some archaeological sites were also ‘ancestral places’ (King 1998). Demands for return of human remains and grave goods started up in earnest in the 1970s (Zimmerman 1981; Rose *et al.* 1996; King 1998) with the most pressing concerns for the return of recent human remains to living tribes and in some cases, to actual descendants.

Eventually this extended to the study and display of any objects or remains that could be associated with contemporary Native groups, or that created a ‘sacred’ connection with anyone of possible Native ancestry. A theme that runs through many writings on NAGPRA and the topic of repatriation can be best summed up with this quote from one of the primary investigators of the Crow Creek site in South Dakota, America: “Many Native America peoples, through a sort of Pan-Indian re-definition of sacredness, now consider all human skeletal material to be sacred…[That] remains are only distantly related to peoples who show concern—or even not related to them at all—makes no difference under the present Native American views of sacredness.” (Zimmerman 1981: 25-26)

Around the same time, in the mid-1980s, this drama began to play out in Australia (Webb 1987; Fforde 2004), with similar arguments raised by that continent’s Aboriginal inhabitants, namely that no amount of tinkering with and poking at skeletal remains would benefit anyone other than the (ghoulish) physical anthropologist doing the ‘research’. Webb recounts the ethical debates and indignation that ensued as Native Australians began to question the value of such detailed analyses of the dead: “A general opinion was that researchers had little regard for Aborigines, either as the living descendants of the population whose remains were being studied or as people….Others said simply, ‘When are you people going to stop studying us?’” (Webb 1987: 294).

One Aborigine view of archaeology in general and physical anthropology in particular is that all such collecting and interpretation is “useless or profane” (Trigger 1989: 144), and Native Australians have viewed archaeologists with deep distrust, ever mindful of the role archaeologists played in labeling the Native groups as primitive, unchanging ‘artifacts’ of early human evolution (Trigger 1989). After the Australian government passed legislation in the 1970s restoring to Native Australians rights of possession over archaeological sites that held cultural importance as well as self-determination over other issues, attention was turned onto the scientific community in much the same way as in America, with greater scrutiny on what was considered research (Trigger 1989; Fforde 2004).

To be fair, the history of white Western contact with the native populations of both Australia and the Americas has been one of devastation. As the sheer quantity of skeletal holdings were truly understood, Native youths became militant and suspicious and their elders deeply saddened that human remains were being subjected to what they perceived as intrusive experiments and investigations. Attaching trust in physical anthropologists onto the historical tapestry of past betrayals and massacres, with theories in direct contrast to Native beliefs was not an easy task. Throughout the 1960s and into the 1970s, it became impossible (Deloria 1968).

Already, the current of civil rights was charging throughout America: less than four months after Martin Luther King Jr. was assassinated in Memphis, the American Indian Movement (AIM) was founded in Minneapolis, Minnesota to unite poverty-stricken Native youths who were floundering in Indian ghettoes (Deloria 1968; Laird 2009: 22; www.aimmovement.org). The catalyst of AIM was to reduce the Native population in Minneapolis jails; the ethos quickly developed into the elimination of what were considered to be the three most destructive forces to Native people: Christianity, white-oriented education and federal government. To Native Americans, the only thing that a white, highly educated physical anthropologist was missing was a bible.

A.2. Retention, Reburial, and Things In-Between

A.2.1 Science and NAGPRA: Retention and Investigation; Who gets to do the research?

In the scientific community anti-NAGPRA sentiment and arguments against it run from exaggerated claims of loss to issues of vital importance. Biological anthropologists maintain that a more complete understanding of our human heritage is key to future survival (White 2005); that increased understanding of prehistoric disease etiology could "alleviate suffering among present-day Native Americans" (Willey 1981: 26 as quoted in White and Folkens 2000: 325); and that far from being racist, predominantly white scientist-led study of non-white remains is no different from white scientists studying white (and black) remains in the Case Western Reserve University medical school series, among others (Buikstra 1981). Stanley Rhine likens the loss of "ancestral voices" as a deliberate choice of "ignorance over knowledge, a choice that flies in the face of what it means to be human." (Rhine 1998: 61); he also laments lost opportunities to learn what it was like to live in another place and time. When asked to defend why I favor curation of ancient remains, I have described repatriation as burning just about the only book I (as a non-molecular biologist) have left to read about one individual's *specific* past, a sentiment perhaps unconsciously echoed, as the phrase is also attributed to K Kennedy of Cornell University in response to the pending repatriation of the Murray Black Collection of Australian fossils (Fforde 2004: 108).

However, Rhine (1998) and Buikstra (1981) notwithstanding, there are many instances when study of the dead is restricted or must be done sparingly with remains quickly reburied. In the case of war dead (remains of soldiers), even pacifist anti-war draftees might be buried in military cemeteries, against the family's wishes; battleground and war grave disturbance are very contentious issues (Brown 2007; Alberti *et al.* 2009). The Hamann-Todd osteological collection curated by the Cleveland Museum of Natural History is indeed studied openly, but the remains are primarily from indigent people who were unclaimed or whose families could not afford to take care of burial (Meindl *et al*. 1990); on the other hand, reburial is obliged when Christian burials are disturbed in churchyards currently in use (Church of England & English Heritage 2005). Indeed, due to the increased cultural sensitivity that came about during the American Civil Rights era (1960s-1970s) and the development of “Identity Politics”, when “only Blacks could speak for Blacks, only women could speak on women’s issues” (Cook-Lynn 1996: 59), communities have become increasingly vocal about the rights of descendants and ethical treatment of disturbed dead. One outspoken critic of American archaeology in general and physical anthropologists in particular has been Michael Blakey of Howard University, a traditionally black university. Blakey became involved early on in the excavation process when the African Burial Ground in New York City was being archaeologically investigated, with Howard University eventually taking over analysis of the remains and artefacts (LaRoche and Blakey 1997). Blakey argues that American archaeologists, being as they are predominately white, are thus inherently racist as they alone reconstruct the past of us all (Blakey 1997: 142). Thankfully Blakey sees hope ahead, as archaeology seeks to be more inclusive and to accede power to the communities (descendants) of those studied, specifically in the African Burial Ground in NYC. Blakey further links this success specifically to NAGPRA (Blakey 1997).

To return focus to the dispute between retention and reburial in the USA, the various arguments in favour of retention and restudy can be examined. Some arguments have more merit than others, as it is difficult to imagine, say, treponemal disease running rampant among Native children, unimpeded without the aid of physical anthropology. A more cogent case can be made for comparing ancient and modern victims of radon exposure in the Southwest, which can present as multiple myeloma, a rare disease predominately associated with older males (Waldron 2009: 183-184). A recent study of pre-Columbian remains of four individuals from New Mexico, USA suggests that multiple myeloma developed with unusual frequency and at younger ages than expected. The four individuals, two males and two females, were estimated to be under age 50 at time of death, with one female possibly age 20-29, and one male 30-39 (Whitely and Boyer 2012). The authors conjecture that the modern health concern of high radon exposure may have been a problem to inhabitants in pueblo communities, and make a compelling case to monitor exposure in present day inhabitants (Whitely and Boyer 2012: 9). Finally, by identifying cancers associated with radiation exposure in individuals who lived up to 1500 years ago, the research serves as a very long-term epidemiological study by which population risk factors due to radon exposure can be assessed (ibid: 10).

Some of the most compelling 'arguments' in support of continued study of skeletons from among these sources are ones that describe the accurate determinations of ancestry of murder victims, due to familiarity with Native American skeletal remains as well as those from other populations. Rhine tells the story of a physician who, on a family picnic, discovered human skeletal remains on the Navajo Reservation in New Mexico. As the remains were on a Native American reservation, the physician leapt to what he felt was an obvious conclusion and declared them Native, and female; however, they were white and male (Rhine 1998). Douglas Ubelaker positively identified Native American murder victims using access to comparative collections (Ubelaker 1990 as cited in White and Folkens 2000). These benefits are more immediate, and poignant, than any potential gains of knowledge for the future and directly impact contemporary human life.

Beyond identifying actual individuals who have come to bad ends, forensic osteology depends on comprehensive knowledge and deep familiarity with the suite of typical differences among and between populations. Of the four main critical aspects required for positive identification – age, sex, stature, ancestry – the most important and difficult to determine is that of one's 'ethnic' background (Byers 2002, Scheuer 2002). Isçan (1988) feels that the identification process actually depends on just one aspect, ancestry or 'group biology' and that determining the specific individual can only follow once that is established. Without assessing remains in reference to a specific population, stature, age, and sex tables cannot be applied (Isçan 1988).

It also must not be assumed that previous work supplies the final word on age and sex estimations and paleoepidemiological analyses. Fifty years after Hooton's seminal work analysing the Pecos Pueblo remains (Beck 2006), Ruff reassessed the assemblage for age and sex (Chamberlain 2006: 91). Whereas Hooton reported males accounted for 60.4% of the sample (those that could be assigned a sex), Ruff found that 50.5% of the remains were male (ibid). This argues for retention and periodic reassessment of remains, as techniques improve and data from comparable collections expands.

A.3 Social Concerns within Indigenous Communities

Perhaps a persuasive argument for the continued study of Native remains could be made by the forensic anthropology community. Since human variability in any population will confound traditional 'markers' of ethnic characteristics, additional information on features and traits that tend to be inherent in populations can only aid in identifying specific individuals. In July 1999, when the author was participating in a field school in the Badlands of South Dakota, the big local story was that a few weeks earlier, two Native youths had been found dead on the Pine Ridge Reservation quite near the white town of White Clay, with their deaths declared 'accidental' – despite their hands allegedly having been tied behind their backs. The Pine Ridge Reservation community remained correctly insistent on adequate investigation leading to due legal process. If the remains had been skeletonised, in order for an anthropologist to presume they were likely of Native American origin, s/he would need to rely on comparative collections, the current literature (continuously improving: see Chamberlain 2006: 91), and past experience: all of which are based on examination of Native American remains.

But the July 1999 Pine Ridge uproar and current news more accurately illustrate the continued antagonistic relationship between Native Americans and Whites than serve as a call for comparative skeletal collections. A recent Pine Ridge newspaper article states that, in an FBI publication from 2000, called "Accounting for Native

American Deaths – Pine Ridge Reservation – South Dakota", the most common response was "No investigation." (Kent 2012). The FBI report had been created as a response to continued community resentment regarding uninvestigated Native deaths occurring around the time of the Wounded Knee rebellion of 1973, including stabbings, shootings, and fatal beatings, most of which were nonetheless "accounted for" with the phrase "No investigation" (ibid). The 39 uninvestigated cases will now be reexamined by US Attorney Brendan Johnson. As for the 1999 deaths of two Lakota youths, the facts were more compelling than the rumors: the men had been beaten to death, a deputy sheriff was a suspect, and this was a lead the FBI declined to pursue. The men had been two more in a series of deaths related to alcohol sales and animosity between Whites and Natives that stretched back to the original Wounded Knee massacre: which had been only slightly more than a hundred years earlier, after all.

As Howells wrote in 1983, "Multivariate analysis makes possible finer distinctions of all sorts…including sex and population assignment, allowing such placement objectively when *adequate samples of identified populations are available* to form the multivariate context." (Howells 1983: 311, emphasis added). In other words, practical experience with a range of variation is essential in order to ascertain the probable source population of a skeletonised individual. It can be argued that, with no further study of indigenous American remains, the ability to identify exactly such remains can become compromised.

Another novel approach may be to focus on how ancestors would be directly helping their descendants in legal and health matters, by allowing their sacred remains to aid in the search for truth. One example could be the apparently high frequency of multiple myeloma among prehistoric inhabitants of New Mexico, potentially due to radon exposure, and what this may signify for modern residents (Whitley and Boyer 2012). In this manner, and coupled with consecrated storage of remains on reservation land, Native peoples would not just retain control of the remains but could be shown how the group would benefit directly from continued study. The motto of the Paleopathology section of the American Association of

Physical Anthropologists is quoted at the start of this chapter: 'The Dead Teach the Living'.

A.4 Collections and NAGPRA: Difficulties with Compliance

The reality of NAGPRA and how it impacts federally funded museums and collections is that of a mandated tax on time and energy. Aside from a few archaeologists who cheerfully view the study of human remains as less than necessary, or even "appalling" (Zimmerman 1987), most physical anthropologists, especially at the University level, find themselves struggling to comply with the documentation and reporting processes of the law (Rose *et al.* 1996). NAGPRA requires that all museums and Federal agencies must create inventories of cultural items (human remains, funerary objects, sacred objects, or "objects of cultural patrimony") (from US Dept of Interior website 2006) in their control or possession. The original legislation called for all existing collections to report their inventories by 1995, and it further provides for museums, universities and other Federally-funded bodies to continue to report inventories if additional cultural objects are discovered in the collections or are obtained at some future time. Once inventories are created, the museums and other Federal agencies must consult with Native American, Native Alaskan and/or Native Hawaiian groups that have been identified as being affiliated with the objects, and must also send notice stating the objects may be repatriated.

This law is a virtually unfunded and yet mandated requirement. While grants are available to assist in both the consultation and documentation process, and any eventual repatriation process, the former are awarded on a competitive basis once per fiscal year and the latter must be applied for before repatriation expenses are incurred and at least 6 weeks in advance of any repatriation. For institutions that are overwhelmed by the prospect of cataloging all the cultural objects they curate, NAGPRA also "provides technical assistance to museums and Federal agencies that need to prepare summaries and inventories for the first time" (National

NAGPRA weblink). In practice, that requires the facility contact the National NAGPRA Program of National Park Service in Washington DC. In reality, universities and museums scramble for the resources to comply with NAGPRA and to provide catalogs of remains, many of which have poor provenience, poor documentations, or destroyed/lost documentation.

When NAGPRA was first enacted, 107 proposals from Native groups were filed for funding, and another 113 grant requests came from museums and universities, for a total of $23 million in potential grants; only $2.14 million for 41 grants was actually awarded. In general, funding accounts for approximately 10% of the perceived need at the museum and University level, forcing the schools to re-direct funding away from other projects or to simply manage somehow on their own (Rose *et al.* 2006).

The typical university cannot compel students to gather information in midst of their own research projects; professors cannot find time to comply while teaching classes, especially with tenure dependent on one creating large bibliographies of publications, attending department responsibilities, and teaching class. A quick perusal of several university websites and their requirements for tenure reveal the typical tenure portfolio to consist of a list of teaching awards, teaching evaluations from students, research and scholarship information (Indiana University). North Carolina State University cites its “Reappointment, Promotion and Tenure Dossier Requirements” need contain “….six realms of responsibilities, i.e., Teaching and Mentoring of Undergraduate and Graduate Students, Discovery of Knowledge through Discipline-Guided Inquiry, Creative Artistry and Literature, Technological and Managerial Innovation, Extension and Engagement with Constituencies Outside the University, and Service in Professional Societies and Within the University Itself….” (NCSU Policies, Regulations and Rules link). And the University of Minnesota requires the portfolio to have all of the above as well as “a minimum of eight external evaluations”. (University of Minnesota website updated 2005).

The "research and scholarship" section of the University of Minnesota's tenure portfolio is more than likely typical of many universities, and requires: a narrative summary of research and "scholarly activity"; a list of peer-reviewed and non-peer-reviewed publications; list of books and book chapters; list of professional presentations and abstracts; list of grants and contract support; the list of persons trained/mentored/advised may be included in this section or under the Teaching section. While an exhaustive list to compile, it is not an unusual requirement for tenure.

This side-track in the present NAGPRA discussion begs the question: When would an up and coming professor squeeze repatriation responsibilities into such a schedule? And a follow-up question: When would an established professor, juggling department obligations, professional meetings, publishing deadlines and a slate of students find the time for repatriation activities? To the teaching professional whose duties include minding the Native American remains, NAGPRA may represent a loss of valuable time and an incalculable loss of unique resources.

A.5 Collections and NAGPRA: Benefits to Compliance; and 'Shared Ownership'

It is specifically due to familiarity with Native American remains that museum collections can be assessed for potential repatriations. Biological characteristics are considered crucial for determining affiliation with any particular tribe, and this is acknowledged in NAGPRA (Ousley *et al.* 2005). The Smithsonian Institute, the recipient of its own version of NAGPRA a year before the national law was enacted, has turned the task into a long-term teaching opportunity for early researchers, and have formulated their own set of standard data capture points (Ousely, personal communication May 2001, September 2007).

Not all researchers feel that NAGPRA has been completely disastrous, and some have welcomed the necessary attention now lavished on once-forgotten bones; the very requirements of NAGPRA that threaten the collections have also been responsible for these remains to be studied in detail (Hollinger 2005). The extremely detailed nature of the Buikstra and Ubelaker (1994) pathology assessments attest to what sort of demographic information is at risk, but reburial is only a more conspicuous loss, accomplished more quickly than the benign neglect that some collections had suffered while awaiting the perfect research project.

For example, due to the lack of interest in the human remains in their collection, the Denver Museum of Nature and Science (DMNS) decided to "proactively address" what staff members foresee as the eventual issues with *unaffiliated* remains (Colwell-Chanthaphonh 2010: 4). The 67 human skeletons curated by the DMNS had arrived via "tragic and discomforting circumstances –burial disturbed out of idle curiosity", phrasing which does suggest the author's sympathies; and yet, if the remains have indeed "sat forgotten – unvisited, untouched, unstudied – for decades" (ibid), the case can be made that here, NAGPRA requirements would at the very least compel someone to analyse the collection for basic demographics.

Positive working relationships have developed between Native groups, and the archaeologists and anthropologists who either remove ancestral remains or examine them. In the American West, the Hopi Nation works with archaeologists when burial places are threatened by construction and osteologists are given time to remove, examine, photograph and metrically record remains before they are given a reburial nearby (Dongoske 2000).

The Zuni Tribe has a similar policy on the handling of human remains, and prefers they be removed from construction zones by professional archaeologists, examined non-destructively in the field, and reburied as nearby as possible. The Zunis are more insistent on the repatriation of carved wooden War Gods removed from shrines than of remains desecrated by removal and curation in museums; the Zunis ask only that previously-obtained remains be treated respectfully, stored correctly, and for the bones to not be subjected to pseudo science, but actual research (Ferguson *et al.* 2000).

In Miami Florida, the prehistoric Tequesta are the presumed population found beneath a downtown parking lot, and the Seminoles and Miccasukees have absolutely no intention in seeing, handling, or dealing with these possibly 2000 year old remains other than to reclaim them, preferably boxed, within two years of the site being closed. The Miami-based commercial archaeological firm that excavated the remains were permitted to carry out basic analyses, including taking measurements and photographs, and to study the remains for demographic information. No destructive analyses have been permitted, but archaeologists, anthropologists and now university students continue to work with the bones. The author has direct knowledge as she was the on-site physical anthropologist for about a year. Currently, more than eight years after being exhumed, the remains are still being studied (e.g, Echazabal 2010).

As of now, only federally recognised Tribes can petition for the return of human remains (Colwell-Chanthaphonh 2010); and some Tribes, such as the so-called Tequesta have completely disappeared. No one will come to reclaim their ancestors: no one remains. This loophole may eventually disappear however, as the holdings of unaffiliated remains vastly outnumbers the culturally identified ones. Under one version of proposed legislation (which has undergone several bouts of public commentary), anyone, anywhere would be permitted to petition for the release and reburial of such unaffiliated skeletons. In such a scenario, one would hope that the remains would be examined.

The risk for other countries, not yet bound by similar legislation lays in waiting for a NAGPRA-type edict to require actual analyses of remains. Under the auspice of pending legislation, understaffed and underfunded institutions will be forced to make do, and examinations may be hasty, or not well-planned. One benefit of even a cursory examination using this suggested protocol is that a preliminary database will be created, giving the workers who follow a starting point to begin asking questions.

A.6 NAGPRA: Future Compliance, Current Costs

The Department of the Interior released the Future Applicability Proposed Rule 43 CFR 10.13 in October 2004. The proposed rule related to the section of NAGPRA that regulates the future compliance of museums and Federal agencies with the law, and specifically addressed the unfunded aspects of NAGPRA and any strain or hardship that compliance would potentially cause such facilities. The rule further invited comments from Tribal Nations, museums and Federal agencies, and the public was to be submitted to the NPS before January 18 2005. Ten years on, current policy (January 2014) is not clear.

NAGPRA originally called for documentation of existing collections to be completed by 1995 with notice of the cultural objects sent to existing Federally-recognised tribes; the question of future compliance was not addressed to the satisfaction of all. Rule 43 CFR 10.13 describes four situations in which an institution might find itself falling, in the future, under NAGPRA regulations: 1. The facility receives new collections; 2. A previously unrecognised Native group receives Federal recognition; 3. An institution in possession of cultural objects receives Federal funding for the first time; or 4. An institution revises an earlier NAGPRA publication.

As of this writing, the extent of public and institution opinion offered to the NPS is not known, nor the date of Final Publication of the rule. Compellingly, the Rule states:

> “Unfunded Mandates Reform Act
>
> “This rule does not impose an unfunded mandate on State, local, or tribal governments or the private sector of more than $100 million per year. The rule does not have a significant or unique effect on State, local

> or tribal governments, or the private sector. A statement containing the information required by the Unfunded Mandates Reform Act (2 U.S.C. 1531 et seq.) is not required.
>
> “Takings (Executive Order 12630)
>
> “In accordance with Executive Order 12630, the rule does not have significant takings implications. A takings implication assessment is not required. Museums are only required to repatriate human remains, funerary objects, sacred objects, or objects of cultural patrimony *for which they cannot prove right of possession* [25 U.S.C. 3005(c)].” (Future Applicability Proposed Rule 43 CFR 10.13 2004)(emphasis added: refer to commentary).

As of March 2010, the number of human remains that had been published in the Federal Register as being of a determined cultural affiliation and therefore ‘eligible’ for repatriation was approximately 32,000 individuals (Colwell-Chanthaphonh 2010: 4). Remains unaffiliated with a Federally-recognised tribe are reported to number over 116,000 (ibid).

A.7 Commentary

Universities have difficulty with NAGPRA compliance. Despite long lists of grants, offers of technical support, and the assertion of the Department of the Interior that such compliance does not represent hardship or economic strain, the requirements of documenting remains and other cultural objects is expensive in time and energy, and falls mainly on the shoulders of a collection’s chief curator.

