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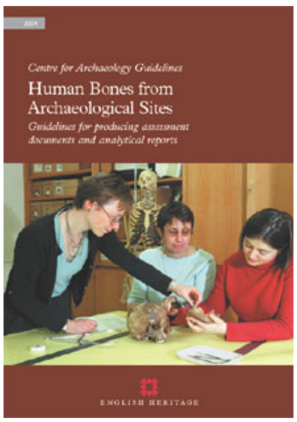
Human Bones from Archaeological Sites



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2004

Centre for Archaeology Guidelines

Human Bones from Archaeological Sites

Guidelines for producing assessment documents and analytical reports

ENGLISH HERITAGE

Preamble

The purpose of this document is to establish guidelines for best practice for the production of assessment documents and analytical reports on human skeletal remains excavated from archaeological sites. It is written primarily for practising osteologists taking part in archaeological fieldwork projects. It should also be of value to Local Authority Curators, Project Managers producing project briefs and project designs, and to Project Officers responsible for supervision of fieldwork.

Successful completion of an archaeological project depends upon careful planning and implementation. Projects normally pass through five phases: planning, fieldwork, assessment, analysis and dissemination. The present document focuses on human skeletal remains within this general framework.

For fieldwork projects expected to yield significant quantities of human remains, a human osteologist should be appointed from the outset as a member of the core team. The osteologist should be qualified at least to masters level in human osteology or, if this is not the case, he or she should have considerable experience in the scientific study of human remains from archaeological sites. During the planning phase, the osteologist should have the opportunity to contribute to the project design. In fieldwork that involves excavation of cemeteries, work on the human remains should form a major component of the project design, and the input of the osteologist in formulating a research agenda will be paramount. In addition, the osteologist should play a part in devising the excavation, recording and sampling strategy for features containing human remains. During the planning phase, the Project Manager should make contact with a suitable museum, university department or other institution for eventual deposition of the project archive. Human remains can take up large amounts of storage space, so it is essential that adequate provision be made if, as is generally the case, the bones will be retained for future study rather than re-buried.

If excavations produce significant quantities of human remains, it is likely that the Project Osteologist will wish to be present on-site regularly during the fieldwork phase. This presence helps to ensure that correct procedures are implemented in the excavation and recording of human remains. This procedure also permits excavation strategies to be fine-tuned to take into account conditions on site, and helps to overcome problems and to take advantage of unexpected opportunities. To help ensure that best practice is adhered to, it is useful for the Project Osteologist to educate all field staff involved in a cemetery excavation in the basics of human osteology and to explain clearly why certain procedures (which may be time-consuming and tedious) need to be followed. The osteologist should also help to ensure that adequate post-excavation processing of human remains is carried out so that the material is in a fit state for assessment. For inhumations, this will involve washing, drying, marking and packing. All deposits containing cremated bone should be subject to whole-earth recovery. Cremated bone needs to be separated from soil and other material by sieving and sorting. Prior to assessment all cremation-related deposits should normally have been processed in this way. The only possible exception is for very large cremation cemeteries (several hundred burials), where it may be sufficient, for the purposes of assessment, to process a sub-sample of the burials.

Human bone assessments

The purpose of an assessment

The aim of the assessment phase of an archaeological project is to evaluate the potential of the fieldwork data and excavated material to contribute to archaeological knowledge, and in this light to identify what further analysis is necessary. During this phase, appropriate specialists undertake the assessment of the different classes of remains recovered during fieldwork. There should be intense communication between the different specialists working on a project to ensure that strands of evidence are brought together to maximise their potential. This collaboration will probably be accomplished through project team meetings. Following this process, the various specialists can revise their draft assessments, which will then be used by the Project Manager to update the project design. The assessment documents are not normally published but are retained as part of the site archive.

The aim of a human bone assessment is twofold. It is to produce a document including factual data about the assemblage (quantity, nature and condition of remains); and to establish whether the material is sufficiently important to merit further study, and if so, what should be done, how long it will take and what it will cost. It is important to emphasise that an assessment document is not a shortened or preliminary version of a bone report; no detailed analytical study should be undertaken until the assessment phase has been completed. Assessment documents will usually be fairly brief – a few sides of A4 paper at most.

To produce an adequate assessment it is necessary both to look at the bones themselves and to study relevant site and context information supplied by the Project Manager or Project Officer. The information that will be needed will probably include the following:

- a copy of the project design
- a brief account of the nature of the site (often called a site narrative)
- a list of contexts yielding human bone, together with a list of what these contexts are (eg inhumation burial, spread of burnt bone, cremation burial (urned/unurned))
- details of which contexts represent disturbed or truncated material
- a provisional dating and phasing of contexts yielding human remains
- plans showing the location of burials or other deposits of human remains
- photographs and/or drawings of inhumation burials *in situ*
- details of the recovery methods used (eg details of sieving protocols for cremations)
- details of associated finds (eg grave goods, presence of a coffin or other relevant information)
- for cremated bone, weight of bone recovered from each context

The assessment document

The first part of an assessment report should comprise factual data about the bone assemblage, describing the quantity and provenance of the skeletal material and the general condition of the remains.

Quantifying the material

In a cemetery site, the number of burials can generally be ascertained from the field records. The completeness of inhumation burials can often be assessed from the site photographs or drawings. Simply looking into the boxes of bone can augment these initial records. For larger assemblages the completeness of burials might be tabulated, as shown in the example below.

Table 1 Skeletal completeness

	approximate completeness				
	>75%	~75%	~50%	<25%	*total*
N	45	40	14	4	103

For cremated bone, remains from each context should be quantified by weight. Weighing cremated bone should form part of the post-excavation processing by unit staff and such data should be supplied to the osteologist.