An interesting difference between semantics and perhaps even the ethos of United States and Britain emerges in an examination of the “Takings” implications addressed in the NAGPRA corollary Rule 43 CFR 10.13, and has been emphasized for this discussion. In the Takings section, it is stated that museums are only obligated to offer repatriation for items “for which they cannot prove right of possession” (Future Applicability Proposed Rule 43 CFR 10.13 2004). In Britain, remains are not considered as ‘belonging’ to the museum in which they may be housed, as human remains and indeed living humans cannot be ‘possessions’ of any state, entity, or other person. In the United States, with its still-painful history of African chattel slavery, and ongoing debate as to who really ‘owns’ Puerto Rico, this sentiment is hardly one that a museum will embrace. This may be a nifty trick of the Rule’s authors or an antebellum allusion to another time, but it cannot be possible to claim any manner of ‘ownership’ of human remains to the satisfaction of all concerned.

Funding for the Arts, museums and anthropology programs is continually slashed in this new era of economic crises, budget deficits and expensive wars on ‘terror’. Collections that arrived in university and museum inventories 100 years ago are rarely documented beyond an accession number. While physical anthropologists did indeed spend the better part of the last 150 years measuring cranial capacity and making dubious statements about intelligence, the science has moved on.

Modern techniques provide opportunities to explore issues of disease, economies, status and migration that are novel, and advances in these techniques and the discoveries of new ones are continuing. For example, modern exposure to radon in the American Southwest can be compared to pre-Columbian remains with evidence of unusually high frequency of multiple myeloma; one would have presumed that the lack of hermitically sealed housing in the past would have offered adequate ventilation, but it seems not to have; these are important issues to consider (Whitley and Boyer 2012). To use an example of modern British remains being studied with a fairly high degree of confidence this is done without consent (discussed in Appendix 1.B), the case of Charles Byrne is instructive. Byrne, who suffered from acromegaly and died in the late 18^{th} century, has been studied since 1909 (Keith 1911) and has recently provided novel information on a DNA mutation related to the pituitary gland (Chahal *et al.* 2011). This information will help members of four families who share a common ancestor with Byrne; 14 individuals among these families also have suffered from pituitary disorders (ibid: 49).

It is vital to acknowledge the errors of the past. The best way to atone for them is to ensure present and future members of Native American, Native Alaskan and Native Hawaiian Nations gain the opportunities for education and economic success that other Americans, in theory, enjoy. The recognition of past sins need not include the loss of future knowledge, if gained respectfully, if it has peer-reviewed merit and if it offers the possibility of true scientific advancement. It is vital to keep discussions open and for both sides of the repatriation issue to listen with as open a mind as possible. One-sided inflammatory arguments, supplemented by tales of arrogance and violence and topped by triumphant stories of success over The Man only incite anger; over-the-top claims of saving the future by citing past diseases also does not help.

Fforde (2004), Trigger (1989) and Webb (1987) discuss the Australian Aborigine concept of creating “Keeping Places” for each community, where the remains of ancestors would be available for study, with the community’s input and involvement in the research and with the community having control over access. White and Folkens (2000) suggest all parties should work to diffuse animosities and direct the energies of the scientific community and Native groups to protect the loss of sites to looters and rampant overdevelopment, as does King (1998). Most authors maintain that the best way to alleviate the suspicions of Native groups is to engage in frequent, ongoing dialogue (Webb 1987; Zimmerman 1987; King 1998;White and Folkens 2000). An insightful comment states, “These issues will only be diffused through public education and through the long-overdue graduate-level education of Native Americans and Aboriginal Australians in physical anthropology.” (White and Folkens 2005: 28).

Appendix 1B: Human Remains in Britain

The aftermath of NAGPRA has led to the repatriations that the 1991 American Association of Physical Anthropologists committee originally feared, with thousands of remains returned to descendants. But at the same time, the legislation has provided a boost for the study of collections (Ousley *et al.* 2005). Thousands of remains that became subject to NAGPRA required analysis to provide tribes with accurate numbers of individuals or to even ascertain tribal affiliations, which meant that, for some collections, the NAGPRA assessments were the first proper analyses given to the remains (Hollinger 2005).

The assessments relied, of course, on previous detailed knowledge of these same tribes. But with NAGPRA in place, tribal rights to their own past and their own ancestors legally asserted, the time had come for anthropologists to make use of the collections, and to amass whatever information they could.

The zeal to return remains seems greater in the UK, certainly for the return of Australian remains. As early as 1991, the University of Edinburgh returned osteological specimens to Aboriginal elders (albeit after much delay) (Turnbull 1997). The 1972 Victorian Archaeological and Aboriginal Relics Preservation Act was utilised in 1984 to prevent fossilized remains from traveling from Australia to an American conference (Fforde 2004). In July 2000, the Prime Ministers of both the UK and Australia released a joint statement of commitment to increase efforts to locate and return Australian Aboriginal remains.

The views of Fforde are very apparent, as she consistently refers to such actions as "appropriate" (Fforde 2004: 137); derides criticism that a Working Group examining the repatriation issue contained no physical anthropologists, characterizing it as having a "diverse membership" (ibid: 138); repeatedly cites glowing accounts of successful repatriations: "recognises our common humanity" (ibid: 139), "the culmination of a very fruitful and positive dialogue…" (ibid: 139). The passages that support her thesis, that repatriation of Australian remains is proper, are offset and thus highlighted and referred to as "new, positive attitude[s]". (Fforde 2004: 115).

Writers detailing the repatriation issue need to state facts evenly as possible, and can certainly share their opinions; but to provide testimony and proper background information for only one side of the argument does not appear to be a discussion of the problem, but rather a polemic. Proselyting is acceptable, but doing so under the guise of information creates misunderstandings and perpetuates a lack of communication.

Fforde does not present scientific counter-arguments in directly quoted, offset passages, but rather writes of the media giving out "incorrect news" (2004: 137) and of the press "fanning the flames of controversy" (ibid: 108) by even *reporting the views* of scientists. Anything that is less than laudatory about repatriation is paraphrased and only partially put in quotes, but entire passages on repatriation are devoted to positive phrases. This can be off-putting for even an open minded anthropologist who might otherwise miss passages that, whilst perhaps not so great for science, do celebrate indigenous rights. In recounting the controversial return of the 9000-15,000 year old Kow Swamp fossils, Fforde writes that "..Aboriginal concerns were beginning to be placed before those of archaeologists.." and continues the section with "…campaigns for the return of the Murray Black Collection and the Kow Swamp fossils continued the trend towards the recognition that Aboriginal people had pre-eminent rights to determine the future of all Aboriginal human remains." (ibid: 105). Fforde completes this introduction to a chapter on fossils with this potentially positive development:

> "By the late 1980s, the unconditional return of ancient remains to one community in New South Wales, and their decision to place these remains in a 'Keeping Place', illustrated that even for the most contentious remains, a compromise between archaeologists and indigenous groups was possible." (Fforde 2004: 105).

Important remains, through compromise that were not 'lost' to reburial include those of Mungo Woman, believed to be the oldest cremation ever discovered (Fforde 2004: 114-115). To Fforde, this apparent victory for "archaeologists" (whom she routinely confuses with physical anthropologists) compensates for the loss of Kow Swamp, which she does admit were the largest collection of (uncremated) Pleistocene remains from a single site in the world. (ibid: 112).

Starting in the late 1990s work began in the UK to legally consider the long term storage of Australian, Tasmanian and other indigenous remains which led to the formation, in March 2001, of The Working Group on Human Remains (Fforde 2004). The Working Group seems to have been sympathetic to the concerns of Aboriginal rights, which is understandable; but devoid of concern for scientists, which is less understandable. Overstating the case helps no one, and serves to deepen antagonistic views and outrage. In the same vein as anthropologists claiming that unfettered study of ancient native Americans is worthwhile if it could save "just one [Native] child's life" (Willey 1981: 26 quoted in White and Folkens 2000: 325), the statements of the Working Group can be viewed with as much skepticism and suspicion as Willey's over-the-top extortions. The Group applauded the new 'collaborations' between indigenous populations and UK museums, despite that these collaborations inevitably ended in the return of remains (Fforde 2004: 142-143.).

One motivating factor for recent governmental interest in ethical concerns of remains was a scandal involving retained children's organs by a researcher at Alder Hey Hospital, Liverpool, a prolonged act of disregard and incompetence that violated aspects of the Human Tissue Act 1961 and was in large part directly responsible for the Human Tissue Act 2004. The entire affair is examined in The Royal Liverpool Children's Inquiry Report, prepared at the behest of the House of Commons (Redfern *et al.* 2001). It makes for disturbing reading. Two other contemporaneous scandals, Bristol Royal Infirmary and the Isaacs Report, added to the atmosphere of distrust. In 2003, when the eventual HTA 2004 was still the Human Tissue Bill, the Working Group made recommendations about repatriation of skeletons; Clause 49 included language regarding "informed consent" being necessary for the retention of any bodies or body parts (Fforde 2004) and recommended that the Human Rights Act 1998 be applied to repatriation disputes (ibid).

But aligning the return of Aboriginal remains or even fossils with the callous disregard of the parents in the Alder Hey mess is disingenuous. It is notable that the abuse of the grieving Alder Hey parents did not meet the requirements to be considered a breach of the HRA 1998, despite that, in some cases, parents received stored organs from children who had been dead for decades, and that others endured second or even further burials as retained organs arrived piecemeal (Redfern *et al.* 2001). Not all parents were reduced to grief from the stored organs. Some felt anger and dismay. For these parents, the worst part was not that their children were buried "incomplete" but more a question of the waste of it all, as the organs had been harvested and stored, but never analysed; had been shelved without documentation; had been removed and then left to decay uselessly (Redfern *et al.* 2001).

A more measured edited volume is Mihesuah's Repatriation Reader (2000). The book brings together papers by Vine Deloria Jr, Clement W Meighan, Patricia Landau and D Gentry Steele, Robert Mallouf and others. The arguments run the gamut from "..opposition to scientific grave looting.."(Riding In 2000), to describing NAGPRA as "..important human rights legislation" that promotes "basic values"(Trope and Echo-Hawk 2000, 123-125), to arguing, "In examining our heritage…..[we] seek to understand the biological history and origins of all humans….Each society's biological history is an integral part…of all humankind." (Landau and Steele, 1996, 2000). No one side is according more importance or carries more weight. Even the often volatile Zimmerman (2000) is included, as is the always firm, often ironic and yet calm voice of Deloria (2000). For an honest look at the issue of repatriation and who might 'own' what, this is a highly recommended book.

Many anthropologists struggle to see both sides of this issue (Webb 1987), and virtually all, this author included, treat remains with respect; one can feel profound sympathy and even affection for the individual who has left behind proof of her stubborn struggle as silent testament to the will to persevere despite illness, catastrophe, disability (Drew 2006).

There is evidence, based on diaries, that some Aboriginal 'remains' were obtained from those still living, as consequence of murder (Fforde 2004: 54), which would of course be unconscionable. In the case of native American skulls obtained from execution grounds or even reportedly from a man who had died "while trying to escape" (Juzda 2009: 162), one can wonder where the line was drawn between 'collecting' and 'obtaining'; but Fforde's work is unabashedly anti-retention; and the US Civil War-era surgeon who sent on a skull from a failed escapee, clearly states that he acted in secrecy, as if from reluctance (Juzda 2009: 162).

The conquest of Australia and Tasmania in the late Eighteenth century began just as anatomists such as John Hunter were becoming notorious for grave-robbing (Moore 2005), and as middle-class and aristocratic men of leisure pursued natural history studies, collected oddities from faraway lands, and presented at scientific societies (Turnbull 1997) (eg Blumenbach, Broca, Morton, Darwin). Indeed, Turnbull cites examples that do give one pause, such as medical practitioners in Australia seizing bodies of patients before (or after) funerals; colonials learning of customs and burial sites and then procuring remains for museums; and the case of AP Goodwin, taxidermist, nature photographer and museum specimen supplier, who reportedly befriended an Aboriginal man dying of tuberculosis, took his portrait during life (for comparative purposes), exhumed him and prepared the skeleton, then in 1891 sold it to the Peabody Museum (Turnbull 1997).

There is certainly agreement that graves were desecrated, belief systems were disregarded, and that museums have often been reluctant to return these remains (Trigger 1989; Turnbull 1997; Fforde 2004: 43-59; UCL Human Remains Working Group 2007). However, the forfeiture of fossils, such as Kow Swamp and the Murray Black Collection (Webb 1987; Fforde 2004) are indisputable losses for science. One might wonder what interesting aspects of human origin and human migration are now unavailable; and what compelling descriptions of Aboriginal lifeways could be shrouded in secrecy due to the repatriation of less ancient and yet prehistoric remains.

Looking forward, positive relationships can be created between researchers and Aboriginals (Webb 1987, Bates 1989, Turnbull 1997). A balance can be achieved between the needs of Aboriginal communities to maintain control over, and respect for their ancestors, and scientists to study the remains:

> "If we build up trust in each other and understand each other better, then the study of Aboriginal remains in Australia need not be stopped, and the Aboriginal people will still be able to control their heritage." (Koori prehistorian Badger Bates in 1989, as quoted by Turnbull 1997).

A more recent case in the UK centered around a fresh call to bury Charles Byrne, an 18th century man with acromegaly known as the 'Irish Giant' and whose remains were coveted and then obtained by John Hunter, and are now displayed in the Hunterian Museum in London (Doyal and Muinzer 2011; Smith *et al* 2012). Doyal and Muinzer (2011) openly acknowledged recent genetic research using Byrne's teeth and its direct and positive impact on living people. Nevertheless, they formally approached the Royal College of Surgeons and the curators of the Hunterian Museum, making their request based on what they considered to be clear statements of Byrne's wishes before he died, specifically for his body to not fall into the hands of anatomist John Hunter and to be given burial at sea (Moore 2005; Doyal and Muinzer 2011). Whilst the contemporary fear in the early modern period of being barred from Heaven if not buried whole was commonplace, and although Hunter openly bribed Byrne's friends to obtain the body, absolute proof that Byrne desired burial at sea is based on hearsay.

Doyal and Muinzer's (2011) request was argued against forcefully by the physical anthropology community (Smith *et al* 2012), and in the end, their request was denied by the Hunterian. What is not in dispute is that, using DNA from Byrne's teeth, DNA mutations were identified, permitting modern people to obtain early treatment for life-shortening disorders such as acromegaly, gigantism and prolactinoma, and thus avoid complications (Chahal *et al* 2011; Smith *et al* 2012). Indeed, discovering this unique genetic mutation has proved so important for four Northern Irish families sharing common ancestry with Byrne, that the researchers term Byrne the "index patient" with this haplotype (Chahal *et al* 2011: 48).

Deeply felt opinions on the study of human remains are not easily changed (Alberti *et al* 2009). In 2001, an article exploring the ethics of presumed consent from the ancient dead, using King Tut as the prime example, perpetuated the fiction that Byrne's skeleton offered "no present countervailing scientific or other gain to achieve by not following the wishes of Charles Byrne" (Holm 2001: 446). With less of an agenda and with a quick glance at the literature, Holm may have discovered that Byrne's enlarged pituitary fossa was observed by Harvey Cushing in 1909 (Keith 1911), and that interest in his case had never ceased (Bergland 1965; Landolt and Zachmann 1980), culminating in the discovery of the genetic mutations (Chahal *et al* 2011; Doyal and Muinzer 2011; Smith *et al*. 2012). The DNA study is clear evidence that museum collections continue to provide useful new information; it is fortunate that Byrne's skeleton had not been disposed of during the previous 200 years and that it survived bombings during the Blitz, when large numbers of Hunter's collection were indeed lost (Moore 2005). One cannot know what new techniques will be available in two centuries, two decades, or even two years.

Appendix 1C: Anthropometry in the past

This section will address the focus of anthropology in the 18th and 19th century. Each 'school' of thought will be examined and placed into historical perspective. These include the French School, led by Broca and his followers Topinard, Hrdlička and Hooton; the German School, which led the way to standardisation of cranial measurements with meetings such as the 1882 Frankfurt conference (Howells 1938: 187), and the emergence of physical anthropology in the Americas, the latter of which fed back into work in 19th century France and Britain.

While many early workers embraced notions of racial superiority and of different 'types' and 'races' of modern humans (including a 'sub type' of American known as the "Old American" complete with defined head shape and pigmentation; see Hrdlička 1925: 2), other workers recognised that the human species, though present in slightly differing forms was essentially a single population. To that end, the study of 'man' encompassed all men and indeed all women, regardless of continent of origin.

C.1 Earliest Work

Johann F Blumenbach (1752-1840) developed an early appreciation of the history of the natural sciences and antiquarian studies; in school he received instruction in archaeology and natural history as well as medical training (Marx 1865: 4, in Bendyshe 1865). The first edition of one of Blumenbach's great works, "On the Natural Variety of Mankind" was written as his doctoral dissertation in 1775 (Marx 1865:8, in Bendyshe 1865). Blumenbach, who held a monogenistic view (that all humans shared a common origin) was among the first scientists to suggest organising human types into races using the skull, and not just the skin colour (Bendyshe 1865: x-xi).

Bendyshe (1865) includes both the first and third edition of "On the Natural Variety of Mankind" in a single volume, which also contains two biographies of Blumenbach. In the 1775 edition (Bendyshe 1865: 64-143), Blumenbach clearly dismisses skin colour as a method of separating humans into racial groups, recognising the influence of climate, geography, heritage and even socio-economic status:

> "It is an old observation of… Pliny that the northern nations are white, [which] is clearly shown by other animals…wolves, dogs, hares…All of us are born nearly red, and at last in progress of time the skin of the Ethiopian infants turn to black, ours to white, whereas in the American the primitive colour remains….Notice the well-known difference which occurs in the inhabitants of …the same country,…according to the kind of life they lead. The face of the working man or artisan, exposed to the force of the sun and the weather, differs as much from the cheeks of the delicate female as the man himself does from the dark American and he again from the Ethiopian." (Blumenbach 1775, from Bendyshe 1865: 107-108).

Although preferring skull shape to skin colour, he was clear about the pitfalls of such groupings.

> "Now the skull of the infant is wet and soft clay, and fit to be moulded into many forms before it is perfectly solidified….To begin with Germany itself, Vesalius says that its inhabitants are remarkable for having the occiput compressed and the head wide; and gives as a reason that infants in their cradles generally sleep on their backs…" (ibid: 114-115).

In the final analysis, whilst recognising that skull shaping was undertaken by a wide variety of societies, Blumenbach decides,

> "But since for a considerable period of time singular shapes of the head have belonged to particular nations, and peculiar skulls have been shaped out, in some of them certainly by artificial means, it will be our business to look at these things a little more carefully, and to consider how far they constitute different varieties of the human race." (ibid: 114).

How Blumenbach himself felt about the fixed nature of racial hierarchy is readily apparent from his own writings, and thus was interpreted according to the biographer. Bendyshe seems certain Blumenbach viewed caucasians as superior (Bendyshe 1865: x); and yet biographer Marx cites a 1781 magazine article written by Blumenbach entitled "On the capacities and manners of the savages", stating,

> "At the time when the negroes and the savages [presumably Native Americans] were still considered as half animals, and no one had yet conceived the idea of the emancipation of the slaves, Blumenbach raised his voice, and showed that their psychical qualities were not inferior to those of the European, that even amongst the latter themselves the greatest possible differences existed…." (Marx 1865: 9, in Bendyshe 1865).

If Blumenbach's skull studies were later used to place human groups into hierarchies, and to justify claims that some populations were inferior to others, it seems a perversion of Blumenbach's aims.

C.2 French, British and American Schools and Colonialism

After Blumenbach, physical anthropology for much of the next 100 years concerned itself with standardising measurements, and with categorizing human variation along the concept of 'race' (Brace 1982: 12). Monogenism was giving way to polygenism, the view that humans are descended from multiples lineages (Juzda 2009: 158). In France, Paul Broca (1824-1880) founded the Societe d'Anthropologie de Paris in 1859 (Spencer 1982: 5) and proceeded to measure the cranial capacities of skulls from various populations in order to assign a 'type' to the population; in America, Samuel Morton (1799-1851) had been doing the same since the 1830s (Todd 1923). Other measurements were developed, to record maximum skull length and breadth, and skull height. Meetings and conferences were convened to determine the optimal base points for measurements, and a standard plane in which to take the measurements (Howells 1938: 187).

Ales Hrdlička (1869-1943) was inspired by Broca to establish physical anthropology as a professional field in America (Spencer 1982: 5). Broca had formed the French School (Ecole d'Anthropologie) in 1875, and Hrdlička had trained there in 1896 (Montagu 1943: 114.) Hrdlička was unable to establish an anthropology school in America, but nonetheless taught visiting scholars anthropometry and anthropology whilst based at the National Museum of Natural

History in Washington DC (Spencer 1982: 6). Hrdlička also launched the *American Journal of Physical Anthropology* in 1918, and founded what became the American Association Physical Anthropology in 1928 (Spencer 1982: 7-8).

Anatomist Sir Arthur Keith (1866-1955) of Oxford, who trained in medicine in Aberdeen in the 1880s, is reported to have embraced racial hierarchies: "Race prejudice…works for the ultimate good of mankind and must be given a recognised place in all our efforts to obtain natural justice in the world" (Keith 1931, quoted by Brace 1982: 13). Keith promoted "race differentiation" and lectured students to never accept "universal deracialisation" even at the loss of "peace and good will in all parts of our world"; and believed in "superior and inferior" races. Keith felt he was "of course of the superior race" (Keith 1950 quoted in Brace 1982: 14). Whilst once again, the biographer can choose certain phrases to highlight presumed beliefs, a careful reading of Keith's own words does lead one to conclude Keith felt, on some level, that certain races were "higher and better" (Keith 1931: 20), and not just during hominid evolution. To Keith, the term "prejudice" refers to instincts and preferences, but by following prejudices, the prehistoric world produced "new and better breeds of men." (ibid: 33).

These notions were passed on. Keith in turn taught Earnest Albert Hooton (1887-1954) when Hooton took a Diploma in Anthropology at Oxford in 1912 (Brace 1982: 13). Hooton blamed crime on "biological inferiority" and claimed "the Australian is far less intelligent than the Englishman" (Hooton quoted by Brace 1982: 15). In turn Hooton taught at Harvard from 1913, becoming a professor of anthropology in 1930, a post he held until he died (Spencer 1982: 6).