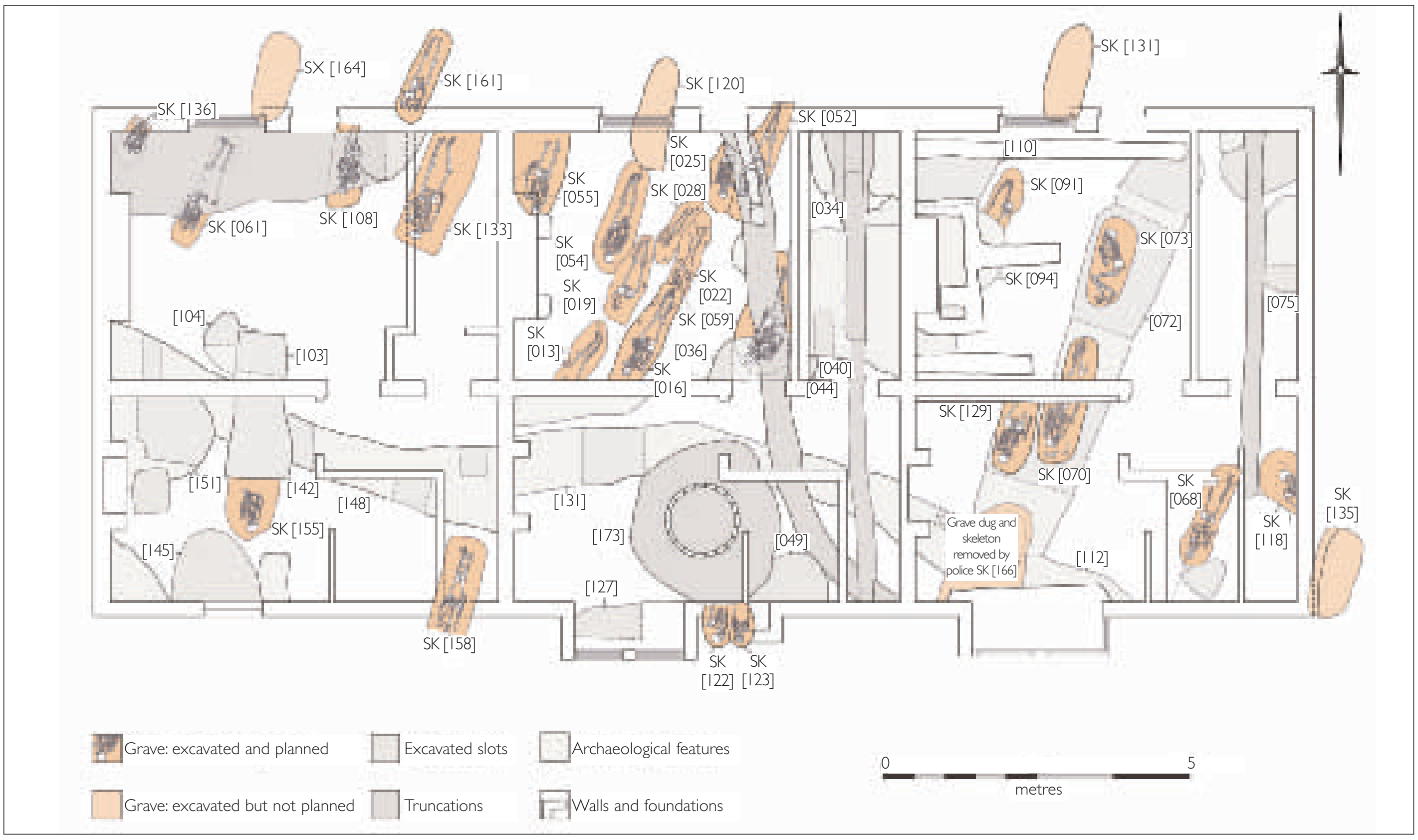

Figure 1 Draft plan of part of the Roman cemetery at Jesus Lane, Cambridge. (© Cambridge Archaeological Unit)

Where material can be sub-divided by phase, it is important to quantify the material by phase so that the osteologist can assess the feasibility of investigating changes in various classes of osteological data over time.

Condition of the bone and nature of the assemblage

Notes should be made on the general condition of the bone, as this will influence the information that can be gained from an assemblage. This part of the assessment needs to be conducted by examination of the skeletal material, either of the entire assemblage or, in the case of large assemblages (more than *c* 100 burials), of a sub-sample of it. Questions that might be considered include: are the bone surfaces so eroded that much pathological information is lost; and are most skulls too broken for measurements to be taken from them? In reference to this latter, it is useful to consider the question of whether some basic reconstruction (ie sticking together of fragments) is merited in order to enable more measurements to be taken and to facilitate recording of other aspects. Generally, only minor reconstruction is worthwhile. Attempting to piece together badly fragmented crania or other bones is generally not worth the time and effort; the emphasis should be on careful recovery during fieldwork and on careful packing to minimise breakage.

It is useful to note the approximate proportion of skeletons showing pathologies sufficiently unusual to demand detailed discussion, photography, radiography or the application of other analytical techniques. Cases of diseases such as tuberculosis, leprosy or syphilis will normally merit this sort of attention, whereas in most instances more common conditions, such as osteoarthritis, cribra orbitalia and simple fractures, will not. It is also worth noting the approximate ratio of adults to juveniles in the assemblage because this will affect the strategy for, and amount of, any analytical work that is proposed. For example many non-metric traits and measurements cannot be recorded on juveniles, and many of the more frequent disease conditions, such as osteoarthritis, are rarely manifested before adulthood.

It is not normally necessary for the purposes of an assessment to attempt to make more precise estimates of age or to determine sex, although it is useful to indicate the extent to which this is likely to be possible, given the state of the remains. For cremation burials, assessment of fragmentation is useful, and this might lead to statements such as ‘most fragments <10mm long’ or ‘many fragments >30mm’.

Potential of the assemblage and proposals for further study

After the summary of the factual data, there should be a brief note summarising the potential of the collection for further study at the analysis phase. This should include a note of what further work (if any) is thought appropriate.

The potential of an assemblage for analysis is affected by the interplay of various factors:

Size. The size of the assemblage is clearly of importance; other things being equal, a large assemblage is generally of greater potential because patterning in data is more readily detected with larger numbers of individuals. For most of the prehistoric period in Britain, however, large cemeteries simply do not exist, so it is crucial that adequate work is carried out on the small assemblages. Only in this way will osteologists be able to build up a picture of prehistoric human skeletal biology.

Skeletal preservation. Clearly, more scientific data can be extracted from complete and well preserved skeletons than from material that has survived in poor condition. It is worth noting, however, that gross bone preservation might not be a good indication of the viability of chemical and biochemical analyses. In some regions soil conditions mean, in general, that bone survival is poor. In such instances poorly preserved material will need to be studied if we are to learn anything about regional palaeopopulations from their physical remains.

The value of disarticulated material. Cemetery excavations generally produce significant quantities of disturbed, disarticulated skeletal material. Such material is of limited scientific value. Firstly, it is usually difficult to date. Secondly, most scientific work involves relating different types of data to one another at the individual level. For example, to study skeletal growth we need to have data both on bone size and on age at death; for the study of physique and stature we need to consider separately measurements of males and females; and for the adequate diagnosis of bony pathologies we generally need to study both lesion morphology and the distribution of lesions in the skeleton. With disarticulated material we cannot combine data in this way.

Figure 2 A late Bronze Age burial in a posthole from a four-post structure, Bradley Fen, Cambridgeshire. (© Cambridge Archaeological Unit)

For these reasons, disturbed, and disarticulated bone is not usually considered worthy of study at the analysis phase. Although the study of material that has become disarticulated as a result of post-depositional disturbance is not a priority for study, the same does not, of course, apply to material, such as that from Neolithic long-barrows, that was deliberately deposited in a disarticulated state in antiquity.

Dating. Clearly, the tighter the dating of an assemblage, the greater its value. The extent to which precise dating is possible, however, tends to vary for different periods. For example, most late medieval collections can only be dated to within a few centuries, whereas it is often possible to tie down early Saxon and post-medieval burials to within much more precise limits. When larger collections can be split into phases their research value is enhanced. When dating is vague (eg 'medieval/post-medieval' or 'prehistoric'), and there are no compelling reasons for radiometric dating of remains, this seriously compromises the value of an assemblage.

Special assemblages. Some assemblages are of particular value because they are unusual in some way. Perhaps the most important type of 'special assemblage' is that for which biographical information – such as name, age, date of death – is available from grave-markers or coffin-plates, and can be associated with individual skeletons. Such assemblages are essentially restricted to the post-medieval period. As well as contributing significantly to our knowledge of post-medieval populations, such collections also enable us to test existing osteological methodologies and to devise new ones. In this way such assemblages increase the quantity and reliability of data potentially available from skeletal remains in general.

Although decisions need to be made on a case-by-case basis, in general if dating and skeletal survival are adequate, most osteologists would consider that even small assemblages, provided they are of articulated skeletons, are worthy of some further study in the analysis phase. Most workers do not consider that disarticulated material from re-worked deposits merits study at the analysis phase.

If an assemblage is thought to be of sufficient potential to merit study beyond assessment, the problems to be investigated through the study of the human remains at the analysis phase should be set out in the assessment document. The problems might be research questions from the project design or they might be questions that become apparent during the assessment phase.

Larger assemblages are in general more likely to make significant contributions to research questions identified in the project design, and further research directions are likely to suggest themselves more readily at the assessment phase than is the case with smaller bodies of material. For larger assemblages, statements such as the following might emerge:

Differences in activity patterns between monastic brethren and layfolk will be investigated by comparison of humerus diaphysial morphology between burials from the monks' burial ground and from lay burials within the church.