However, alternative considerations of Hooton's work can significantly mitigate modern opinions. Hooton promoted recording and analysis via cranial and postcranial metrics, variation related to environmental adaptation and "discrete variation" (epigenetic traits) (Cook 2006: 51). Due to excavating some of the Pecos Pueblo burials that he later analysed, Hooton became the first anthropologist to apply archaeological context to human remains (Beck 2006: 85); he considered the frequency and distribution of disease with respect to age and sex (ibid: 91). And, whilst at Harvard, where he founded and maintained the anthropology department for forty years, Hooton taught most of the ‘greats’ of the mid-20th century, such as WW Howells, or trained those who in turn trained students of their own (Anonymous 1954; Beck 2006). Howells himself reportedly did not view Hooton as racist, and openly thanked Hooton for inspiring him to become an anthropologist; but Howells also “renounced….typological thinking” and tended not to discuss Hooton’s “fervent eugenicism” (Godfrey 2008: 118-119).

Ales Hrdlička, who emigrated from Bohemia to New York at age 13, viewed France as the “mother country of physical anthropology” and Broca as its “principal founder” (Hrdlička quoted in Brace 1982: 15). However, Hrdlička was trained in anthropometry at The French School by Manouvrier, himself a student of Broca but one who considered human variation related to environment and who openly decried the racism of Broca’s teachings (Brace 1982: 16). Manouvrier blamed French bigotry on the need to justify colonial holdings in foreign countries (Brace 1982: 18). Similarly, the claim of American anthropologist Samuel Morton (1799-1851) that Africans were ‘naturally inferior’ to Americans of European descent was meant to justify American slavery (Brace 1982: 18; Juzda 2009: 159).

The back and forth citations and similarity in essay topics between French and American anthropologists in the 1830s to 1860s seems to have further strengthened the like-minded views on ‘race’. Shared capitalist concerns over colonial holdings and the perceived need to maintain African chattel slavery on American plantations appear to have been at the root of at least some of these views. Morton wrote on “hybridity” and on the question of “viable fertile offspring” (Brace 1982: 18), a compelling concern in 1830s America, which was occupied by three ‘races’: indigenous groups, European immigrants and African captives (Brace 1982: 17). Morton’s essay on “hybridity” acknowledged the similar work of French polygenist Bory de Saint-Vincent; and Broca’s essay “Des phenomenes d’hybridite dans le genre humain” is contemporary to a very similar essay by Morton’s student Josiah Clark Nott (1804–1873) (Brace 1982: 18).

In addition to reportedly propagating racist views, Morton wrote the first book on anthropometry in 1839, as applied to prehistoric Native American skeletal material (Brace 1982: 19), and was acknowledged as the premier anthropologist of America by Broca himself, placing Morton on a par with Blumenbach (Brace 1982: 19). Broca's student Paul Topinard (1830-1911) went on to create a textbook on anthropometry called *l'Anthropologie* (1876), wherein he specifically recognised Morton's work with craniometry: "Identified by Morton, it has become, in the hands of Mr. Broca, a mathematical operation that is now growing" (Topinard 1876: 229; translated by R Drew).

Under the aegis of Hrdlička and Hooton, Morton's technique of measuring skeletal elements, advanced by Broca and Topinard, were returned to America (Brace 1982: 19).

C.3 Cranial metrics and continued notions of race

The 18th and 19th century reliance on the skull presumed that relatively few crania could represent an entire 'race' and that skull morphology would not vary within a population. The practice of retaining and examining post-cranial remains is only 100 years old (Todd 1923; Armelagos *et al.*. 1982; Brace 1982; Juzda 2009: 158).

Craniometric study of American indigenous subjects continued after Morton's work, with a continued reliance on primarily skulls to differentiate between different Native American tribes and indeed between different global populations (Juzda 2009: 158-159). Shortly after the end of the American Civil war, and as the pro-Colonial-expansion "Indian Wars" and mass relocations of Natives to reservations heated up, Dr George Alexander Otis (1830-1881), the Assistant Surgeon General of the United States Army, sent out letters to Army medics requesting osteological specimens (Juzda 2009: 156). This resulted in the US Army Medical Museum amassing upwards of 3000 crania, mostly sent in by reluctant field surgeons who disliked rooting among relatively fresh burials and rotting corpses. The goal was to build up anatomical specimen collections; to add to the existing stores of examples of Civil War battle injury and disease pathologies; and to aid in anthropological studies of human evolution (ibid: 159). Juzda makes the interesting point that this call for specimens in 1868 came right as Darwin's theory of evolution permitted both monogenetism and polygenetism to claim victory: all of humanity may have come from one stock, but lowly backwaters of evolution had left most human populations ranging along hierarchical scales of intellect and ability (ibid: 159). Typology of human skulls could continue to organize human groups, and comparisons of human and non-human primate skulls to differentiate between 'primitive' and more 'advanced' humans.

Franz Boas (1857-1942), whilst perhaps best known for his studies of head shape among American-born immigrants (Radosavljevich 1911; Brace 1982: 309; Trigger 1987), nonetheless focused his graduate programme on ethnology and ethnolinguistics and can best be considered a cultural anthropologist rather than a physical anthropologist (Spencer 1982: 4). He is viewed as the founder of the four field approach to anthropology (Cole 1996: 293). In 1896, Boas stated a preference for a combined and disciplined Culture-History approach for studying recent and extent human groups, investigating the distribution of 'culture traits' in specifically delineated populations (Boas 1896: 906). He advocated studying the *process* of cultural development; the processes by which groups adopted new techniques. He illustrated how similar results can arise from differing source motives: artistic designs based on stylized representation of nature symbols; or similar manufacturing techniques giving rise to similar designs (ibid: 904). Another example was the use of masks, found globally, yet which, depending on the group, were used to frighten off spirits, trick spirits, or invoke spirits; Boas thus warned against over-reliance on explanations of hyper-diffusionism (ibid: 908). Granted, Boas was discussing cultural evolution and the attempt of cultural anthropologists to locate grand cultural rules; but one can envisage how his warnings to guard against creating simplistic just-so stories to explain cultural similarities could be applied to warn physical anthropologists against making assumptions of *biological* evolution based on a few similarly shaped skulls.

By the early 1900s, Boas was examining and metrically analysing skull shapes of recent immigrants and their children, and determined that dolichocephalic (long-shaped) skulls gave way to brachiocephalic (round) shape forms within one generation (Radosavljevich 1911; Trigger 1987). This cast doubt on studies that relied on craniometrical groupings and correlations for placing skulls into an ancestral populations. Of course, other researchers had made observations on cranial plasticity from the start of cranial studies, notably Blumenbach, who never actually measured any skulls (Cook 2006:32). He had recognised that 'racial' clines existed among "…forms of skulls…one running as it were into the other by all sorts of shapes, gradually and insensibly…", and blamed the archetypal "constancy of characteristics" on "the racial habit" (Blumenbach 1795, as cited in Armelagos *et al.* 1982: 308).

Other anthropologists advanced additional theories regarding skull shape, such as that function influenced shape, termed the "mechanical-functional" theory (Radosavljevich 1911: 396-397). Hrdlička warned against using very few specimens or a "semipathological" skull to represent a type (Hrdlička 1907 as quoted by Radosavljevich 1911: 402). Similar warnings were sounded by anthropologists such as Virchow, who in 1896 (as stated in Armelagos *et al.* 1982: 308) was adamant that typology of skull shapes could not be accomplished with reasonable scientific certainty (also Brace 1982). Broca and followers such as Topinard were just as certain that it was indeed possible and denied Darwin's assertion of one human chain of continuity, but that the races were separate with some being superior (Brace 1982).

The assumption that races could be stratified according to appearance and brain case capacity was further provoked by the concern over immigration to America. That white America feared the weakening of their 'race' from (European!) immigrants was another example of a persistent perception that other races existed, and that some were superior to others. By 1909, Boas (1909: 842) addressed this issue and explicitly dismissed the existence of 'pure' European lines by considering thousands of years of population movement around Europe, and rejected contemporary concerns that "mongrelization" of extant Northern American populations by recent European immigrants was “unprecedented”. However, Boas was not reluctant to discuss human variation, and states,

> “I do not believe that the negro is, in his physical and mental make-up, the same as the European. The anatomical differences are so great that corresponding mental differences are plausible.” (Boas 1909: 847-848).

Taken out of context this statement could seem a continuation of the concept of racial stratification. Indeed, the same paragraph briefly continues to expand on the notion of difference and dip toward the dread “inferiority”. Again, if Boas’ text is abridged, misunderstood or edited for specific purpose, the effect supports any number of contemporary workers who were convinced that Europeans were intellectually and socially superior to Africans. However, when taken as a whole, Boas acquits himself (more or less) in the end, by pointing out that apparent population differences in cranial capacity between whites and blacks were not as great as the variations found *within* a ‘racial’ population; and ended by citing political, philosophical and industrial development in African nations:

> “There is, however, no proof whatever that these differences signify any appreciable degree of inferiority of the negro, notwithstanding the slightly inferior size, and perhaps lesser complexity of structure, of his brain; for these racial differences are much less than the range of variation found in either race considered by itself. This view is supported by the remarkable development of industry, political organization, and philosophic opinion, as well as by the frequent occurrence of men of great will-power and wisdom among the negroes in Africa.” (Boas 1909: 848)

Hrdlička so admired the French School he spent the bulk of his working life trying to recreate it in America. Although Broca viewed humans as belonging to hierarchies, not all of his own students shared his rigid views on stagnant tiers of human development. It is ironic that Hrdlička, who does not seem to have shared the views of Broca and Topinard, would have focused on their institutes and not their teachings. Sadly, by his ardent support for the French School, Hrdlička allowed these racist notions to gain a foothold in American physical anthropology.

Appendix 2: RAS 2012 Answer Sheet

Rapid Assessment Form ANSWER FORM **Please refer to booklet for instructions.**

Skeleton Number _____________Box/Burial Nos._________________________________ Country of origin ________________

If the remains are currently being curated, they may be separated into labeled bags. **After you have completely finished with the assessment,** please take care to return elements to the same marked bag, especially hand/foot bones.

OVERALL IMPRESSION OF REMAINS

Are remains already in a marked box? **Yes / No**
Are elements stored in separate bags such as Left Leg and Right Arm? **Yes Some bags No**

Overall impression of remains: **Fairly Complete Individual YES / PARTIAL / NO**

Bones in **Good condition** (not broken, outer surfaces not flaking away?) **YES / NO**

<u>Sex: if information available:</u> Male/ Prob M / Female / Prob F / Unknown / Juvenile
<u>Age range: if information available:</u> (Juvenile) (18-25) (25-35) (35-45) (45+) (50+)

<u>Cranial observations:</u> **<u>Circle best</u> answer possible <u>Circle N/A</u> if aspect is fragmented or missing.**

<u>I. Skull</u>

1. a. Skull complete? YES / NO*
IF NO* → Broken into a few large pieces? OR **Shattered?**

b. Juvenile and unfused? [if unfused, complete this section as best as possible]

2. Frontal plate (Forehead): **Sloped somewhat back to rear of skull** OR **Vertical OR Moderate** OR **N/A**

3. Raised **glabella** (lump between eyes) **YES / NO / MILD** or **N/A**

4. **Supra-orbital ridge** (ridge over the eyes) **Robust** (large, pronounced) OR **Gracile** (slight, mild) OR **Moderate** or **N/A**

5. Occipital plate (back of skull): **Robust muscle attachments**, protruding beak of bone
OR **Mostly smooth** OR **Moderate** or **N/A**

6. Zygomatic arches (cheek bones; protruding arches on sides of facial area)
Robust (thick) OR **Gracile** (thin, fragile) OR **Moderate** or **both N/A**

7. Lateral (outer) edges of **orbits** (eyes): **Rounded/thick** OR **Sharp/ thin/**
OR **moderate** or **both N/A**

8. Mastoid process (lump of bone behind ear hole) **Wide and large** OR **Small and narrow**
OR **moderate** or **both N/A**

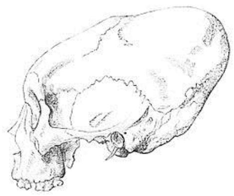
9. **SupraEAM crest** (ridge over ear and mastoid process) **YES / NO / SLIGHT**
or **both N/A**

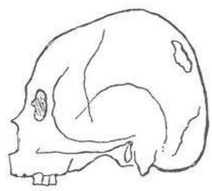
10. Maxilla (upper jaw and half of nasal cavity) **Left side**: **Complete / Partial N/A**
Right side: Complete / Partial N/A

11. Nasal area: **Complete / Partial** OR **N/A**

12. Was skull artificially modified in life? (best noted on complete or fairly complete skulls)

a. Extreme **horizontal flattening** at front, rear, conical shape to skull) **YES / NO**





12.a horizontal modification **12.b vertical modification**

(12.a source: http://www.bibliotecapleyades.net/atlantida_mu/atlantis/img/27500.jpg;
12.b source: 'Deformed skull of Koskeemo Indian, Vancouver Island Wellcome M0005587.jpg': http://commons.wikimedia.org/wiki/File:Deformed_skull_of_Koskeemo_Indian,_Vancouver_Island_Wellcome_M0005587.jpg.)

b. Extreme **vertical flattening** at sides or top of skull? **YES / NO**

13. Premature suture fusion:(unusual bulges or flattened or inverted areas near squiggly suture lines) Note: premature fusion may also cause skull to appear asymmetrical.
YES [see below] / NO
→ **Only if YES, choose: Sagittal** (midline superior suture) OR **Lamdoidal** (Upside down V-shaped twin sutures at back of skull) OR **Several areas**.

14. Are **mastoid processes** (bony lumps behind ear holes) **Misaligned** and uneven when viewed from bottom of skull? **YES / NO** OR **N/A**

<u>II. Mandible (</u>lower jaw) + Teeth in both jaws

1. Is Mandible present? **YES** OR **NO**
→ If Yes: **Complete and unbroken** OR **Several large sections** OR **Mostly small pieces**

2. a. Mandible: **Overall: Robust** (heavy, thick) OR **Gracile** (delicate, thin)

b. Is mandible **edentulous** (toothless)? **YES** or **NO**

3. Mental eminence (chin) **Squared off** (wide) OR **Rounded** perhaps somewhat pointed
OR **Moderate** OR **N/A**

4. **Condyles** (rear knobs of bone; where mandible connects to skull**) present?**
YES / NO / PARTIAL OR **N/A**

5. Gonial Angles (rear lower angle of jaw: Jaw line): **Robust** (square, flaring outward, with
ridges) OR **Rounded** (curved, thin) OR **Moderate** OR **N/A**

6. Teeth in general (both upper and lower jaws): Choose as many as necessary.
Unworn (like new) / **Mild Wear** (some flattening of cusps, but no dentin exposted)
/**Moderate** (more cusps flattened, some dentin exposed) / **Very worn or chipped** (grey
or brownish dentine completely exposed) / **Teeth lost during life** with socket filled in by
bone (healed over: no socket) **Teeth Missing (likely post-mortem)** with empty sockets

<u>III. Post-cranial bones:</u> (all bones below the skull) **Circle best answer possible.**

1. Long bones (arms and legs). Three arm bones and three leg bones per side.
All 12 present and look complete [**please refer to sketch**] OR
All 12 probably present but one or more broken into large sections OR
Can't be sure if 12 present, Most broken or Fragmented, many small sections OR
No long bones and/or very few fragments.

Note: if long bones missing or too fragmented to assess, <u>please skip to Section IV.</u>

2. Overall size of larger long bones (femur, humerus, tibia) **if probably adult**
Large, heavy, and "robust", with pronounced bumps and ridges (muscle attachment
sites), OR

Smallish, thin, smooth and "gracile" (few muscle attachments are noticeable) OR
Moderate.

3. Joint areas: found at the ends of long bones, where one bone joins (articulates) with another
Look Complete OR
Fairly complete, some edges broken OR
One or two missing entirely (broken off) OR
Most joint areas missing.

4. Patella. Both present One present N/A

IV Clavicle (collar bone) and Scapula (shoulder blade), and Ribs

1. Clavicle: Is the **Medial** end (the flaring, cone-shaped end)
Immature and unfused (example: wrinkly, with ridges) OR
Mature (flat, rounded, ragged) OR
N/A

2. Left and Right clavicles present? **YES BOTH** **ONE** **N/A**

3. Left and Right scapulae present? **YES:** both in good/fair condition
ONE in good condition **BOTH Fragments** **BOTH N/A**

4. Ribs
a. Costal ends (toward front, not toward spine/vertebrae**) Flattish/wrinkly** appearance
(youthful) **YES / <u>NO</u>** [if NO see below] OR **N/A**

b. → <u>If NO</u>: **Cup-shaped** or **V-**Shaped with s**mooth/round scalloped** edges**?**
YES / <u>NO</u> [if NO see below]
→ <u>If NO</u>: **Deeply excavated with ragged/thin/uneven** edges? **YES**

c. Condition of Ribs: **Complete / Large sections / Fragments/ N/A**

V. Vertebrae:

1. Are there any vertebrae? YES NO

2. Do the vertebrae appear to be complete or mostly complete? YES / NO

How many vertebrae in total? ____________ OR **N/A** due to fragments
C __________ T _________ L __________

VI. Wrist, Ankle, Hands, Feet, Fingers and Toes **(Carpals, Tarsals, Metacarpals, Metatarsals, Phalanges)**

Assessing individual hand and foot bones is beyond the scope of this general form.

Unless bones are stored in bags labelled by side, simply give total counts of all bones.
If stored in bags labelled by side, record the number of left bones, the number of right bones.
Don't worry if you cannot separate tarsals from metatarsals, metatarsals from phalanges, etc. If you can, that is excellent, but just determining if hand/foot bones are present at all
is very important. If bones are broken or youthful unfused, or if sesamoid bones are also in the bags, you will end up with more than the normal counts of adult bones below.

1.Carpals (small, squarish and irregular) ________________ (8 each hand, 16 in total)
2. Metacarpals (short tubular bones, with rounded heads and squared bases) _________________ (5 each hand, 10 in total)
3. Phalanges: (fingers tend to be flatter, toes narrower at mid-shaft) _________________ (14 each hand, 28 in total)

4. Tarsals (larger, some like triangular cubes. This includes the heel) ________________ (7 each foot, 14 in total)
5. Metatarsals (short tubular bones, with narrower heads and squared bases) ________________ (5 each foot, 10 in total)
6. Phalanges: (narrow at mid-shaft) ________________ (14 each foot, 28 in total)

VII. Os coxae (pelvic or hip bones)

1. Are **pelvic bones complete**? **Fairly complete**? **Shattered? [**do your best if pelvic
bones are shattered. It may be very difficult to determine L from R pubic bones.**]**

Note: a broken bone will often have exposed honey-comb spongy bone and splintered edges. A bone ragged due to extreme age or other factors have a more closed-over appearance even if it has holes. Even professionals can't always tell a broken bone from one damaged during life.

2. Pubic symphysis (oval front region) [see sketch**]** present? **YES / Yes but partly broken**
NO, N/A pubic symphysis broken off.

3. R and L symphyses present? **YES / NO: R present or L present**

4.. a.Pubic symphysis surface **Billowy (**wrinkly; furrowed)? **YES / NO / Slightly**

OR Flat surface **YES / NO**

b. If flattish, are there irregular '**ragged' holes or bony growths? YES / NO**

c. Pubic symphysis edges: Is **front (ventral) edge** flattened? **YES / NO**

d. Sharp/distinct rims (edges) Both **YES / BOTH NO**
OR Only one edge (front or back) with sharp rim

e. Ragged irregular edges Both **YES / BOTH NO** /
OR Only one edge (front or back) ragged

5. Sub-pubic Ramus: strut of bone branching off below oval **Pubic symphysis:**
Thick, vertical? at ~45 degrees, descends directly from oval pubis face <u>OR</u>
Thin, flaring, curved away from pubis?, with small neck between pubis and downward arc of ramus

Rear of pelvic bones.
6. Greater sciatic notch (deep curve at back of each hip):
a. Deep, narrow, perhaps tilted back to rough and raised articulation for sacrum
OR **Wide, shallow**, symmetrical OR **Intermediate** OR **NA**

b. If both hips present: **Do Left and Right** sciatic **notches match**? **YES / NO**

7. Outer side of pelvic bones**: hip sockets. Are the rims:**
Round/oval with firm edges OR Irregular, 'bumpy' rough OR very uneven

8 . Auricular Surface (ear-shaped region near back of pelvic bones**)**
Billowy, solid, with gently rounded wrinkles? **Yes / Yes some / No N/A**
OR
Rough, ragged appearance, irregular, 1 mm holes, many tiny sharpish peaks**?**
YES/ Yes some NO N/A
OR Intermediate?

9. Pre-auricular sulcus (a trench, a groove) below auricular surface [please see info book]
YES wide, pronounced OR **YES mild** OR **NO N/A**

The sacrum is a flattish thick triangle of bone that connects to the hip bones at the auricular surface. A typical adult sacrum has five segments, and when viewed from the front, two columns of four holes down each side.

10. Is the **sacrum** present? **YES / Yes but broken / Yes but fragments / NO**

11. Are all the **sacral segments fused into one bone? YES NO**

12. If fused onto one bone, is there a **gap** or opening between **S1 and S2? YES NO**

Yes fused, but fusion line still visible.

LONG BONE LENGTH: THE FEMUR.

The thigh bone (femur) will be the only skeletal element measured using this system. Femur length can correlate with stature, and femur head width (diameter) can correlate with biological sex and body mass. Length is measured with an osteometric board, and femoral head diameter with sliding calipers.
If an osteometric board is not available, estimate length of the femur using the scale on the side of this sheet. If calipers are not available, estimate maximum femur head diameter using the same scale.
The maximum **width of the femur head is the widest part of the round knob or ball** at the top of the femur. This ball creates the ball and socket of the hip joint.
If one or both femora are broken into only a few large sections and can be re-fit, please take length. If length is not measurable or bone is missing, select N/A.

Length (mm) L femur: MAX Total Lenth _________ mm or N/A

Diameter (width) of Head _________ mm or N/A

R femur: MAX Total length: _________ mm or N/A

Diameter of Head _________ mm or N/A

CHECKLIST FOR OBSERVING NORMAL AND ABNORMAL BONE CHANGES

For all checklist choices: Related conditions are outlined in BOLD. Inside each bold section, please choose only one option.
If the area is normal or does not have the condition, please choose not present.
If the area is not observable due to breakage, please choose N/A.

Please use **N/A** when element is missing and cannot be assessed. Please choose only **one** degree of pathology per heavily- outlined area. Leave the other boxes blank.

Feature	Description	Present on bones √	Notes
Most or all of teeth in sockets	**Healthy teeth** in an overall healthy mandible and/or maxilla. Write N/A and answer all below if not healthy.		
Skip next four options for this section if all teeth appear healthy and in the socket. (skip to calculus)			
POSTMORTEM Tooth Loss	**Some sockets** empty; no woven bone filling them in; some teeth in place. Sockets not filled in; tooth loss is after death.		
OR	**No teeth.** All sockets empty but "clean" and without spongy bone in sockets. Not lost due to obvious disease		
If no sockets are empty please check √ here in Notes. -→			
CARIE (tooth decay; 'cavities')	**Mild** one or two small yellowish marks or small holes on sides or tops of teeth.		
OR	**Moderate:** One or two **very large** caries, tooth hollowed out. OR **Severe** Many large caries; more than three teeth hollowed out and only roots left in socket.		
If no caries are observed please check √ here in Notes -→			
TOOTH LOST during life.	**Mild** One, two or even three sockets filled in with bone.		
OR	**Moderate/ Severe:** Most or all teeth lost before death, with sockets filled in or even obliterated.		
If no filled-in sockets are observed please check √ here -→			
WORN/chipped Teeth: Enamel removed.	**Mild**: Some dentin exposed through the enamel.		
OR	**Moderate/Severe**: Most teeth worn flat or to an angle, or broken off.		
If no worn teeth are observed please check √ here -→			

CALCULUS	Hardened substance on tooth surfaces; resembles 'cement'. Can be at base of teeth at 'gum line'.		
If no calculus observed please check √ here -→			
Feature	**Description**	**Present on bones √**	**Notes**
Periodontal disease	**Mild or Moderate**: small amount of raised, porous (spongy) bone around bases of *some* teeth		
OR	**Severe:** large holes in body of jaw, exposing tooth roots. Note: the twin holes above mental eminence are normal passages for nerves and blood vessels.		
If no periodontal disease observed please check √ here -→			
Dental Hypoplasia	**Ridges and furrows** on front (anterior) surface of canines or premolars (not front teeth).		
If no dental hypoplasia observed please check √ here -→			

The remainder of the form will follow in this pattern. Sometimes, the choice for "normal" or "unremarkable" will come *before* the options, sometimes after. The goal is to make the options as clear as possible.

If two or more options to describe a trait are offered, such as "Mild" or "Moderate" or "Extreme", please choose only one, and select the most extreme one.

If the condition or trait is not observed, or if the part of the bone being discussed is not available, please check the appropriate default box. Thank you!

SKULL: abnormal bone deposits and bone loss; fractures.

FEATURE	**DESCRIPTION**	**Present? √**	**Notes**
EYE ORBITS: Option of "not observed" will be offered FIRST for following sections.			
Inside orbits, on roof or at sides : Unremarkable. Please skip next three boxes and check here in Notes →			
OR	Slight holes on roof or internal side of orbit		
OR	More holes, may resemble spikes of bone		
MAY ALSO INCLUDE deposited bone accumulated on inner surface of orbits			

	Thick, grayish or brownish deposits on roof or side of orbits. May resemble wet sand		

OUTER SKULL: TOP, REAR, SIDES. May select more than one.

Outer skull [not including face]: **Unremarkable. If no unusual bone deposits or bone loss is observed, please skip next five boxes and check here→**			
	Thick greyish/brownish eposits on skull. In patches.		
	Small holes, close together, ~1 mm or so in diameter. May cover large areas of skull surface		
FEATURE	**DESCRIPTION**	**Present? √**	**Notes**
And / Or	Small roundish bumps on front or sides		
And / Or	Patches of bone loss on outer skull: small, perhaps 15-20 mm maximum diameter. Can include perforation.		
And / Or	Large patches of bone loss: can be quite extensive with irregular edges. .		

Skull vault thickness can be observed only if skull is in fragments. If not broken, please skip next two boxes.

Vault fragments	Unremarkable, average thickness is well under 10 mm		
OR	skull vault being thicker than 10 mm except at very rear of skull		

LONG BONES: Joint areas.
Appearance on MOST or ALL long bone joints, including hip socket

FEATURE	**DESCRIPTION**	**Present ? √**	**Notes**
Healthy. **Joint edges generally smooth, no bony lumps (osteophytes), no holes or shininess on joint surfaces. If no pathology observed, or no joints are available to be assessed, skip to vertebrae and check here →**			
OR	**Most joints, overall**: sharpened edges, small patches of shininess (eburnation), small bony lumps (osteophytes) on joint surfaces or around edges		
OR	**Several joints extremely abnormal**, across several limbs. Include shoulder and hip socket. Widespread.		

Local injury or disease on ONE joint? → ONLY IF YES please complete sections below. Otherwise skip next two boxes.

Abnormal joint in one arm	Shoulder, or elbow, or wrist: check mark if present. Specify which one in Notes box at far right		
Abnormal joint in one leg	Hip, or knee, or ankle: check mark if present. Specify which one in Notes box at far right.		
Local injury or disease SEVERAL bones? → ONLY IF YES please indicate below. If no such pattern observed, skip the following two boxes.			
Several joints abnormal?	Indicate multiple injured joints below. Example: R shoulder, AND L shoulder, or L hip, AND R knee. **etc.**		
Upper limbs (arms)			
Lower limbs (legs)			

VERTEBRAE: spinal column.
Appearance of vertebral body (centra), on top, bottom and sides, and contact facets.

FEATURE	DESCRIPTION	Present? √	Notes
CERVICAL (neck) vertebrae **Saddle shaped bodies and oblique contact plates (facets) look smooth or otherwise unremarkable. If so, skip the following boxes and check here→**			
OR	SOME Saddle shaped bodies look porous, "moth eaten", contact facets enlarged, with foamy appearance.		
OR	As above but more extreme. Facets may be shiny (eburnated).		
OR	Bodies may be fused together.		
THORACIC (chest, rib) vertebrae **Heart shaped /roundish bodies and vertical contact facets smooth, unremarkable. No bony growths (osteophytes*) on edges of vertebral bodies. If T verts look unremarkable, skip 3 boxes below and check here →**			
OR	A few osteophytes* (rounded bone growths) on two or three bodies. Contact facets widened and flattened, rib articulations may be deepened and enlarged.		
OR	Same as above, but contact facets enlarged, with foamy appearance; maybe with regions of eburnation (shininess). Increased osteophytes*.		
OR	Osteophytes* severe. Several vertebral bodies may be fused together. Eburnation and/or porosity (holes due to bone loss) at articulations. Bodies may be abnormally flattened compared to other T verts.		

LUMBAR **Oval / kidney-shaped bodies and curved contact facets smooth, unremarkable. Bodies do not have bony growths on edges, sides of bodies are relatively vertical. If so, please check here →**			
OR	A few osteophytes* (rounded or spiky) on one or two bodies. Facets widened and porous. Sides of vertebral bodies may be concave.		
OR	Osteophytes* on most lumbar bodies. Vertebrae may be fused together. Eburnation and/or porosity at articulations. Bodies may be abnormally flat.		
IF VERTEBRAE ARE FUSED TOGETHER, is there a smooth sheet of bone down the front of the vertebrae? It has been described as resembling melted candle wax. Skip this section if not applicable.			
	Three to five vertebrae fused (C, T or L) →		
	Six or more vertebrae fused together. →		

FRACTURES: HEALED INJURIES sustained months or years before death. ***See box below for unhealed fractures sustained around time of death. These can be curved, have smooth edges or a smooth surface that ends in abrupt torn area. (Post-mortem damage to bones will have very splintered, uneven edges)** **Long bones, ribs → in NOTES, record affected bones.**			
FEATURE	**DESCRIPTION**	**Present ? √**	**Notes**
Please choose from single fracture OR multiple fractures below. If no fractures observed, check here→			
SINGLE Fractures long bones	**Well healed:** Slight grayish ring of raised, porous bone around bone shafts (callus), or mild angle or bend to one bone shaft (therefore not rickets), or small bulge on bone.		
OR	Badly angled or overlapping bone. May be associated with one small round edged hole (drainage canal).		
OR	Badly angled or overlapping, with round-edged holes (drainage sinuses); unusual boney lumps, patches of raised bone that may be quite extensive.		
MULTIPLE fractures long bones	**Well healed:** Slight grayish ring of raised, porous bone around bone shafts, mild angle to bone shafts (is this rickets?), small bulges on long bone shafts. **→ in NOTES, record affected bones.**		
And/Or	Badly angled or overlapping bones. May be associated with one or very few small round edged holes (drainage canals). **→ record affected bones.**		

Ribs: Please choose from single fracture OR multiple fractures. If no fractures observed, check here→			
SINGLE fracture RIBS	**Well healed:** Slight raised ring of greyish bone (callus), or mild atypical angle or bulge on rib shaft.		
OR	**Poorly healed / poorly set**: associated with roundish-edged holes (drainage sinuses); patches of raised bone and/or moth-eaten bone with holes		
Multiple fractures, ribs	**Well healed** Slight raised ring of greyish bone (callus), or mild atypical angle to or bulge on rib shafts.		
OR	**Poorly healed or poorly set**: associated with roundish-edged holes (drainage sinuses); patches of raised bone and/or moth-eaten bone with holes		

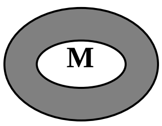
***Any suspected perimortem (near time of death) fractures? Curved, smoothed edges; may resemble broken bottle glass: curved, sharp well-defined edges. LIST BONES IN BOX BELOW**

CORTICAL THICKNESS: Bone shaft "walls".

Can only be assessed via a break near the MIDDLE of the bone, because cortex thins out near the ends of long bones. We can observe the mid-shaft only if the bone happens to be broken.

Consider cortex compared to the size of the bone. For example, a "thin" ulna may be 2 mm thin on an exposed mid-shaft, but a thin femur might have shaft walls that have a width of 4 mm.

The shaded area is the Cortical bone.



"M" marks the medullary cavity. Note: this is a **"normal"** cortex.

Feature	**Description:**	**Present ? √**	**Notes**
If no upper limbs (arm bones) are broken, check here and skip to next section. →			
UPPER LIMBS (arms) Cortical mass of exposed mid-shafts.	**If several arm bones broken are they all "normal"?** **Normal** bone in comparison to size of shaft.		
OR	**Abnormally thickened**, with a **very narrow** medullary cavity **in comparison to the overall** width of the shaft.		

OR	**Thin cortical bone** in comparison to rest of shaft.		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers.		
INDIVIDUAL ARM BONES: as above but refers to one arm bone (humerus, ulna, radius) being markedly different from the same bone on the other side			
Please record the abnormal arm bone(s) here			
If no lower limbs (leg bones) are broken, check here and skip to next section. →			
LOWER LIMBS (LEGS) Cortical mass of exposed mid-shafts.	**Thick healthy "normal"** bone in comparison to size of shaft.		
OR	**Abnormally thickened**, with a very narrow medullary cavaity in comparison to the overall width of the shaft.		
OR	**Thin cortical bone** in comparison to rest of shaft		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers.		
INDIVIDUAL LEG BONES as above but refers to one lower limb (femur, tibia, fibula) being markedly different from the same bone on the other side			
Please record the abnormal leg bone(s) here			

Trabecular (spongy) bone in any mid-shafts? Abnormal spongy bone in a mid-shaft region can be observed if exposed by postmortem break		
Trabecular ("spongy") bone exposed in mid-shaft of arm bones? If yes list affected bones in long box directly below	Or N/A	
Trabecular ("spongy") bone exposed in mid-shaft of leg bones? If yes list affected bones in long box directly below.	Or N/A	

	MUSCLE ATTACHMENT SITES		

Feature	Descriptions	Present? √	Notes
LONG BONES UPPER LIMBS (Arms)	**Raised lines, ridges, or humps p**resent and noticeable		
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology!		
OR	**Almost non-existent.** Can be felt with fingers more than seen; or are very mild.		
LONG BONES LOWER LIMBS (Legs)	**Raised lines, ridges, or humps** present and noticeable?		
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology		
OR	**Almost non-existent.** Felt with fingers more than seen or very mild		

Miscellaneous: if these traits or pathologies are noted, check √Present.

Feature	Description.	Present √ or NA	Notes
Endocranial (inner) skull vault defects	Bone loss seen on inside curves of skull vault: any defect with raagged or rounded edges on inner vault surface. **<u>Can only be seen in broken / partial skull.</u>**		
VERTEBRAE Possible infectious disease	Scooped out areas of destruction on vertebral body. Can be viewed internally using the defect, or observed on front corners on vertebral body. If present, please put count of affected vertebrae in Notes area.		
Lumbar vertebra fused to Sacrum	Abnormal growth, fusion: lower lumbar vertebra (L5) fused with sacrum. May be partial: one side of L5 fused to sacrum, or on both sides.		
VERTEBRAE 'Schmorls node's	Irregular smooth sided depressions on top and/or bottom surface **of a few** centrae (vertebral bodies) **OR**		
VERTEBRAE 'Schmorls nodes'	Irregular depressions on top and or bottom surface **of many** vertebral bodies.		

RIBs (any number)	**Bone deposits** on insides (**inner curves**) New abnormally placed bone on top of the surface. May look brown, or like wet sand pressed onto ribs. May also look lumpy.		
RIBs (any number)	**Bone deposits** on outer sides (**outside of curves**).		
RIBS (any number)	**Fusion between two or more ribs. Bridge of bone between ribs.**		

Long bones: abnormal bone (inflammation; infection)			
If all long bone shafts and associated joints look relatively normal, check here and skip the next boxes. →			
Feature	**Description. Inflammation that only involves outer shaft.**	**Present √ or N/A**	**Notes**
Long bones. Does not include joints, ribs or vertebrae	**Mild:** One long bone, tibia for example, with raised new bone on surface. May be in raised rows, looking mostly dense but with some small holes. May look 'lumpy'.		
OR	**Moderate/ Severe:** Widespread on tibia, other long bones, etc. Thickened, abnormal deposits may be extensive. May be arranged in linear manner in raised smooth rows. Does not include rounded holes that extend INTO shaft.		

Long bone shaft chronic conditions that involve the outside and inside of the bone (medullary canal). May have spread to joints. Healed (first two options) and Ongoing (third option). May select ONE from healed, AND ongoing.			
Long bones and related joints: arms, legs, hips	**Mild:** Dense, lumpy bone with one or very few small defects (holes) with smoothed edges. Defects can be scooped out areas 're-filled' with bone. On one or two bones only.		
OR	**Healed Moderate/Severe**: larger defects, more widespread, over several limbs **BUT WITH SMOOTH MARGINS** and **NO** ragged edges, no spicules (spikey bone) inside defects. .		
May ALSO be ongoing in one area and healing elsewhere.	**Active, ongoing:** Holes rimmed with spikey bone, ragged irregular edges. Defects can be quite large. Patches of spikey bone on shafts, often surrounded by raised rim of rough bone.		

Orthopaedic injuries or bone/joint abnormalities. **Continued onto next page.**

Feature	Description	Present? = √. Not Present. =**N/A**	Notes
Ball and socket **joint: Humerus head** after trauma**.**	**Odd shaped, small rounded defects** (bone chips or small holes), **heads flattened, heads partly missing, small bone chip added to round surface.**		
Femur head subjected to trauma.	**Odd shaped, small rounded defects, heads flattened, heads partly missing**		
Joints defects: In lower femur, lower humerus, anywhere on radius, ulna, tibia: **MILD**	**Small <u>defects</u> on inside joint surfaces,** on the rounded or concave surfaces that meet as a joint. **Bone chips missing (1-2mm), tiny bone fragments added, small edges missing off joints. On one or two surfaces.**		
Joint defects, moderate/ severe	**Small defects on bone, widespread over many joints, or very large sections (3 mm+) missing from two or more joints.**		
Feature	**Description**	Present= √**,**Not present= **N/A**	
Sacrum	**Odd shaped:** Rather straight, or very curved (even bent or folded). Too long (6+ segments, based on five rows of large holes or 'foramen') or too short (less than 5 segments, based on 3 rows of foramen)		
Rickets mild	**Long bones with curved shafts. Especially lower limbs. Mild.** Some bowing on some elements, but matched between left and right. (ex: L&R femur, and/or L&R tibia; but not only one femur or one tibia)		

Rickets moderate/ Severe	**Long bones with curved shafts.** More widespread, on upper as well as lower limbs, **marked curves.**		
Rickets: possible indication	**Ribs** with **extreme curvature:** ribs that don't lay flat on the table. [Not the normal curve around the lungs which is front to back].		
Rickets: possible indication	**Scapula:** is the blade (the thin, long and wide triangle) **curved noticeably?**		

Please use Notes sparingly. Most observations should be in the checklist sheets. Details such as individual long bones with extreme bone changes can be detailed here.
If you have training that enables you to enhance earlier observations, please add these here.

Notes:

Appendix 3: Information Booklet

Rapid Assessment Form <u>**Information Booklet**</u> **February 2014**

Thank you for gathering information from skeletons. A separate data recording sheet will be used together with this booklet.

Equipment and Optimal Study Space:
2 m x 1 m workspace
Osteometric board or 1 metre ruler/scale.
Sliding calipers
Gloves if required or desired.
Skull ring (can be a circular 6 inch (15 cm) foam flower/wreath stand if needed)

Box number, burial number, skeleton catalogue number:
Different institutions (museums, universities, archaeological firms) will use different cataloguing systems assigned to remains. It is important to record all information on a storage box that relates to the entire skeleton. This can be done on the top of Page 1 of recording sheet, along with you name, date and the supposed country or region of origin of the remains (i.e., North America, England, Caribbean, and so on).

On subsequent pages, please record your initials and date, as well as one pertinent piece of cataloguing information.

Please refer to sketch of complete skeleton on page 5 as needed. Smaller details of specific bones will be placed throughout this guide.

To begin, take the archive box or set of bags referring to the (hopefully) single individual and put them on a lab table.

If the remains are currently being curated, they may be separated into labeled bags. You will need to remove the bones from bags in order to assess them. Just leave them out until finished. If desired, you can place the bones on top of their bags whilst doing the assessments. Please take care to return elements to the same marked bag when you are completely finished.

If hand and feet are labeled by side, i.e., Right Foot; Left Hand, take great care to keep the sides separate during this assessment. The labeled bags should be kept as near to the small bones as possible during assessment.

<u>**Overall Impression of Remains**</u>

Are remains already in a marked box? By this it is meant: are the remains boxed as a specific catalogued individual?

Are elements stored in separate bags such as Left Leg and Right Arm? This refers to the condition of storage inside the box: are elements grouped and labeled?

Overall impression of remains: Do there seem to be a lot of bones, such as long bones, a skull, curved ribs, and squarish vertebrae?

The "condition" of the remains refers to the bone quality. Are the bones in a fairly good state of preservation, or are the outer surfaces bleached white, peeling or flaking away? Do the skeletal elements seem to be broken?

Sex: if information available from museum catalogue, or written on side of box:
Age range: if information available as above.

INVENTORY SEGMENT

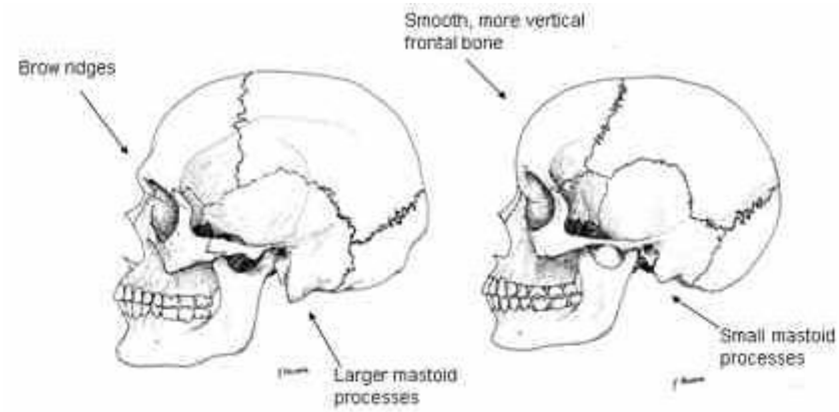
Cranial observations: **Circle best answer possible Circle N/A if aspect is fragmented or missing.** If the feature comes in pairs, such as cheekbones, and one side is fragmented or missing, please score the available side. Please label L or R next to feature that could be observed.

Note: a young juvenile would not have developed a fused skull, in other words the skull segments would not yet have become attached. Therefore the skull vault sections will be separate but not because the skull has been shattered. The separate sections may have rounded edges if the skull is from a very young juvenile, or serrated and irregular edges if from an older juvenile or young adult.
The skull segments of a juvenile are usually thin, only a few millimetres, whereas an adult skull vault can be much thicker. Conversely, the skull of a very elderly individual may also be thin.
If you are not sure if skull fragments are from an adult or a juvenile, do not be concerned.

If you are confident that the skull is from a young juvenile with unfused segments, please select Juvenile where requested.

I. Skull

1. Skull complete OR **Broken: see above for details.**



M **F**

Appendix 3: Information Booklet

(Source: http://www.wadsworth.com/anthropology_d/special_features/forensics/forensics_index/pix/ALTFIG2S.jpg.)

2. Frontal plate (Forehead)

3. Raised **glabella** (lump **above and between** eyes)

4. **Supra-orbital ridge** (ridges **over** the eyes)

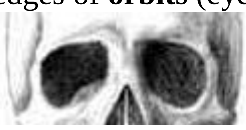
5. Occipital plate (back of skull): Not labeled. Note that the male has a protruding back of the skull, whereas the female's rear skull is more rounded. The male skull has a pronounced 'external occipital protuberance' due to **Robust muscle attachments.**

Note: for paired features like cheekbones and eye sockets, if one is N/A, you can score the other one.
If both sides are present and one side is very different from the other, please circle two descriptions and write R and L next to the description.

6. Zygomatic arches (cheek bones; protruding arches on sides of facial area)

(Image adapted from skulls shown in Item I.1.)