Even for smaller assemblages, efforts should be made to focus work on archaeological problems if this is possible. For example:

There are several decapitated burials of Romano-British date. The age and sex of the affected individuals, the character and location of the cut-marks on the cervical vertebrae, and the position of the skulls in the graves, will be discussed in the light of previous work on this class of burials. This part of the proposed work will contribute significantly to the study of ritual practices at the site, a question identified as a priority in the project design.

Or:

For the four late Saxon burials, which are apparently not associated with any formal cemetery area, comparisons will be made with findings reported from other groups of late Saxon interments found in non-cemetery contexts in an attempt to shed light on reasons for this unusual burial practice.

For some small assemblages, however, it is difficult to address specific research questions, even though the material might still be considered to merit some further work beyond assessment. In such instances, statements such as the following are adequate:

For the four cremation burials, weight of bone present, estimations of mean fragment size, bone colours (to aid estimation of firing temperatures), minimum numbers of individuals in each burial and, where possible, age and sex will be recorded. Attempts will be made to diagnose any pathological changes encountered, and any artefacts or animal bone will be extracted and passed to relevant specialists.

For most assemblages, it is useful to make comparisons with reports published on material from other sites. This might simply be to put the results from the material under study in context, or particular comparisons might be needed to help fulfil specific research aims, as in the examples above. A detailed list of site reports to be used for comparative purposes is not required as part of the assessment document, but it is useful to give some idea of the sorts of comparisons that might be made.

Details of the proposed analytical work should be given. Often the basics can be summarised by citing a published osteological report – one of the writer's own or someone else's – but it must be a published report, not an unpublished manuscript. A statement such as this might be used:

Age and sex determinations, and metric and non-metric traits will be recorded as in Mays (1996), and pathological changes will be examined and possible diagnoses suggested.

Details of any other aspects to be recorded should also be given. A few sentences showing how the recording strategy is related to the overall aims of the work should also be included, particularly for large assemblages or where novel techniques are proposed.

Traditionally, site-based reporting work on human remains has relied upon visual examination of the material, backed up by measurement, and perhaps radiography to aid the interpretation of some pathologies. In recent years, however, archaeology has benefited from the introduction of a number of novel techniques, such as stable isotope analysis and the amplification of ancient DNA, which may be applied to human remains. The techniques used for study of an assemblage should to a large extent be determined by the questions to be investigated, and this applies no less to chemical analytical techniques such as DNA and stable isotope determinations, than it does to the more traditional methods. If there are research questions that are best addressed using advanced analytical techniques (and the Project Osteologist may need to contact an appropriate specialist in those analytical techniques to help determine this) then the assessment should propose that those be used. The use of such techniques, however, should be adequately justified in terms of the questions addressed. The number and type of samples to be analysed, who is to conduct the analysis, and the costs involved should each be clearly explained. As a third party, rather than the Project Osteologist, will usually perform these analyses, there will need to be close liaison between the Project

Osteologist and the laboratory staff who will carry out the work. No samples of bone or teeth should be removed for destructive analysis until the updated project design, containing the osteological assessment document with the planned work and costings, has been approved, and the skeletons in question have been fully recorded at the analysis phase by the Project Osteologist.

Costings and timings

An estimate of the amount of osteologist's time required to conduct the proposed programme of work should be given. Other costs, for work done for a fee, should be itemised. As well as analytical work, such as DNA or stable isotope analyses, extra costs would include the production of images, such as radiographs and photographs. Images are usually selected to illustrate some unusual or important pathological condition, in order to help a reader of the analytical report to form his or her own opinion of the validity of any diagnosis offered. Images would also help illustrate complex bony alterations, which are difficult to describe in words. When scheduling work for the analytical phase, account should be taken of the order in which tasks need to be done (eg osteological recording prior to removal of samples for destructive work). An estimate of the approximate length of the proposed analytical report should be given.