7. Lateral (outer) edges of **orbits** (eyes)

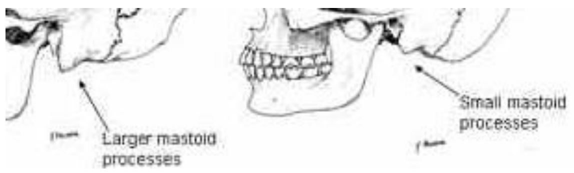


M

F

(Source: http://www.juniordentist.com/wp-content/uploads/2008/09/male-skull-vs-female-skull.jpeg.)

8. Mastoid process (lump of bone behind ear hole)

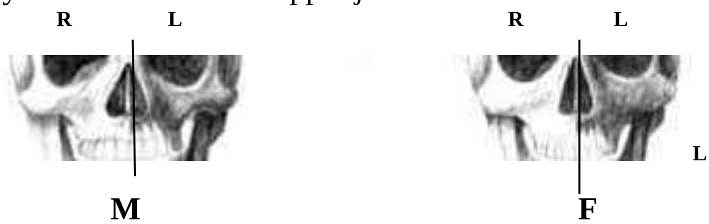


M **F**

(Image adapted from skulls shown in Item I.1.)

9. SupraEAM crest (ridge over ear and mastoid process)

10. Maxilla: upper jaw and nasal cavity. Each side, L and R, creates one half of the nasal (nose) cavity and one half of the upper jaw. .



(Image adapted from anterior view of skulls in Item I.7.)

11. Nasal area: **Complete / Partial** OR **N/A**

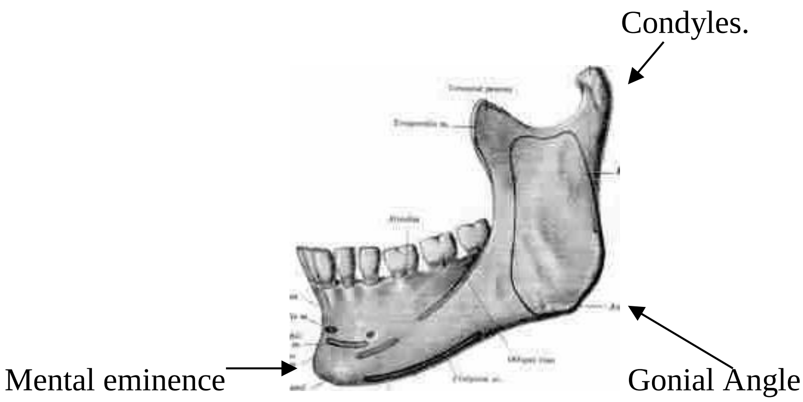
<u>II. Mandible</u> (lower jaw)

1. a. Is Mandible present?

(Image adapted from anterior view of skulls in Item I.7.)

b. Mandible Overall: Robust (heavy, thick) OR **Gracile** (delicate, thin)

c. Endentulous (toothless)? Yes No



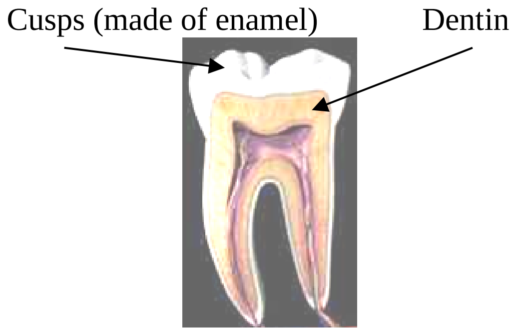
(Source: http://www.probertencyclopaedia.com/j/Mandible.jpg.)

2. Mental eminence (chin) Note: the **twin holes just above the chin are normal** passages for blood vessels and nerves.

3. Condyles (rear knobs of bone; where mandible connects to skull**) present?**

4. Gonial Angles (rear lower angle of jaw: Jaw line): The gonial region can be 'everted' (bent outward; think of someone with a very square jaw), or be rounded and even rather thin. Muscle attachments can also leave very strong linear tracks.

5. Teeth in general (upper jaws as well as mandible): Choose as many options as necessary.

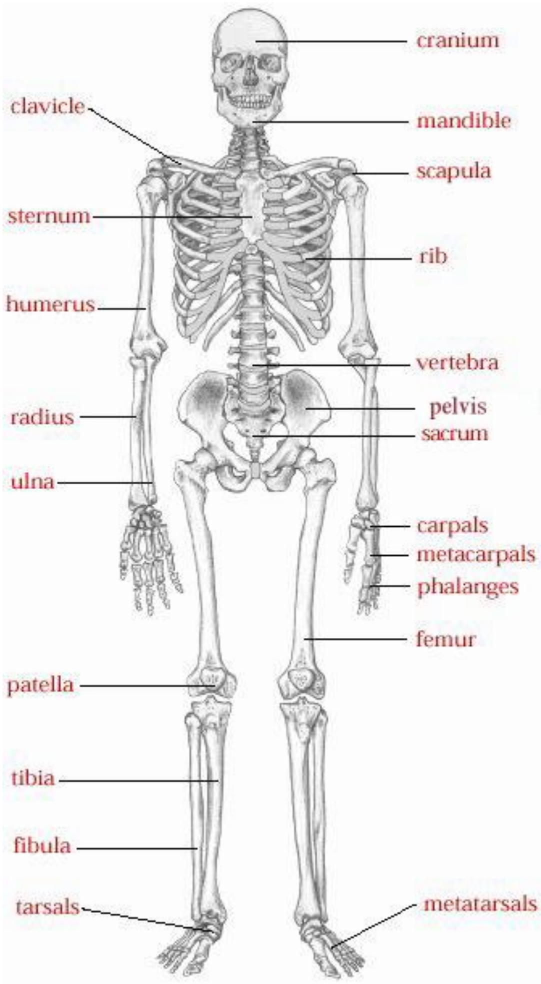


When enamel has been worn off, dentin is exposed (Source of image: http://www.3dscience.com/img/Products/Images/clip_art/tooth_cross_section_web.jpg).

When a tooth is moderately worn down, some enamel remains but the brownish dentin is exposed. A very worn-down tooth lacks all the enamel and only has dentin left for a chewing surface. Eventually, the tooth will become very small, like a tiny wooden peg, and eventually may fall out.
If a tooth is lost BEFORE DEATH, i.e. during life (also termed 'ante-mortem'), the body will try to fill the socket with bone. In this case, the jaw will look like a tooth was never there, or will retain a roughened area where the tooth once was.
Hollow, empty sockets in a mandible or skull are generally presumed to be left by teeth lost AFTER death, or post-mortem. This signifies that the tooth was either lost very shortly before death, or that the tooth fell out after death, and the socket was unable to be repaired. .

<u>III. Post-cranial bones:</u> (all bones below the skull) **Circle best answer possible.**

Long bones (arms and legs). Three arm bones and three leg bones per side.



(Source: http://hes.ucfsd.org/gclaypo/skelweb/graphics/skelant.jpg.)

1. The long bones are:
Upper Limbs: Humerus (upper arm), Ulna and Radius (forearm)
Normally, three per arm
Lower Limbs: Femur (thigh), Tibia (shin bone) and Fibula (thin calf bone)
Normally, three per leg.

Note: if long bones missing or too fragmented to assess, <u>please skip to Section IV .</u>

Age estimates using maturity of long bones:

Adult versus **Older Juvenile (Adolescent)** versus **Younger Juvenile (child).**

Adult
All parts of each long bone will have fused together, indicating a minimum age at death of 23-25 years. The rounded knobs of bone for the shoulder or hip will be firmly attached to the humerus and the femur, and the roundish "knuckles" of the elbow and knee will also be fused. None of the ends of

any of the long bones will still have an immature endplate: a wrinkled, billowy, flattish surface.
The adult size of a humerus with all end plates fused is about 25-30 cm, measured from rounded half-sphere for the shoulder, to the wavy elbow joint. The adult femur, from rounded ball for the hip, to the wavy double-rounded knee joint is *at least* 40 to 45 cm.

Older Juvenile ('Teenager' or adolescent)
Some long bones are not complete. They are not broken, but ends are flattish and "wrinkly", with rows of ridges or furrows. Even so, the humerus and femur will be almost adult size. The rounded knob of bone on the femur and the half-sphere of the humerus may not be fully attached (fused). The curvy knuckles at the lower end of the femur may not be attached.

→ The unfused femur can be measured, but only with either the top and bottom end plates in place on the measuring board (or when using a metre stick) for stature, or with ALL endplates either not in place or excluded from the measure. The latter method allows the main shaft to be compared with growth charts for an estimated age range.

Younger Juvenile
Most long bone ends are flattish and wrinkly. Humerus and femur much smaller than adult size.

→ The young juvenile femur shaft can be measured, and its length compared with growth charts for an estimated age range.

NOTE: If skeleton appears to be from a juvenile, please mark each page as juvenile, by circling JUV in upper R hand of page, and proceed as best you can.

2. Overall size of larger long bones (femur, humerus, tibia) **if probably adult**

Large, heavy, and "robust", with pronounced bumps and ridges (muscle attachment
OR **Smallish, thin, smooth and "gracile"** (few muscle attachments noticeable)
OR **Moderate**.

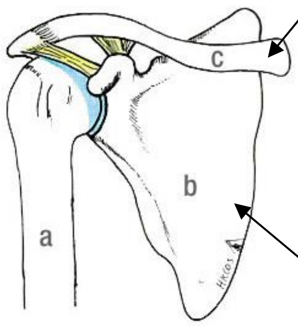
3. Joint areas are found at the ends of long bones, where one bone joins (articulates) with another in a moveable joint: the shoulder, the elbow, the wrist; the hip, the knee, the ankle. The end plate that forms the joint might not be attached to the long bone shaft if the individual had not reached maturity.

4. Knee cap: patella. Oval or triangular flattish bones approx. 2 in x 2 in that slide over the lower end of the femur. Should be two (L and R).

IV Clavicle (collar bone) and Scapula (shoulder blade)

shown with humerus (upper arm). Also Ribs

Clavicle: flattened at shoulder end, wide/flaring at chest end (**medial)**



Scapula: thin blade, with thick bar on one side

(Source: http://pic.hkcos.org.hk/hkcoswebcontents/f/FIJHBvRwvYJyrCV6TUUqoIe4oeLvgZgIgqv2Aj.jpg.)

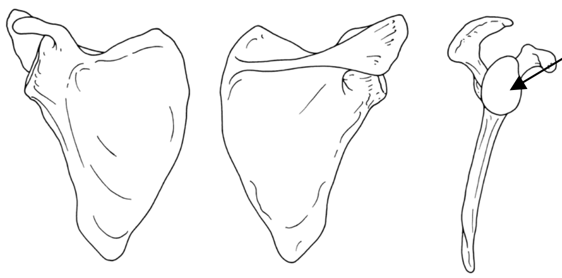
1. Clavicle: Is the **Medial end** (flaring, wide, cone-shaped middle, toward mid-chest)

Immature and unfused (example: wrinkly, with ridges) OR
Mature (flat, rounded, ragged) OR
N/A

2. Left and Right clavicles present? **BOTH ONE N/A**

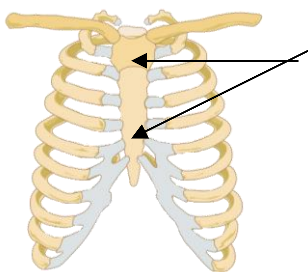
3. Left and Right scapulae present? YES both in good condition
ONE in good condition BOTH Fragments BOTH N/A

Glenoid cavity for humerus



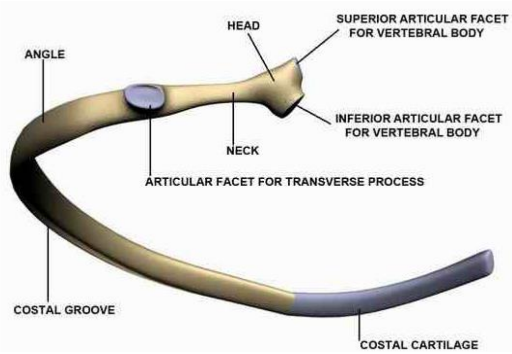
(Source: http://msjensen.cehd.umn.edu/webanatomy_archive/Images/Bones/scapula1.gif.)

4. Ribs: Shown with clavicles and 'breastbone': sternum and manubrium



(Source: http://www.sciencekids.co.nz/images/pictures/humanbody/ribcage.gif.)

The ribs attach to the vertebrae (spinal column) in the back, and then curve around to the chest. Ribs attach to vertebrae at the 'head' and join to chest cartilage at the 'costal' or sternal end.



(Source: http://files.turbosquid.com/Preview/2011/11/27__13_47_05/5th%20rib%20posterior%20view%20LABELED.jpgf89b7f03-da75-482d-9cda-47707e421423Large.jpg.)

The head and neck areas of a rib can show osteoarthritic changes, since these are joints.

The appearance of the **costal** (chest) end of a complete rib can be used for ageing. If the costal end is flat and billowy, this is a youthful feature. As the individual ages, the costal end will develop a cup-like or vee-like indentation, and the adjacent edges will become ever more serrated.

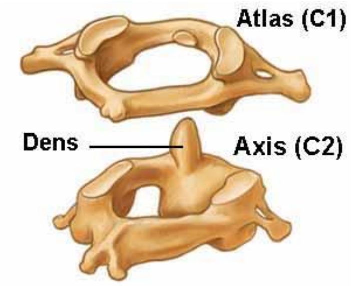
a. **Condition** of Ribs: Most will resemble the illustration of the typical rib shown above, although they will range in size and thickness. The First rib is flat, wide and short. The subsequent ribs are longer and more curved, until the two false ribs, which are thin, short, even stunted. A complete set has 12 Right and 12 Left ribs, but not all of these may be easily recognizable, especially if some are broken and have sections missing.

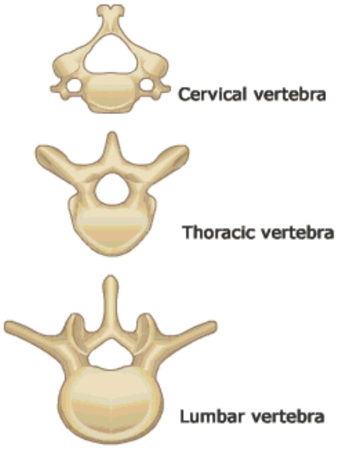
Most ribs look **Complete (head, sternal end)** OR are in **Large sections** OR are in **Fragments** OR **N/A**

b. Costal end with billowy or furrowed/wrinkled appearance **(**youthful) **?** **YES** **NO***

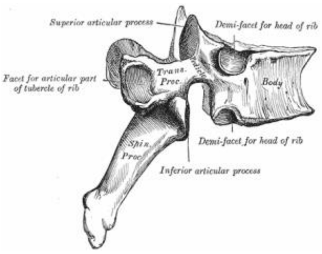
. → If NO*: **Cup-shaped** or V-Shaped with s**mooth** edges**?** **YES** **/ NO***
→ If NO*: **Deeply excavated with ragged** edges? **YES**

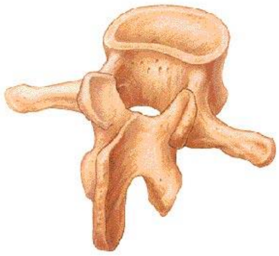
<u>V. Vertebrae</u> The top two cervical (neck) vertebrae are unusual, but the rest follow the basic pattern of body, spinal chord passage, contact joints for subsequent vertebrae.





V.a: Special Cervical (neck) vertebrae V.b: Different types of vertebrae
(V.a source: http://www.spineuniverse.com/conditions/neck-pain/cervical-spine-surgery-will-you-need-surgery-your-neck-pain; V.b Source: http://www.getbodysmart.com/ap/skeletalsystem/skeleton/axial/vertebrae/menu/image.gif.)





V.c: Typical Thoracic (chest) vertebra V.d: Typical Lumbar (lower back) vertebra.
(V.c source: http://en.wikipedia.org/wiki/Thoracic_vertebrae#mediaviewer/File:Gray90.png; V.d source: http://umm.edu/programs/spine/health/guides/anatomy-and-function.)

NOTE: Typically, we have 7 cervical (neck) vertebrae (C), 12 thoracic (upper torso) vertebrae (T) and 5 lumbar (lower back) (L) vertebrae.

The spinal cord passes through most vertebrae via a rounded passage located between the weight-bearing body and the 'contact facets' which connect one vertebra to the next one.

Most cervical vertebrae have concave, 'saddle shaped' bodies, and perforations on either side for arteries. They connect to each other by oblique contact joints (facets).
The thoracic vertebrae are larger than the cervical vertebrae and have bigger rear and side bone protrusions called processes. They connect to each other with vertical contact facets.
The lumbar vertebrae have the largest bodies, smaller side processes, and large rear processes, and connect via curved, interlocking facets.
Some vertebrae may have been lost in the burial environment or during excavation, but some individuals have slightly varying numbers of the different vertebrae.

1. Are there any vertebrae? YES NO

2. Do the vertebrae appear to be complete or mostly complete? YES / NO

3. How many vertebrae in total? ___________ OR **N/A** due to fragments
There are normally 7 C, including the circular C1 and the peg-topped C2. There are normally 12 T vertebrae. There are normally 5 L vertebrae.

VI. Wrist, Ankle, Hands, Feet, Fingers, Toes (Carpals, Tarsals, Metacarpals, Metatarsals, Phalanges)

Assessing individual hand and foot bones is beyond the scope of this general form.
Each hand is made up of 27 separate bones. The wrist is comprised of 8 carpals, the palm of 5 metacarpals, and the digits have two phalanges (finger bones) for the thumb, and three phalanges for each finger, totaling 14 phalanges. Tips of fingers can be very small.

Carpals are very small, with some triangular in shape, and some curved. Metacarpals are very similar to 'long bones' in that they are tubular bones, not flat bones like ribs or shoulder blades. Metacarpals have rounded heads and squarish bases.

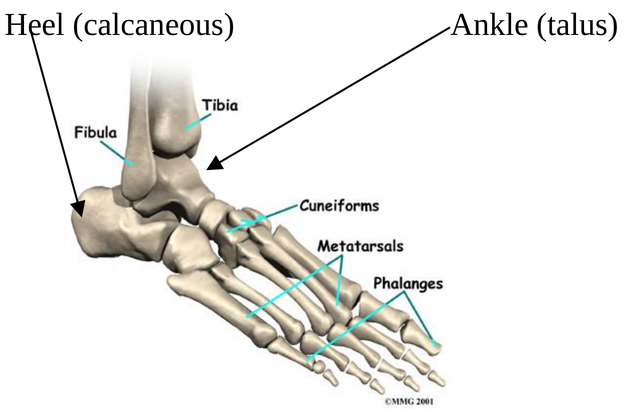
Phalanges (singular: a phalanx) are short bones, oval in profile, that make up the digits of the fingers and toes. Finger phalanges are slightly less flat/oval than toe phalanges.

The foot is similar to the hand: the ankle is comprised of 7 tarsals, which are similar to carpals but larger. The heel is a tarsal and is quite large. The foot has 5 metatarsals, longer and narrower than metacarpals. The toes are comprised of 14 phalanges. Tips of toes can be VERY small.

Unless bones are stored in bags labelled 'Left' or 'Right' (hence 'sided'), simply give total counts. If sided in bags, record the number of left bones, and the number of right bones. Do not worry if you cannot differentiate between the different sorts of bones. The metacarpals may be broken; and if the

individual was adolescent, the bases and heads may not have fused onto the shafts. (Image: http://www.isamartialarts.net/images/wrist_anatomy_bones04.jpg.)

It is good enough to simply record that hand and/or foot bones are present. Try to determine which ones are present only if you have the time. But, this information is very useful!

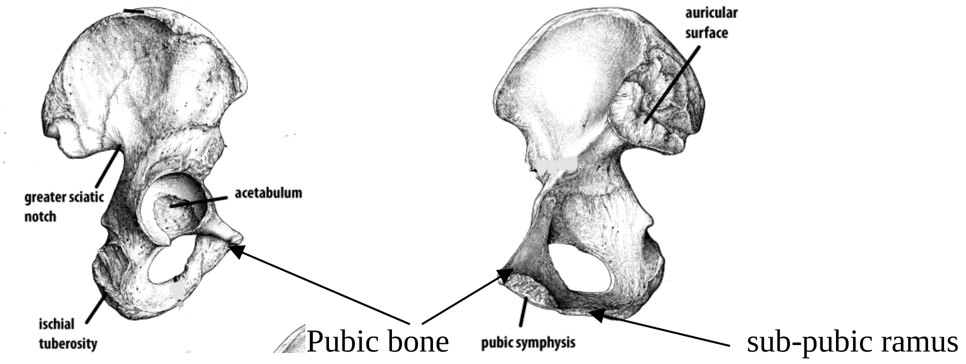


(Image: http://www.eorthopod.com/images/ContentImages/foot/foot_anatomy/foot_anatomy_bones05.jpg .)

VII. Os coxae (pelvic or hip bones)

The hip bones are comprised of three bones that meet and form the hip socket: Above the hip socket, the blade (ilium) is a curved and flattened bone, somewhat like a shallow bowl. The pubic bone, in front of the socket, extends forward. Below the hip socket, which is about 2.5 inches (60 mm) wide, is a thick mass of bone (the ischium). A bar of supporting bone runs from the end up the pubis to the ischium. When the two halves of the pelvis are united, the hip sockets are on the outer sides. The front of the pelvis meets at the pubic bones, but the back of the pelvis is separated by a triangular bone called the sacrum.
The pelvic bones are paired Left & Right. As with paired features in the skull, if only one side is available, score that side.
If both bones are available, and one side is markedly different than the other side please score both and write L and R next to the descriptions.

(Image from https://yapanayoga.com/2011/03/%E2%80%9Ci-si-issues%E2%80%9D-mean/.)



Outer side of R pelvic bone. **Inner side of R pelvic bone.**
(Images adapted from http://johnhawks.net/graphics/os_coxa_labeled_2010.png.)

Note: a broken bone will often have exposed honey-comb spongy bone and splintered edges. A bone ragged due to extreme age or other factors have a more closed-over appearance even if it has holes. Even professionals can't always tell a broken bone from one damaged during life.

Pubic bone: bar of bone jutting forward from the top of the hip socket (the acetabulum). The pubic bone ends in a flattish oval surface, called the **pubic symphysis**. The pubic symphysis undergoes changes throughout the life cycle and is used to age an individual.
Below the oval pubic symphysis is a bar of bone called the 'sub-pubic ramus' which runs between the pubic symphysis and is part of the ischium, a very solid, often lumpy bone below the hip socket (acetabulum).
The pubic bones are often different between adult males and adult females, undergo changes during adulthood, and thus are useful for estimating age and biological sex, but this region is thin and fragile and does not always survive the burial environment.

1. Are **pelvic bones:** **Complete** **Fairly complete** **Shattered** **N/A**

NOTE: do your best if pelvic bones are shattered. It may be very difficult to determine L from R pubic bones.**]**

2. At the end of the pubic bone is the oval face called the **Pubic symphysis** (front region) complete, damaged or missing? See sketch labelled 'Inner side of R Pelvic Bone'.

3. Are **both R and L symphyses** present? If you cannot assign a 'left' or 'right' side to the pelvic bones just select a side as best you can. **YES / NO, only L / R**

4. The Pubic symphysis surface can be **Billowy (**wrinkly; furrowed) which is a youthful appearance, Flat or flattish, or the surface can have **ragged holes or bony growths**. In the sketch labelled 'Inner side of R Pelvic Bone' the pubic symphysis surface is shown with a furrowed surface.

Pubic symphysis edges (rims): The edges (or rims) of the oval symphysis will mature from billowy, indistinct edges at the sides of the furrowed, billowy youthful pubis, to a rimmed oval with a distinct and definite edge. As the individual ages, the edges of the oval begin to break down from hard work and/or extreme age. The symphysis in 'Inner side of R Pelvic Bone' has distinct edges. The sketch is also shown below with the image rotated.

5. Bar of bone between pubis and ischium**: 'Sub-pubic Ramus':** length of bone extending down below the oval Pubic symphysis, shown in sketch 'Inner side of R Pelvic Bone'.

Thick, vertical descends directly from oval pubis face. In the sketch, the ramus is thick, and drops directly from the pubic symphysis. OR

Thin, flaring and curved away from pubis, with small neck between pubis and downward

arc of ramus. It will take practice to note differences.

6.. Greater sciatic notch is a deep curve at back of each hip, placed between the hip socket and the rest of the tall wide blade of the ilium. The general shape and depth of the notch can correspond to biological sex.

Deep, narrow, perhaps tilted back away from socket. **Deeper than it is wide**.

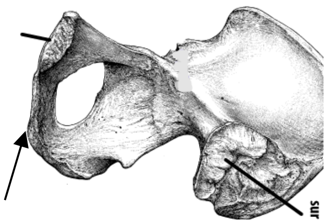
OR

Wide, shallow, symmetrical. OR **Intermediate** Unsure OR **NA**

If both hips present: **Do Left and Right** sciatic **notches match**? **YES / NO**

7. Outer side of Pelvic bones: the **hip socket or acetabulum**. Do the edges appear to be round/oval with firm edges? As we age the edges accumulate damage. With damage, the edges become irregular, rough, bumpy and can lose a distinct rim. In the sketch 'Outer side of R Pelvic Bone', the edges (rims, margins) appear firm.

8 and 9.. Inner side of Pelvic bones: the **Auricular surface** and **pre-auricular sulcus.**



sub-pubic ramus

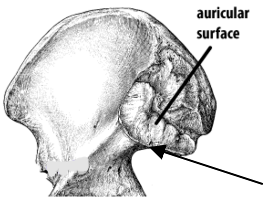
This ear-shaped or kidney shaped region is called the '**auricular surface'** (image adapted from http://johnhawks.net/graphics/os_coxa_labeled_2010.png.)

The 'Auricular Surface' is located at the rear of the pelvis, adjacent to the greater sciatic notch. This surface undergoes changes as we age. In youth it is billowy. As we get older, it can accumulate holes, sharp bone peaks, irregular surface.

8. **Billowy**, solid, with gently rounded wrinkles? OR **Rough, ragged appearance, irregular**,

1 mm holes, many tiny sharpish peaks**?** **Intermediate?**

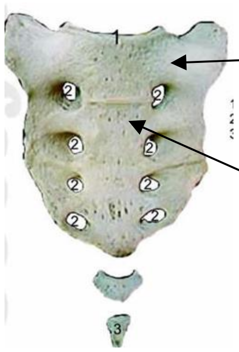
9. Pre-auricular sulcus (trench, groove) tends to correspond to biological sex. If present, it is located below the auricular surface and alongside the back edge of the greater sciatic notch.



Sulcus located here IF it is present

The sulcus can be wide, pronounced, narrow, or not present (image adapted from http://johnhawks.net/graphics/os_coxa_labeled_2010.png.)

The sacrum is a flattish thick triangle of bone, wide on top and narrow at the base. It connects to the hip bones at the auricular surface. A typical adult sacrum has five segments, and when viewed from the front or rear, two columns of four holes down each side.



S1

There is no gap remaining between S1/S2 (Question 12)

S2

(Image source: http://www.mccc.edu/~falkowl/images/Sacrum-answers_000.jpg.)

10. Is the **sacrum** present? The sacrum pictured above is not broken, is fully fused, and has a normal number of sacral segments indicated by the double row of four holes. The small bones below it are the coccyx.

11. Is the sacrum **fused into one bone**? In the image above, the sacrum has fused into one bone. The segments fuse into one bone during middle adolescence.

The top two segments, called S1 and S2 can be fully fused but still retain an opening, or a gap until age 28-30. Even when fully attached, an opening between S1 and S2 can remain until age 30.

12. Is there a **gap** remaining between **S1 and S2 [see illustration]**?

LONG BONE LENGTH: THE FEMUR.

The thigh bone (femur) is the only skeletal element measured using this system. Femur length can correlate with stature, and femur head width (diameter) can correlate with biological sex and body mass. Length is measured with an osteometric board, and femoral head diameter with sliding calipers.
If an osteometric board is not available, estimate length of the femur using a 1 metre scale.
If calipers are not available, estimate maximum femur head diameter using the same scale. The maximum width of the femur head is the widest part of the round knob or ball at the top of the femur. This ball creates the ball and socket of the hip joint.
If one or both femora are broken into only a few large sections and can be re-fit, please take length.
If the femora are from an adolescent and BOTH large endplates are present and can be held whilst bone measured, take the length. Alternatively, the length of the femur shaft of a juvenile without the two end plates but including the neck for the ball joint can be measured.
If length is not measurable or bone is missing, select N/A.

The femur maximum length is obtained by measuring along the shaft from the base to the head.

The head of the femur is measured across the widest part of the round knob or ball-like joint. Only measure the ball of the joint.

PALEOPATHOLOGY SEGMENT

CHECKLIST FOR OBSERVING NORMAL AND ABNORMAL BONE

For all checklist choices: Related conditions are highlighted in BOLD lines.
Inside each bold section, please choose only one option.
If the area is normal or does not have the condition, please choose not present.
If the area is not observable (bone missing or broken), please write N/A.

Please use **N/A** when element is missing and cannot be assessed. Please choose only **one** degree of pathology per heavily- outlined area.

Feature	Description	Present on bones √	N/A
Most or all of teeth in sockets	Healthy teeth in an overall healthy mandible and/or maxilla. **Write N/A if no mandible or maxilla.**		
Even if teeth appear healthy, to be certain that no conditions exist, first briefly look at the choices below. Are there any gaps between teeth, where a tooth once was but is now gone? Are there large sections of upper or lower jaw with filled-in sockets, indicating the teeth were lost months or even years before death? Do any teeth have large hollowed-out holes on their sides, tops? Are there accumulations of brownish, porous bone around the base of teeth? Are there large round holes (3 mm or more) through the mandible or maxilla that exposes the roots of teeth? Note→ The twin holes on the chin, above and either side of the chin, are normal passages for blood vessels and nerves.			
POSTMORTEM Tooth Loss	**Some sockets** empty. Cleaned out. Hollow. The sockets do not have bone filling them in. Some teeth remains in place.	**THIS** **OR**	**Only choose one of the options.**
OR, if more extreme than only a few empty sockets, leave box above empty and choose option below.			
	No teeth. All sockets empty but "clean" and without spongy bone in sockets. Not lost due to obvious disease	**THIS**	
If no sockets are empty please check √ NOT PRESENT.			
Caries (tooth decay; 'cavities')	**Mild** one or two small yellowish or brownish patches on the enamel, or some small holes.	**THIS** **OR**	**Only choose one of the options**
OR	**Moderate:** One or two very large caries with entire tooth hollowed out. **Severe**: Many smaller caries, or several very large caries; +3 teeth with cusps gone and only roots left in socket.	**THIS**	
If no caries observable please check √ NOT PRESENT.			
Tooth loss during life.	**Mild** One or two sockets filled in. Can occur within months of losing a tooth.	**THIS** **OR**	Only choose

OR	**Moderate:** Many sockets filled in. Possible **abscesses** (abnormal openings) on mandible or maxilla. **Severe:** Most or all teeth lost before death, with sockets filled in or even obliterated.	**THIS**	one of the option s
If no sockets filled in please check √ NOT PRESENT.			

Feature	**Description**	**Present or Not Present √**	**N/A**
Worn/chipped Teeth: Enamel removed.	**Mild**: Some dentin exposed through the enamel.	**THIS** **OR**	Only choos e one of the option s
OR	**Moderate/Severe**: Most teeth worn flat or to an angle, or broken off.	**THIS**	
If no teeth appear to be worn please check √ NOT PRESENT.			
Calculus	Hardened substance on tooth surfaces; resembles 'cement'. Can be at base of teeth at 'gum line'.		
If no calculus observed please check √ NOT PRESENT.			
Periodontal disease	**Mild**: small amount of raised, porous (spongy) bone around bases of *some* teeth or even **Moderate:** noticeable spongy bone between and in front of/behind all teeth.	**THIS** **OR**	Only choose one of the options
OR	**Severe:** large holes in body of jaw, exposing tooth roots	**THIS**	
If no porous bone or abnormal holes observed please check √ NOT PRESENT.			
Dental Hypoplasia	**Ridges and furrows** on front (anterior) surface of canines or premolars. **The canines are the 'biting teeth', our sharpest teeth, and premolars are the two just behind canines toward back of jaw.**		
If no ridges are observed please check √ NOT PRESENT.			

The remainder of the form will follow in this pattern. Sometimes, the choice for 'normal' or 'unremarkable' will come before the options. The goal is to make the options as clear as possible.
If a pathology or age-related trait described is observed in two or more states, such as 'Mild' and/or 'Moderate' and/or 'Extreme', please choose only the most extreme one. Example: if the trait is mild in one region of a bone and severe on another region of the same bone, please choose severe.

If the condition or trait is not observed, or if the part of the bone being discussed is not available, please check in the appropriate default box. Thank you!

SKULL: Abnormal bone deposit, bone loss, fractures.

FEATURE	DESCRIPTION	Present? √ or N/A	N/A
EYE ORBITS: Orbits can show bone loss or bone deposits as a result of various factors. The default "not observed" will be offered FIRST for this section.			
Inside eye orbits, on roof or at sides : UNREMARKABLE or N/A Please check here →			
OR	**S**light holes on roof or internal side of orbit		
OR	More holes, may resemble spikes of bone		
FEATURE	**DESCRIPTION**	**Present? √**	**N/A**
Rather than holes, may be deposited bone	Some grayish deposits on roof or side of orbits (internal bleeding, may indicate scurvy).		
OR	Larger, thicker deposits.		

OUTER SKULL: TOP, REAR, SIDES. May select more than one.			
Outer skull [not including face] Unremarkable. Please skip next five boxes and check here →			
	Thick greyish or brownish deposits on skull. May resemble wet sand stuck to skull.	**Can choose more than one.**	
→ Can also include	Porosity (~1 mm holes) on rear or sides of skull.		
And / Or	Roundish bumps on front or sides		
And / Or	Patches of bone loss on outer skull: small with ragged edges; or can be perforating hole. Can also be small with smoothed, 'healed' edges. Diameter should be less than 15-20 mm.		
And / Or	Large patches of bone loss. Can be quite large.		
Only if skull has been shattered and is in fragments can the skull vault thickness be observed. The front and sides are typically 6-8 mm in a healthy adult.			

Vault fragments	Unremarkable, average thickness is well under 10 mm	Choose one, but only if vault thickness exposed.	
OR	skull vault being thicker than 10 mm anywhere except at very rear of skull (occipital protuberance) which is normally thicker bone		

FEATURE	DESCRIPTION	Present? √	N/A
LONG BONES: Joint areas. Appearance on MOST or ALL long bones, including hip sockets.			
Healthy. **This is hard to determine if one has limited experience on bones. However, joints work best when the bone surfaces that make up the joints are smooth, have rounded or somewhat rounded edges, and the joint bone itself is free of holes and small bone deposits.** **The joint edges should generally smooth and unremarkable, without any bony lumps (called osteophytes) which can interrupt the smooth motion of the bones within the joint. Do your best. It is probable that only really dreadful joint disease will be observable and that is just fine.** **If joints for the most part are "healthy" (or N/A) then please check the first box and skip the subsequent boxes in this entire section. →**			
Continued from previous page. **Description** **If present √**			
OR	Overall, many or most joints have sharpened or "well defined" joint edges. May be small patch of shininess (eburnation), small osteophytes (bony lumps) on the joint surfaces or around edges.	**Only choose one of these options. If overall most joints are ok,**	
OR	Several joints extremely abnormal, across several limbs, both arms and legs. Can include shoulder and hip socket. The joints can be enlarged, with noticeable areas of bone destruction, eburnation (shiny patches) and deep grooves on joint surfaces. Widespread. Not just one joint or one side of body.	**and only one is extremely severe, you will have the option to select that below.**	
Local injury or disease on ONE joint? → ONLY IF YES please complete sections below. If no single joint seems abnormal compared to others, skip the next two boxes.			
One joint or bone different from most of others?	**Example: the end of ONE bone has pitting, shiny patches, ragged bony growths at the edges, whereas most others look smooth. Perhaps the matching end of the articulating bone looks similar.**		
Abnormal joint in one arm	Shoulder, elbow, wrist: Specify in box at right		

Abnormal joint in one leg	Hip, knee, ankle: Specify in box at right.		
Local injury or disease SEVERAL bones? → ONLY IF YES please indicate below. Example: All one side of the body, or random arrangement (R knee, R hip, L shoulder). If most joints resemble the others as far as health or damage, please skip the next two boxes.			
Several joints or bones abnormal?	Indicate injured joints below. Example: R elbow, L shoulder, L hip, R knee.		
Upper limbs			
Lower limbs			

	VERTEBRAE Appearance of vertebral body (centra), on top, bottom and sides, and contact facets.	**Present on bones√**	**N/A**
CERVICAL Saddle shaped bodies and oblique contact plates (facets) look smooth or otherwise unremarkable, or are N/A, please check here →			
OR	SOME Saddle shaped bodies look porous, "moth eaten", contact facets enlarged, with foamy appearance.		
OR	As above but more extreme. Facets may be shiny (eburnated).		
OR	Bodies may be fused together.		
THORACIC Heart shaped or roundish bodies and vertical contact facets look smooth, unremarkable. NO osteophytes (lumps) of bone on edges. Youthful "billows" and furrows that radiate out along top and bottoms of vertebral bodies are normal and not disease. . If normal, or unremarkable, or N/A, please check here →			
OR	A few small osteophytes (rounded bone growths) on edges of two or three bodies. Facets widened and flattened, side processes may have rounded rib articulations deepened and enlarged. A few facets may be eburnated (shiny).		
OR	Same as above but more widespread and observed in many vertebrae. Contact facets enlarged, with foamy appearance; more regions of eburnation. Sides of vertebrae may look pinched inward.		
OR	Articulations may be fused, osteophytes severe, or adjacent vertebral bodies fused together. May have eburnation and/or porosity (holes caused by bone loss) at articulations. Vertebral bodies look porous, "moth eaten". Bodies may be abnormally flattened compared to other T verts.		
LUMBAR Oval or kidney-shaped bodies and curved contact facets look smooth, unremarkable. NO lumps or spikey growths on edges of vertebra bodies. Youthful "billows" and furrows that radiate out along top and bottoms of			

vertebral bodies are normal and not disease. If normal, unremarkable or N/A, check here →		
OR	A few small osteophytes (rounded or spiky bone growths) on edges of one or two bodies. Facets widened and porous. The sides of vertebral bodies may be concave.	
OR	Osteophytes extend from most lumbar bodies, in round-tipped spikey growths. Articulations may be fused, and adjacent vertebral bodies fused together. May have eburnation and/or porosity (holes caused by bone loss) at articulations. Bodies may look porous, "moth eaten", may be abnormally flattened.	

IF VERTEBRAE ARE FUSED TOGETHER, is there a smooth sheet of bone down the front of the vertebrae? It has been described as resembling melted candle wax. Skip this section if not applicable.		
	Please skip this section if multiple fused vertebrae are not observed. If multiple fused vertebrae are observed in the C, T or L regions, please choose the appropriate box: Three to five vertebrae fused (C, T or L)→	
	Six or more vertebrae fused together (C, T, and/or L) →	

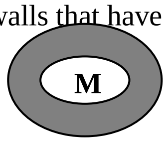
FRACTURES: <u>HEALED</u> INJURIES →[Skip if no Fx] ← Long bones, ribs. → in NOTES, record affected bones.			
FEATURE	**DESCRIPTION**	**Present? √**	**N/A**
SINGLE Fracture, one long bone	**Well healed:** <u>Slight</u> grayish ring of raised, porous bone around bone shafts (callus), or <u>mild</u> angle or bend to a single bone shaft (therefore not rickets), or small bulge on long bone shafts.		
Feature	**Description**	**Present?**	**Notes**
OR	**Badly angled or overlapping bone** from an unreduced fracture. The fracture was not splinted, and the break has healed in abnormal position. May be associated with one or very few small round edged holes (drainage canals).		
OR	**Infected**: Associated with round-edged holes (drainage sinuses); rough edged holes; unusual boney lumps, and/or patches of raised bone that may or may not have rows of ridges.		

MULTIPLE fractures: several long bones	**Well healed:** Slight grayish ring of raised, porous bone around bone shafts, mild angle to bone shafts (is this rickets?), small bulges on long bone shafts. → **in NOTES, record affected bones.**		
And/Or	Badly angled or overlapping bones: the breaks have healed in abnormal position. May be associated with one or very few small round edged holes (drainage canals). → **record affected bones.**		
Single fractures, RIBS	**Well healed:** _Slight raised ring of greyish bone (callus), or mild atypical angle to or bulge on rib shaft.		
OR	**Poorly healed or poorly set**: associated with roundish-edged holes (drainage sinuses); patches of raised bone and/or moth-eaten bone with holes		
Multiple fractures, ribs	**Well healed** Slight raised ring of greyish bone (callus), or mild atypical angle to or bulge on rib shaft.		
OR	**Poorly healed or poorly set**: associated with roundish-edged holes (drainage sinuses); patches of raised bone and/or moth-eaten bone with holes		

CORTICAL THICKNESS: Bone shaft “walls”.

This can only be assessed on a break near the MIDDLE of the bone, because cortex thins out near the ends of long bones. We can observe the mid-shaft only if the bone happens to be broken.
If a long bone is broken around the middle, the interior can be observed.
The “hollow” area in the middle once held the marrow and other tissues. This hollow space is called the medullary canal, the medullary cavity or the marrow canal. The surrounding walls of bone are the sides of the long bone shaft itself.
The thickness of the shaft will vary depending on body mass, activity, and health.

Consider cortical thickness COMPARED TO THE ACTUAL BONE. For example, the cortical (sides) of a healthy forearm will never be as thick as an unhealthy but larger femur with abnormally “thin” cortical mass. An ulna may be 2-3 mm thin on an exposed mid-shaft, but a thin femur might have shaft walls that have a width of 4 mm.
The shaded area is the **Cortical** bone.



“M” marks medullary cavity.
Note: this is normal **“thick”** cortex.

If the shaded / grey cortex in the diagram above was even wider, and the Medullary canal remaining the same or was reduced, the cortex would be abnormally thick.
If the Medullary canal was the same size and yet the cortex (grey/shaded area) much thinner, the cortex would be considered thin.

If none of the long bones are broken, please skip this section.

Feature	Description:	Present √	N/A
LONG BONES: UPPER LIMBS. (Arms)	**Normal cortical** bone in comparison to size of shaft. Please refer to illustration.		
OR	**Abnormally thickened**, with a very narrow medullary cavity in comparison to the overall width of the shaft. .		
OR	**Thin cortical bone** in comparison to rest of shaft.		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers. It is important that only MIDDLE areas are assessed. The ends of bones always have rather thin cortical bone		
INDIVIDUAL ARM BONES: as above but refers to one arm bone (humerus, ulna, radius) being markedly different from the same bone on the other side.			
	Please record the abnormal bone(s)		
LONG BONES: LOWER LIMBS. (Legs)	**Normal cortical bone** in comparison to size of shaft.		
OR	**Abnormally thickened**, with a very narrow medullary cavity in comparison to the overall width of the shaft. Note→ The tibia (shin bone) has very thick cortex at the front crest (where we hit a table with our shins in the dark). Adult tibia crest can be normal at 8+ mm with rear shaft, same area, only 4-5 mm.		
OR	**Thin cortical bone** in comparison to rest of shaft		
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 1 mm or less if using calipers.		
INDIVIDUAL LEG BONES as above but refers to one lower limb (femur, tibia, fibula) being markedly different from the same bone on the other side			
	Please record the abnormal bone(s)		
'Trabecular bone' in any mid-shafts?	**Trabecular is a spongy, porous bone normally found in the ends of long bones, and inside the hips, ribs. It is abnormal in the middle of a long bone. It can only be observed if exposed by postmortem break.**		

MUSCLE ATTACHMENT SITES: ridges where muscles have attached to the bone.			
Feature	**Description**	**Present bones√**	**N/A**
LONG BONES Upper Limbs (arms)	**Raised lines, ridges, or humps** on long bones that mark the attachment site of large muscles. Present and noticeable? Note→ Ridge on side of upper humerus, protruding bumps near humeral head. Protrusion (about 1 " long) near round top of radius. Ridge along shaft of ulna.		
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology!		
OR	**Almost non-existent.** Can be felt with fingers more than seen; or are very mild.		
LONG BONES Lower Limbs (legs)	**Raised lines, ridges, or humps** present and noticeable? Note → Long ridge down back of femur; protruding crests near femur head. Oblique ridge down upper back of tibia.		
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology		
OR	**Almost non-existent.** Felt with fingers more than seen or very mild		

Miscellaneous → If not present or observable, Write N/A ←

Feature	**Description**	**Present or N/A**	**N/A**
Endocranial (inner) Vault defects	Any defect with rounded edges on inner vault surface. ONLY observable on a partial or broken skull vault.		
VERTEBRAE Possible infectious disease	Scooped out areas of destruction on the vertebral body		
Lumbar vertebra: fusion to sacrum.	Abnormal fusion of lowest lumbar vertebra with top of sacrum. Fusing can be on one side or both.		
VERTEBRAE Schmorls nodes	Irregular depressions on top and/or bottom surface **of a few** centrae (vertebral bodies). The depression can be rounded or irregular. Has smoothed sides, similar to mark left by head on a pillow.		
VERTEBRAE Schmorls nodes	As above, but increased number. Irregular depressions on top and or bottom surface **of many** vertebral bodies.		
RIBs (any number)	**Bone deposits** on insides (inner curves) or bone defects. The new bone may look brown or like wet sand pressed onto the ribs. May also look lumpy.		
RIBs (any number)	**Bone deposits** on outer sides (outside of curves).		
RIBS (any number)	**Fusion between two or more ribs. Bridge of bone between ribs.**		

Ribs	**Uneven, rocking shape to ribs when laid flat on a table. Does not refer to the normal curve around the lungs.**		

Long bone: shafts and joints. Abnormal bone (inflammation; infection)

Feature	Description	**Present √**	**N/A**
Long bones, can also include joints,	**Mild** One limb, tibia for example, with raised new bone on surface. May be in raised rows, looking mostly dense but with some small holes. May look 'lumpy'.		
OR	**Moderate/ Severe** Widespread on tibia, other long bones, etc. Thickened, abnormal deposits may be extensive. New bone may be smooth, or with sharp "spikes" (spicules); may be arranged in linear manner of raised rows.		
Only long bones, including joints	**Healed Mild:** single or small defect (hole) or **several small** defects with <u>smoothed</u> healed edges. Defects can be small, shallow scooped out areas, possibly re-filled with bone.		
OR	**Healed Moderate/Severe**: larger defects, more widespread, over several bones **BUT WITH SMOOTH MARGINS** and **NO** ragged edges, no spikey bone near or within defect..		
May <u>ALSO</u> be: May be in different stage of healing elsewhere.	**Active, ongoing:** More holes, edges very spikey, ragged. Shape of defect not rounded but random and irregular. Defects can be quite large (+2 cm, +3 cm) . Medullary canals filled with spongy bone (trabecular bone		

Orthopedic injuries or bone/joint abnormalities: Specific disease.
→N/A if not present←

Ball and socket joints: Humerus or Femur heads Subjected to trauma.	**Odd shaped, small rounded defects, heads flattened, heads partly missing.** The rounded heads can be noticeably flatter; 'dropped' out of typical position ; or have sections missing with rounded edges. Also included small pieces of bone accumulating on the rounded heads. **Note→ On Answer sheet, humerus and femur assessed in separate boxes.**	
Joints defects, such as distal femur, tibia humerus: MILD	**Small defects on joint surfaces, on the rounded or concave regions that are in actual contact when joint functions.** Does not include the rounded heads of femur and humerus, assessed just above**. Small (1-2 mm) bone chips missing, bone fragments added, and or edges missing off joints. On one or two surfaces.**	

Joint defects, moderate	Small defects on bone, **widespread** over many joints**, or large sections (3mm+)** missing from **two or more joints.**	
Sacrum	**Odd shaped:** Rather straight, very curved (even bent or folded), too long (6+ segments, based on five rows of large holes or 'foramen') or too short (less than 5 segments, based on 3 rows of foramen).	
Rickets mild	**Long bones with mildly curved shafts.** Especially lower limbs. Mild. Some bowing on some elements. Left should match right of the same bone, such as left and right femur with curve; left and right tibia. Otherwise, one curved bone may represent greenstick fracture.	
Rickets moderate	**Long bones with markedly curved shafts.** More widespread, on upper as well as lower limbs.	

Appendix 4: Revised RAS

Rapid Assessment Form ANSWER FORM Please refer to booklet for additional instructions, and supportive text and illustrations.

Skeleton Number ______________Box/Burial Nos.____________________________ Country of origin _________________

If the remains are currently being curated, they may be separated into labelled bags. **After you have completely finished with the assessment,** please take care to return elements to the same marked bag, especially hand/foot bones.
All skeletal elements are listed using their 'correct' name and 'popular' name. All elements, or specific details of individual elements, are illustrated in Information Booklet.

OVERALL IMPRESSION OF REMAINS

Are remains already in a marked box? **Yes** **No**
Are elements stored in separate bags such as Left Leg and Right Arm?
Yes **Some bags** **No**

Overall impression of remains: **Fairly Complete Individual** **YES** **PARTIAL**
NO

Bones in **Good condition** (not broken, outer surfaces not flaking away?)
YES **NO**

Sex: if information provided: Male/ Prob M / Female / Prob F / Unknown / Nonadult

Age range: if information provided: (Infant) (2-14) (15-25) (25-35) (35-45) (45+)

Cranial observations: Circle ONE best answer possible Circle N/A if aspect is fragmented or missing. Please refer to Information Booklet for support illustrations

I. Skull

1. Skull complete? **YES** **NO***
IF NO* → **Broken into a few large pieces?** OR **Shattered?**

2. Frontal plate (Forehead): **Sloped somewhat back** OR **Vertical** OR **Moderate (**between two extremes**)** OR **N/A**

3. Raised **glabella** (hump of bone between and above eyes)
YES OR **NO** OR **MILD** OR **N/A**

4. **Supra-orbital ridge** (ridge running over the eyes)
Robust (large, pronounced) OR **Gracile** (slight, mild) OR **Moderate** OR **N/A**

5. Occipital plate (back of skull):
Robust (pronounced beak or humps of bone) OR **Mostly smooth** OR
Moderate OR **N/A**

6. Zygomatic arches (cheek bones; protruding arches on sides of facial area)
Robust (thick) OR **Gracile** (thin, fragile) OR **Moderate** OR
both N/A

7. **Lateral** (outer) edges of **orbits** (eyes): **Rounded/thick** OR **Sharp/ thin/** OR
M**oderate** OR **both N/A**

8. Mastoid process (lump of bone behind ear hole) **Wide / large** OR
Small / narrow OR M**oderate** OR **both N/A**

9. **SupraEAM crest** (ridge over ear and mastoid process) **YES** OR **NO** OR
SLIGHT OR or **both N/A**

10. Maxilla (upper jaw & half of nasal cavity) **Left side**: **Complete** OR **Partial** OR **N/A**
Right side: Complete OR **Partial** OR
N/A

11. Nasal area: **Complete** OR **Partial** OR **N/A**

<u>**II. Mandible (**</u>lower jaw) + Teeth in both jaws

1.a Is Mandible present? **YES** OR **NO**
→ If Yes: **Complete and unbroken** OR **Several large sections** OR
Mostly small pieces

b. Mandible: **Overall:** **Robust** (heavy, thick) OR **Gracile** (delicate, thin) OR
Moderate (between two extremes)

c. Is mandible **edentulous** (toothless)? **YES** OR **NO**

2. Mental eminence (chin): **Squared off** (wide) OR **Rounded** perhaps pointed OR
Moderate OR **N/A**

3. **Condyles** (rear knobs of bone; where mandible connects to skull**) present?**
YES OR **NO** OR **PARTIAL** OR **N/A**

4. Gonial Angles (rear lower angle of jaw: Jaw line)**: Robust** (square, flaring outward, with ridges) OR **Rounded** (curved, thin) OR **Moderate** OR **N/A**

5. Teeth in general (consider both upper and lower jaws): Choose as many as options necessary.

Unworn (like new) **Mild Wear** (some flattening of cusps, but no dentin exposed)

Moderate (more cusps flattened, some dentin exposed) **Very worn or chipped** (grey or brownish dentine completely exposed) **Teeth lost during life** with socket filled in by bone (healed over: no socket) **Teeth Missing (post-mortem, or after death)** with empty sockets

<u>III. Post-cranial bones:</u> (all bones below the skull) **Circle best answer possible.**

> **Note: a broken bone will often have exposed honey-comb spongy bone and splintered edges. A bone ragged due to extreme age or other factors have a more closed-over appearance even if it has holes. Even professionals can't always tell a broken bone from one damaged during life.**

1. Long bones (arms and legs). Three arm bones and three leg bones per side.

All 12 present and look complete [**please refer to sketch**] OR

All 12 probably present but one or more broken into large sections OR

Can't be sure if 12 present most broken / fragmented, many small sections OR

No long bones or very few fragments.

Note: if long bones missing or too fragmented to assess, <u>please skip to Section IV below.</u>

2. Overall size of larger long bones (femur, humerus, tibia) **if probably adult**

Large, heavy, and "robust", with pronounced bumps and ridges (muscle attachment sites), OR

Smallish, thin, smooth and "gracile" (few muscle attachments are noticeable) OR

Moderate.

3. Joint areas: found at the ends of long bones, where one bone joins (articulates) with another

Look Complete OR
Fairly complete, some edges broken OR
One or two missing entirely (broken off) OR
Most joint areas missing.

4. Patella (knee cap: oval, flattish disc of bone). **Both L&R present**
One (L OR R) present **N/A**

IV Clavicle (collar bone), Scapula (shoulder blade), and Ribs

1. Clavicle: Is the **Medial** end (the flaring, cone-shaped end):
Immature and unfused (example: wrinkly, with ridges) OR
Mature (flat, rounded, ragged) OR
N/A

2. Left and Right clavicles present? **YES BOTH** **ONE** **N/A**

3. Left and Right scapulae present? **YES:** both in good/fair condition
ONE in good condition **BOTH Fragments** **BOTH**
N/A

4. Ribs:

a. Condition of Ribs: **Complete** **Large sections** **Fragments**
N/A

b. Costal ends (toward front, not toward spine/vertebrae**)** **Flattish/wrinkly (**youthful)
YES **NO** [if NO → **see below**] OR **N/A**

→ **If NO**: **Cup-shaped** or **V-**Shaped with s**mooth/round scalloped** edges**?** **YES**
NO [if NO → **see below**]
→ **If NO: Deeply excavated with ragged/thin/uneven** edges? **YES**

V. Vertebrae:

1. Are there any vertebrae? **YES** **NO**

2. IF YES Do the vertebrae appear to be complete or mostly complete?
YES **NO mostly fragments**
How many vertebrae in total? ___________ OR **N/A** due to fragments
NOTE: If you cannot identify the three main types of vertebrae (Cervical, Thoracic, Lumbar), an overall count is adequate.

This Section is OPTIONAL: Using illustrations in Information Booklet, please provide counts of the three different types of vertebrae:

C _________ T ________ L _________

VI. Wrist, Ankle, Hands, Feet, Fingers and Toes (Carpals, Tarsals, Metacarpals, Metatarsals, Phalanges)

Assessing individual hand and foot bones is beyond the scope of this general form.

Unless bones are stored in bags labelled by side (ex: left hand, right foot), simply give total counts of all bones per type.
If stored in bags labelled by side, record the number of left bones, the number of right bones in appropriate area (hand or foot).

If all podials (hand and foot bones) are in one single bag, provide count here: ___________

Go to VII. Os Coxae

Total count of small bones for hand (if not labelled separately) _____________
OR
Left Hand (if labelled as 'left') _______Right Hand (if labelled as 'right')_____

Total count of small bones for foot (if not labelled separately) ______________
OR
Left Foot (if labelled as 'left') _____Right Foot (if labelled as 'right') ________

Don't worry if you cannot identify the different types of hand or foot bones. If you can identify and count the different bones, using the Information Booklet, that is excellent, but just determining if hand/foot bones are present at all is adequate. If bones are broken or nonadult (unfused), or if sesamoid bones are also stored in the bags, you will end up with more than the normal counts of each type of adult hand/foot bones provided below.

This Section is OPTIONAL:

HAND
1.Carpals (small, squarish, or irregular) L=_____R=_____(8 each hand, 16 total)
2. Metacarpals (short tubular bones, with rounded heads and squared bases)
L= ____ R=_____(5 each hand, 10 total)
3. Phalanges: (finger phalanges tend to be flatter along mid-shaft, toe phalanges rounder) L=_____R=_____(14 each hand, 28 total)

FOOT
4. Tarsals (larger than carpals, some like triangular cubes. This includes the heel)
L=_____ R=_____(7 each foot, 14 total)
5. Metatarsals (short tubular bones, with flattish heads and squared bases)
L=_____ R=_____(5 each foot, 10 total)
6. Phalanges: (toe phalanges rounder than hand phalanges, and narrowed at mid-shaft) L=______R=_____(14 each foot, 28 total)

VII. Os coxae (pelvic bones, also termed hip bones)

Note: a broken bone will often have exposed honey-comb spongy bone and splintered edges. A bone ragged due to extreme age or other factors have a more closed-over appearance even if it has holes. Even professionals can't always tell a broken bone from one damaged during life.

Front of pelvic bones

1. Are **pelvic bones: Complete Fairly complete Shattered N/A**
NOTE: do your best if pelvic bones are shattered. It may be very difficult to determine L from R pubic bones.**]**

2. Pubic symphysis (oval front region) present? [see sketch in Information Booklet**]**
YES OR **Yes, partly broken** OR **N/A: pubic symphysis broken off.**

3. Both (L & R) symphyses present? **YES both** OR **NO neither** OR **One (L or R) present**

4. a.Pubic symphysis surface **Billowy (**wrinkly; furrowed)? **YES NO Slightly**
b. Flat surface **YES NO Slightly flat**

c. Are surfaces 'ragged' with holes or bony growths? YES NO

d. Sharp/distinct rims (margins; edges) **Both YES** OR **Both NO** **Only one** edge sharp

e. Ragged irregular margins (edges) **Both YES** OR **Both NO** OR **Only one** edge ragged

5. Sub-pubic Ramus: strut of bone branching off below oval **Pubic symphysis:**
Thick, vertical? descends directly from oval pubis face <u>OR</u>
Thin, flaring, curved away from pubis?, with small neck between pubis and oblique arc of ramus

Rear of pelvic bones.

6. Greater sciatic notch (deep curve at back of each hip):
a. Deep, narrow, perhaps tilted back to rough and raised articulation for sacrum OR
Wide, shallow, symmetrical OR **Intermediate** OR **NA**

b. If both hips present: **Do Left and Right** sciatic **notches match**? **YES NO**

7. Outer side of pelvic bones**: hip sockets. Are the rims:**
Round/oval with firm edges OR **Irregular, 'bumpy' rough** OR **Very uneven,** noticeably damaged

8. Auricular Surface (ear-shaped region near back of pelvic bones**):**
Billowy, solid, with gently rounded wrinkles? **Yes** **Yes some** **No** **N/A**
OR
Rough, ragged appearance, irregular, 1 mm holes, many tiny sharpish peaks**?**
YES **Yes some** **NO** **N/A**
OR Intermediate?

9. Pre-auricular sulcus (a trench, a groove) below auricular surface [please see information booklet]
YES wide, pronounced OR **YES mild** OR **NO** **N/A**

The sacrum is a flattish thick triangle of bone that connects to the hip bones at the auricular surface. A typical adult sacrum has five segments, the widest at the top and smallest at the bottom; and when viewed from the front, two columns of four holes down each side.

10. Is the **sacrum** present? **YES** **Yes, large fragments** **Yes, small fragments**
NO

11. If complete: Are all the **sacral segments fused into one bone?** **YES** **NO**

12. If fused into one bone, is there a **gap** or opening between **S1 and S2?** (Please see
Information Booklet illustration**)** **YES** **NO** **Yes fused**, fusion line visible.

VIII. LONG BONE MEASUREMENTS: THE FEMUR.

The thigh bone (femur) will be the only skeletal element measured using this system. Femur length can correlate with stature, and femur head width (diameter) can correlate with biological sex and body mass. Length is measured with an osteometric board, and femoral head diameter with sliding calipers.
If an osteometric board is not available, estimate length of the femur using a metric scale.
If calipers are not available, estimate maximum femur head diameter using the same scale.
The maximum **width of the femur head is the widest part of the round knob or ball** at the top of the femur. This ball creates the ball and socket of the hip joint.
If one or both femora are broken into only a few large sections and can be re-fit, please take length. If length is not measurable or bone is missing, select N/A.

Length (mm) L femur: MAX Total Length _________ mm or N/A
Diameter (width) of Head _________ mm or N/A

R femur: MAX Total length: _________ mm or N/A
Diameter of Head _________ mm or N/A

Appendix 4: Revised RAS

CHECKLIST FOR OBSERVING NORMAL AND ABNORMAL BONE

For all checklist choices: Related conditions are outlined in BOLD. Inside each bold section, please choose only one option: Present/ Not Present/ Not Available.
If trait or abnormality is observable, choose Present
If the area is normal or does not have the condition, please choose Not Present.
If the area is not observable due to breakage, please choose N/A.

Please use **N/A** when element is missing and cannot be assessed. Please choose only **one** degree of pathology per heavily- outlined area. Leave the unused boxes blank.

Feature	Description	Pre-sent √	Not Pre-sent √	N/A
Most or all of teeth in sockets	**Healthy teeth** in an overall healthy mandible and/or maxilla. Select Not Present and answer all below if not healthy.			
The following options are probably not present if teeth mostly deemed 'Healthy' but please examine dental traits below anyway				
POSTMORTEM Tooth Loss	**Some sockets** empty; no woven bone filling them in; some teeth in place. Sockets not filled in; tooth loss is after death.			
OR	**No teeth.** All sockets empty but "clean" and without spongy bone in sockets. Not lost due to obvious disease			
CARIES (tooth decay; 'cavities')	**Mild** one or two small yellowish marks or small holes on sides or tops of teeth.			
OR	**Moderate:** One or two **very large** caries, tooth hollowed out. OR **Severe** Many large caries; more than three teeth hollowed out and only roots left in socket.			
TOOTH LOST during life.	**Mild** One, two or even three sockets filled in with bone.			
OR	**Moderate/ Severe:** Most or all teeth lost before death, with sockets filled in or even obliterated.			
WORN/Chipped Teeth: Enamel removed.	**Mild**: Some dentin exposed through the enamel.			
OR	**Moderate/Severe**: Most teeth worn flat or to an angle, or broken off.			
CALCULUS	Hardened substance on tooth surfaces; resembles 'cement'. Can be at base of teeth at 'gum line'.			

Periodontal disease	**Mild or Moderate**: small amount of raised, porous (spongy) bone around bases of *some* teeth			
OR	**Severe:** large holes in body of jaw, exposing tooth roots. Note: the twin holes above mental eminence are normal passages for nerves and blood vessels.			
Dental Hypoplasia	**Ridges and furrows** on front (anterior) surface of canines or premolars (not front teeth).			

The remainder of the form will follow in this pattern. For every trait that you are asked to observe, please choose ONE option: Present, Not Present, or N/A. The goal is to make your choices as clear as possible.

If a trait can be described as two options, such as "Mild" or "Moderate" or "Extreme", please choose only one, and select the most extreme one.

If the condition or trait is not observed, or if the part of the bone being discussed is not available, please check the appropriate default box. Thank you!

SKULL: abnormal bone deposits and bone loss; fractures.

FEATURE	DESCRIPTION	Present √	Not Present √	N/A
EYE ORBITS: Option "not observed" will be offered FIRST in following sections.				
Inside orbits, on roof or at sides : Unremarkable. Please skip next two boxes and check here in Not Present →				
OR	Slight holes along inside of orbit, or slight grey/brown bone deposits that resemble wet sand.			
OR	More holes, may resemble spikes of bone; or more notable 'wet sand' deposits.			

OUTER SKULL: TOP, REAR, SIDES. May select more than one.

FEATURE	DESCRIPTION	Present √	Not Present √	N/A
Outer skull [not including face]: **Unremarkable. If no unusual bone deposits or bone loss is observed, please skip next five boxes and check here→**				
OR	Thick greyish/brownish deposits on skull. In patches.			
And / Or	Small holes, close together, ~1 mm or so in diameter. May cover large areas of skull surface			

And / Or	Small roundish bumps on front or sides			
And / Or	Patches of bone loss on outer skull: small, perhaps 15-20 mm maximum diameter. Can include perforation.			
And / Or	Large patches of bone loss: can be quite extensive with irregular edges.			
Skull vault thickness can be observed only if skull is in fragments. If not broken, please select N/A				
Vault fragments	Unremarkable, average thickness is well under 10 mm			
OR	skull vault being thicker than 10 mm except at very rear of skull			

LONG BONES: Joint areas. Appearance on MOST or ALL long bone joints				
FEATURE	**DESCRIPTION**	**Pre-sent √**	**Not Pre-sent √**	**N/A**
Healthy. **Joint edges generally smooth, no bony lumps (osteophytes), no holes or shininess on joint surfaces. If no pathology observed, or no joints are available to be assessed, select Not Present or N/A →**				
OR	**Most joints, overall**: sharpened edges, small patches of shininess (eburnation), small lumps (osteophytes) on joint surfaces or around edges. Can include **one** small round or irregular area of joint bone missing.			
OR	**Several joints extremely abnormal**, across several limbs. Include shoulder and hip socket. Widespread. Head (round knob) of femur or half-sphere of humerus may be misshapen.			
Local injury or disease on ONE joint? → ONLY IF YES please complete sections below. Otherwise select N/A				
Most joints appear 'normal', but ONE region is severely abnormal: joint area enlarged, osteophytes on edges (margins), small round or irregular area of joint area missing		**Pre-sent √**	**Not Pre-sent√**	**N/A**
Abnormal joint in one arm	Shoulder, or elbow, or wrist: check mark if present. Half-sphere of humerus may be misshapen.			
Abnormal joint in one leg	Hip, or knee, or ankle: check mark if present. Round head of femur may be misshapen.			

Local injury or disease SEVERAL joints? → ONLY IF YES please indicate below. If no such pattern observed, select N/A.				
FEATURE	**DESCRIPTION**	**Pre-sent √**	**Not Pre-sent√**	**N/A**
Several joints abnormal?	**As above. Abnormal shape, appearance or small regions of bone loss.**			
Upper limbs (arms)				
Lower limbs (legs)				

VERTEBRAE: spinal column.

Appearance of vertebral body (centra), on top, bottom and sides, and contact facets.

FEATURE	DESCRIPTION	Present√	Not Pre-sent √	N/A
CERVICAL (neck) vertebrae **Saddle shaped bodies and oblique contact plates (facets) look smooth or otherwise unremarkable. If so, skip following 3 boxes and check here→**				
OR	SOME Saddle shaped bodies look porous, "moth eaten", contact facets enlarged, with foamy appearance.			
OR	As above but more extreme. Facets may be shiny (proper term: eburnated).			
OR	Bodies may be fused together.			
THORACIC (chest, rib) vertebrae **Heart shaped /roundish bodies and vertical contact facets smooth, unremarkable. No bony growths (osteophytes*) on edges of vertebral bodies. If so, skip 3 boxes below and check here →**				
OR	A few osteophytes* (proper term for a type of rounded bone growths) on two or three bodies. Contact facets widened and flattened, rib articulations may be deepened and enlarged.			
OR	Same as above, but contact facets enlarged, with foamy appearance; maybe with regions of eburnation (shininess). Increased osteophytes*.			
OR	Osteophytes* severe. Several vertebral bodies may be fused together. Eburnation and/or porosity (holes due to bone loss) at articulations. Bodies may be abnormally flattened compared to other T vertebrae			
LUMBAR (lower back) vertebrae **Oval / kidney-shaped bodies and curved contact facets smooth, unremarkable. Bodies do not have bony growths on edges, sides of bodies are relatively vertical. If so, please check here →**				
OR	A few osteophytes* (rounded or spiky) on one or two bodies. Facets widened and porous. Sides of vertebral bodies may be concave.			
OR	Osteophytes* on most lumbar bodies. Vertebrae may be fused together. Eburnation and/or porosity at articulations. Bodies may be abnormally flat.			
IF MULTIPLE VERTEBRAE ARE FUSED TOGETHER, please indicate here **Use N/A if this section is not applicable.**				

Three to five vertebrae fused (C, T or L) →			
Six or more vertebrae fused together. →			

FRACTURES: HEALED INJURIES sustained months/ years before death.
****See box below for unhealed fractures sustained around time of death. These can be curved, have smooth edges, or a smooth surface that ends in an abrupt torn area.**
(Post-mortem damage to bones will have very splintered, uneven edges)

FEATURE	DESCRIPTION	Present √	Not pre-sent √	N/A
Please choose from single fracture OR multiple fractures below. If no fractures observed, check here→				
SINGLE Fractures long bones	**Well healed:** Slight grayish ring of raised, porous bone around bone shafts (callus), or mild angle or bend to **one** bone shaft (therefore not rickets), or small bulge on bone.			
OR	Badly angled or overlapping bone. May be associated with one small round edged hole (drainage canal).			
OR	Badly angled or overlapping, with round-edged holes (drainage sinuses); unusual bony lumps, patches of raised bone that may be quite extensive.			
MULTIPLE fractures long bones	**Well healed:** Slight grayish ring of raised, porous bone around bone shafts, mild angle to bone shafts (is this rickets?), small bulges on long bone shafts.			
And / Or	Badly angled or overlapping bones. May be associated with one or very few small round edged holes (drainage canals). .			
Ribs: Please choose from single fracture OR multiple fractures. If no fractures observed, check here→				
SINGLE fracture RIBS	**Well healed:** Slight raised ring of greyish bone (callus), or mild atypical angle or bulge on rib shaft.			
OR	**Poorly healed / poorly set**: possibly with roundish-edged holes (drainage sinuses); patches of raised bone and/or 'moth-eaten' bone with holes			
Multiple fractures, ribs	**Well healed** Slight rings of greyish bone (callus), mild angle or bulge on rib shafts.			

AND/OR	**Poorly healed or poorly set**: possibly with roundish-edged holes (drainage sinuses); patches of raised bone,, moth-eaten bone, holes			

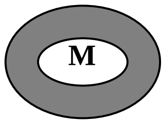
****Any suspected <u>perimortem</u> (near time of death) fractures? Curved, smoothed edges; may resemble broken bottle glass: curved, sharp well-defined edges. LIST BONES IN BOX BELOW**

CORTICAL THICKNESS: Bone shaft "walls".

Can only be assessed via a break near the <u>MIDDLE</u> of the bone, which exposes the internal bone area near the mid-shaft. This is because cortex (cortical bone) naturally thins out near the ends of long bones. We can observe the mid-shaft only if the bone happens to be broken.

Consider cortex compared to the size of the bone. For example, a "thin" ulna may be 2 mm thin on an exposed mid-shaft, but a thin femur might have shaft walls that have a width of 4 mm.

The shaded area is the Cortical bone.



"M" marks the medullary cavity. Note: this is a **"normal"** cortex.

Feature	Description	Pre-sent √	Not Pre-sent√	N/A
If no upper limbs (arm bones) are broken, check here and skip to lower limbs in next section. →				
UPPER LIMBS (arms) Cortical mass of exposed mid-shafts.	**If several arm bones broken are they all "normal"?** **Normal** bone in comparison to size of shaft.			
OR	**<u>Abnormally</u> thickened**, with a **very narrow** medullary cavity **in comparison to the overall** width of the shaft.			
OR	**Thin cortical bone** in comparison to rest of shaft.			
OR	**<u>Abnormally</u> thin bone,** almost as thin as a piece of paper. 1mm or less with calipers.			
INDIVIDUAL ARM BONES: as above but refers to <u>one</u> arm bone (humerus, ulna, radius) being markedly different from the same bone on the other side				
Please record the abnormal arm bone(s) here				
If no lower limbs (leg bones) are broken, skip remaining observations on lower limb bones. Go to trabecular bone in the next section and check here. →				

LOWER LIMBS (LEGS) Cortical mass of exposed mid-shafts.	**Thick healthy "normal"** bone in comparison to size of shaft.			
OR	**Abnormally thickened**, with very narrow medullary cavity in comparison to overall width of the shaft.			
OR	**Thin cortical bone** in comparison to rest of shaft			
OR	**Abnormally thin bone,** almost as thin as a piece of paper. 2mm or less with calipers.			

INDIVIDUAL LEG BONES as above but refers to one lower limb (femur, tibia, fibula) being markedly different from the same bone on the other side	
Please record the abnormal leg bone(s) here	

Trabecular (spongy) bone in any mid-shafts? Abnormal spongy bone in a mid-shaft region can be observed if exposed by post-mortem break. If no bones are broken, please select N/A			
	Pre-sent	**Not Pre-sent**	**N/A**
Trabecular ("spongy") bone exposed in mid-shaft of arm bones? **If yes list affected bones in long box directly below**			
Trabecular ("spongy") bone exposed in mid-shaft of leg bones? **If yes list affected bones in long box directly below.**			

MUSCLE ATTACHMENT SITES

Feature	Descriptions	Present √	Not Present√	N/A
LONG BONES UPPER LIMBS (Arms)	**Raised lines, ridges, or humps p**resent and noticeable			
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology!			

OR	**Almost non-existent.** Can be felt with fingers more than seen; or are very mild.			
LONG BONES LOWER LIMBS (Legs)	**Raised lines, ridges, or humps** present and noticeable?			
OR	**Large, ragged ridges with scooped out defects** near and within muscle site. Can look like pathology			
OR	**Almost non-existent.** Felt with fingers more than seen or very mild			

Long bones: Abnormal Bone (Inflammation; Infection)				
FEATURE	**DESCRIPTION**	**Pre-sent√**	**Not Pre-sent√**	**N/A**
If all long bone shafts and associated joints look relatively normal, check here and skip this entire section. →				\
LONG BONES ONLY. Does not include joints, ribs or vertebrae	**Mild:** One long bone, tibia for example, with raised new bone on surface. May be in raised rows, looking mostly dense but with some small holes. May look 'lumpy'. Only on surface.			
OR	**Moderate/ Severe:** Widespread on tibia, other long bones, etc. Thickened, abnormal deposits may be extensive. May be arranged in linear manner in raised smooth rows. Only on outer surfaces; does not extend INTO shaft.			

Long bone shaft chronic conditions that involve the outside (outer shaft) and inside of the bone (medullary canal). Healed (first two options) and Chronic/ Ongoing (third option). May select ONE from Healed, AND / OR also Ongoing (if observed).				
FEATURE	**DESCRIPTION**	**Pre-sent√**	**Not Pre-sent√**	**N/A**
LONG BONES ONLY. Does not include joints, ribs or vertebrae	**Healed Mild:** Dense, lumpy bone with one or very few small defects (holes) with <u>smoothed</u> edges. Defects can be scooped out areas 're-filled' with bone. On one or two bones only.			
OR	**Healed Moderate/Severe**: larger defects, more widespread, over several limbs **BUT WITH SMOOTH MARGINS** and **NO** ragged edges, no spicules (spikey bone) inside defects. .			
May <u>ALSO</u> be ongoing in one area and healing or healed elsewhere.	**Active, ongoing:** Holes rimmed with spikey bone, ragged irregular edges. Defects can be quite large. Patches of spikey bone on shafts, often surrounded by raised rim of rough bone.			

Miscellaneous: if these traits or pathologies are noted, check √Present.

Feature	Description.	Pre-sent√	Not Pre-sent√	N/A
Endocranial (inner) skull vault defects	Bone loss seen on inside curves of skull vault: any defect with ragged or rounded edges on inner vault surface. **Can only be seen in broken / partial skull.**			
VERTEBRAE **Possible infectious disease**	Scooped out areas of destruction on vertebral body. Can be viewed internally using the defect, or observed on front corners on vertebral body. If present, please put count of affected vertebrae in **Present**√ box with √.			
Lumbar vertebra fused to Sacrum	Abnormal growth, fusion: lower lumbar vertebra (L5) fused with sacrum. May be partial: one side of L5 fused to sacrum, or on both sides.			
VERTEBRAE 'Schmorl's nodes'	Irregular smooth sided depressions on top and/or bottom surface **of a few** centrae (vertebral bodies) **OR**			
VERTEBRAE 'Schmorl's nodes'	Irregular depressions on top and or bottom surface **of many** vertebral bodies.			
RIBs (any number)	**Bone deposits** on inside (**inner curves**). Abnormal bone formation along inner surface. May be brown and porous, or look like wet sand pressed onto ribs. May resemble bumps of 'normal' coloured bone.			
RIBs (any number)	**Bone deposits** on outer sides (**outside of curves**). As above but on rib outer curves.			
RIBS (any number)	**Fusion between two or more ribs. Bridge of bone between ribs.**			
Rickets Mild	**Long bones with curved shafts, especially lower limbs.** Mild curves; some bowing on some elements, but matched between left and right. (ex: L&R femur, and/or L&R tibia; but not only one femur or one tibia)			
Rickets moderate /Severe	**Long bones with curved shafts.** More widespread, on upper as well as lower limbs, **marked curves.**			
Rickets: possible indication	**Ribs** with **extreme curvature:** ribs that do not lay flat on the table. [Does not include normal curve around the lungs which is front to back].			

Rickets: possible indication	**Scapula:** the blade (the thin, long and wide triangle) **curved noticeably**			

Please use Notes sparingly. Most observations should be in the checklist sheets. Details such as individual long bones with extreme bone changes can be detailed here.
If you have training that enables you to enhance earlier observations, please add these here.

Notes:

Appendix 5: Participant Comments

Participant Comments from Week One as recorded by author or as written as notes on answer sheets.

Problems include a need for pictures or illustrations. Need ‘normal’ option. Need to reverse C T L count. Need immature iliac crest. Need patella, scapula, clavicles. Need to simplify hand and foot bone counts, they lose an hour here. Need clarity for ramus description, and a sketch.

02IC
“A separate booklet with detailed sketches, photos, even showing a specific pathology would be useful. ALSO organise record sheet so that all Qs relating to, e.g., lower limb are together.”
“Delete scale. Issue ruler.”

03RC
“? Further definition of parts” “What is Wide? etc”. “what is misaligned?” “Uncertain of anatomy—sketch indicator?” Instead of my phrase “Only if Yes” he suggests “Only if Present, ---“ For Gr sciatic notch: “Uncertain of anatomy-sketch indicator?” For sacrum: “As pelvis in pieces uncertainty again as to anatomy. Sketch?” For T path: Circled several words in descript and wrote “definition”: articulations (fair enough) and osteophytes, defined repeatedly thru section except this one place.
Stopped at cortical thickness.

04AH
Made very good suggestions on assessing degree. Rather than Mild/Gracile, Robust, Moderate, at each query ask: “Strongly pronounced / moderately pronounced / not pronounced” (torus), or “Raised / Mildly raised / Not raised” (glabella). “Protruding, moderately protruding, not protruding” (external occipital). Didn’t like multiple choices for orbits, preferred broken into separate observations. “Rounded, moderately rounded, not rounded; Sharp, moderately sharp, not sharp”, but this may be too much detail and offer too many opportunities for mistakes. For glabella and torus area, writes “Too many multiple Qs to which answer of Y or No is impossible”.

Same suggestion with rib ends but here he is correct. Needs to be fixed. “Need 3 separate Qs: Is it cup y/n V-shaped y/n Smooth y/n”

Did not count podials, writes “feet and hand bones are separated” This may be adequate.
Wrote in details of premortem TL and postmortem TL and wear etc rather than checking boxes. Stopped at cortical bone assessment.

05GL
Did excellent on first half of form. Lost too much time at vertebrae and podials. Made excellent (and since adopted) suggestion for femur head: to describe as “ball”. Very good on clavicles. For ‘medial end’ she wrote “what does this mean=middle end?? confusing” but correctly chose mature clavicle medial anyway and wrote: “now I understand—perhaps highlight ‘toward the centre’ of skeleton”.

So this volunteer can become confused but will read information to better understand what is expected. Did throughout form. Made comment, crossed out as she found info she needed. → **for future I must supply glossary!**

Next to description of post-mortem damaged bone versus in vivo trauma, she writes: “very important” and then “Very useful information. Should appear earlier in this form”. True. Beside “vertebrae” in rib section she writes “In spinal column” which is good term for novices.

Excellent on pubic bones, but the form needs a better explanation of dorsal versus ventral, saying “one side” made participants think Left versus Right rather than two sides of the same pubic bone. Was trying to avoid “front or back” for folks who would not know how to consider the front versus back of an os coxa.

Comment adjacent to podial counts: “‘sided’: what does this mean”. Larger sized drawings needed of foot and hand. .

For diameter of femur writes “Please put exactly what needs to be measured – just the ball or complete top of femur”.

Writes “Outer view” and “Inner view” near sketch of os coxa.

Sulcus “Where is it? Need it marked on sketch page 5. N/A could not comment”

Writes “what are osteophytes?” then crosses out, presumably after spotting word defined in several other locations.

Due to inserted headers, “Name Date Box/skel” appears atop each page, but also at top of page 1. She writes “why twice?” For country of original writes ‘UK (Perhaps since we are in UK)’. Beside age ranges “? not available”

Near (badly photocopied) sketch “This would be clearer as a B&W drawing”.

In notes: “After 3 hours I could not continue! Overall the whole form needs to be simplified for amateurs. Absolutely exhausted!”

Three sorts failed to complete form: lost time with fiddly podials and verts [MUST move specific counts to ‘extra work’ or pathology!]. GL didn’t complete for this reason.
Or was too busy giving stick on form’s shortcomings and designing new Qs. Third type to leave unfinished was frustrated, hesitant and unsure, or annoyed at form.

06PH.
“Need to ID [sub-pubic ramus] on sketch”. “Perhaps with a novice the first few results could be discarded, but form a valuable part of the learning process”

07RH
Supplied small comments throughout (such as ‘Some processes detached and fragmentary’ in the count of cervical vertebrae). Also sketched posterior of skull (with foramen magnum, teeth and mastoids) to illustrate that skull was warped:

"This [for. mag.] is off-centre (moved L)." Drew arrow and wrote "flat" for R occipital. "Rear of skull: L and R are differently shaped, R side flattened".

He went on to mention it again, when the pathology section on skull did not have an area to note the asymmetry: [having chosen "roundish bumps on front or sides"]: "This doesn't really fit- the skull (rear) appears to be more developed on the left side than the right—it is not symmetrical, but this doesn't seem to be due to roundish bumps, but it is not 'unremarkable'!" Premature suture fusion, assessed in the inventory, has likely affected the shape of the skull.

Also noticed diff between sulcus posterior to mastoids. "R process is positioned nearer back of skull, and notch adjacent is 'V' shaped; notch on L side is 'U' shaped." → **might need notes section in inventory for observant volunteers. This suite of traits would be very interesting for anyone studying torticollis, premature suture fusion or scoliosis.**

08MH
Assessed same skeleton as partner and indeed worked together but each recorded independent observations. Sorted out the asymmetrical skull by recognising premature fusion of Lambda, almost the only one to do so.

Pretty much the only participant to successfully unravel the auricular surface assessment.

"NB- Looking at reference skeleton is very useful. Also being able to compare skeletons would be useful especially to assess robust/gracile, wide/narrow etc".

15BD:
" would benefit from pictures (pubic symp) Lots of jargon – needs pictures of examples. "

16 WH
"A diagram of each needed. " (vertebrae)

17CB
"need pictures to help."

19KM
"A sketch or something might help to identify."

20ND
"Top and lower jaw separate?" (dentition)

21TR
"What do you classify as 'moderate'?"
[For mandible] More definition: Complete Unbroken / Complete several lg sections / Complete mostly small pieces / partial: several large sections Partial: Mostly small pieces. Mention possibility of sesamoid bone in big toe? Break down upper and lower jaws.

[for cortex] 'No broken bones, move to next section'. If you get rid of 'None or N/A' completely, your options are 'Present' and 'Notes'.   [he offers] Present' for each option and [suggests] 'If None of the above tick here'.

22ZE
"What's wrinkly? What do you mean by ragged? "

23MS
"no option for 'None' "(for dentition)   "What would this look like?" [for Schmorl's]. "Found a bit confusing" [periosteal inflammation or infection; medullary infection]

24AF
<u>Chose None for every option except a present pathology</u>. In his own way, good.

25 SH
[worked with author on pube query design: Very billowy / Mild billows / Flat with sharp edges / Flat with ragged edges / Ragged.]. " Perhaps diagram of teeth?" [cortex] "Maybe a 'not broken' section?"

26AY
<u>Chose None for all possible pathologies unless was Present</u>]

27PF
identical answers to 26AY. Not scored.

28AP
<u>Chose None for all pathology options unless Present]</u>

32BB
For glabella: "Nothing to compare it to".
"No experience of this at all, found it quite difficult. When asked whether something is thick or thin [cranial morphology at start of sheets] need something to compare this with, e.g., How many mms or Thinner than what."
Also felt quite "punch drunk" by the end.

Note: 32BB could not choose pathological versus normal, no previous experience and nothing to compare. Same with ragged pubic margins versus post-mortem damage.
Not clear what meant by 'Costal rib ends'
Not clear what meant by 'front of Vertebra'   [author assumed!]
Form not clear: not easy to see where to choose NA versus leaving Q blank.

33AB
"Initial handling/ examination/ identification of human and animal bones at Bournemouth March 2012. "

34OM
"Have no experience so down to guesswork! Sorry if I have 'seen' the wrong things."

Appendix 6: Links to Sketches used in RAS

Links to web pages from which sketches are taken for Winchester 2012

skull in profile M vs F http://www.drbecky.com/skulls.gif

Diane France M vs F skulls
http://www.wadsworth.com/anthropology_d/special_features/forensics/forensics_index/pix/ALTFIG2S.jpg

Skull M v F anterior and lateral: http://www.juniordentist.com/wp-content/uploads/2008/09/male-skull-vs-female-skull.jpeg

mandible http://www.probertencyclopaedia.com/j/Mandible.jpg

skeleton from google http://www.lessontutor.com/jm_skeleton.html

skeleton with clearer labels
http://hes.ucfsd.org/gclaypo/skelweb/graphics/skelant.jpg

tooth in cross section
http://www.3dscience.com/img/Products/Images/clip_art/tooth_cross_section_web.jpg

hand http://www.isamartialarts.net/images/wrist_anatomy_bones04.jpg

foot
http://www.eorthopod.com/images/ContentImages/foot/foot_anatomy/foot_anatomy_bones05.jpg

clavicle humerus scapula
http://pic.hkcos.org.hk/hkcoswebcontents/f/FIJHBvRwvYJyrCV6TUUqoIe4oeLvgZgIgqv2Aj.jpg

scapula
http://msjensen.cehd.umn.edu/webanatomy_archive/Images/Bones/scapula1.gif

arm http://thesebonesofmine.files.wordpress.com/2011/05/arm1.gif

rib
http://files.turbosquid.com/Preview/2011/11/27__13_47_05/5th%20rib%20posterior%20view%20LABELED.jpgf89b7f03-da75-482d-9cda-47707e421423Large.jpg

C T L
http://www.getbodysmart.com/ap/skeletalsystem/skeleton/axial/vertebrae/menu/image.gif

L vert http://www.umm.edu/spinecenter/education/images/vertebra.jpg

Appendix 6: Links to Sketches used in RAS

rib cage with clavs
http://www.sciencekids.co.nz/images/pictures/humanbody/ribcage.gif

hips, L verts, femur www.julesmitchell.com

R os coxa medial http://johnhawks.net/graphics/os_coxa_labeled_2010.png

hip bones   http://api.demandmedia.com/DM-Resize/cdn-write.demandstudios.com/upload//2000/900/70/5/402975.jpg?w=400&h=400&keep_ratio=1

sacrum   http://www.bartleby.com/107/Images/small/image95.jpg

sacrum http://www.mccc.edu/~falkowl/images/Sacrum-answers_000.jpg

cranial deformation horizontal
http://upload.wikimedia.org/wikipedia/commons/thumb/9/91/PSM_V17_D754_Cranium_of_koskeemo_indian.jpg/272px-PSM_V17_D754_Cranium_of_koskeemo_indian.jpg

cranial deformation vertical
http://www.bibliotecapleyades.net/atlantida_mu/atlantis/img/27500.jpg

Appendix 7: Content of Accompanying CD

0 Index
1 Questions for Protocol Versions 1 and 2
2 Excel Spread Sheets: All Answers by week
Inventory, Paleopathology. Important Qs Adult v Student
3 Independent samples t test
4 Pared samples t test