What constitutes a reasonable time estimate for a particular size of assemblage varies greatly, depending upon the nature of the material and the work to be carried out on it. For recording inhumations, an estimate of about two skeletons per day is reasonable, if they are fairly complete adults, to cover most of the basic aspects: recording of skeletal elements, metric and non-metric analyses, and identification and recording of pathologies. Less complete material and immature skeletons generally take less time. For substantial cremations, a rate of about four per day is reasonable. Time to analyse the data and write the analytical report would be in addition to these times.

Curation and storage

It is usual during the assessment phase of an archaeological project to give attention to provisions for the long-term curation of the project archive. It is useful in the osteological assessment to give recommendations on the desirability of retaining the skeletal collection for future study. The existence, on record, of an informed scientific opinion on this matter would be useful if there is any future debate regarding the value of retaining the remains.

Human Bone Reports

Once the updated project design has been approved, the analysis phase of the project begins. In this phase, the Project Osteologist will implement the analyses recommended in the assessment document and will produce an analytical report, in publishable text, describing the findings. The exact format of the published osteological report will depend upon the nature of the assemblage, the site archaeology and the place chosen for publication (eg as a journal article, monograph or other form). The most usual format for cemetery sites is for the osteological report to be a separate section, while the results of the report are integrated, as appropriate, into other sections of the fieldwork report. The more important the assemblage, and the more relevant the osteological results are to broader archaeological questions, the greater will be the impact of the findings from the human bones on the conclusions of the fieldwork report. The analysis phase also results in the production of a data archive consisting of copies of the primary data on paper or in electronic form, together with radiographs, photographs and other records.

The purpose of the report

It will be apparent from foregoing sections of these guidelines that the primary purpose of a bone report should be to shed light upon the questions identified during the assessment phase. However, there are also two secondary, but nevertheless important, functions. A bone report makes osteological data available to other osteologists: it can be used as a source of comparative data by those preparing bone reports on other assemblages or by those writing research papers, or it might feature in reviews or meta-analyses of aspects of osteological work. A third function of the bone report is to alert osteologists to the existence of a research collection that might be of interest to them. It is a common misconception that the publication of a bone report represents the culmination of the scientific study of the material. For all but the lesser collections this is untrue – the appearance of the bone report publicises the existence of the collection and stimulates interest in its study among researchers.

The readership of the report

It follows from the above that the readership for an osteological report is likely to be twofold. Firstly, there are archaeologists, and perhaps scientists who are not osteologists, who will read the report for the light it might shed on general archaeological and scientific questions. Not least among this group is the Project Manager for whom the work is carried out. He or she bears ultimate responsibility for the nature of the overall report on the fieldwork and for the extent to which the osteological findings feature in the overall interpretation and appraisal of the fieldwork results. Secondly, there is a readership, primarily of osteologists, who might read it for its contribution to general archaeological and scientific problems, but will probably use it primarily for the data it contains.

Reports should be written with an archaeological but non-osteologist readership in mind. They should be as free as is practicable from technical jargon, and should be written concisely in clear, simple language. Such a style will make the material easier to integrate into the main report and will be comprehensible to non-osteologists.

The content and structure of the report

Human bone is found in a variety of situations and quantities, and this diversity of material will be reflected in the content and structure of reports. Some generalisations can be made, however.

Content

The detailed content of the report will depend to a great extent upon the nature of the material and the research questions to be investigated and should reflect the strategy formulated at the assessment phase. Nevertheless, reports should normally contain information on the following aspects:

- quantity and nature of the material
  For inhumations an inventory of bones and teeth present in each burial should be recorded, and approximate skeletal completeness for each burial estimated. For cremations, weight of remains and some measure of fragmentation should be given, and a note made of bone colours.
- demography (age and sex)
- normal variation (metric and non-metric aspects of the cranial and post-cranial skeleton, including estimates of stature)
- abnormal variation (injury and disease of the bones and teeth)

Structure

As is generally the case with scientific research papers, most osteological reports should consist of the following parts: introduction, methods, results (in the main body of the text and also perhaps as an appendix) and discussion. A summary or conclusions section might also be added.

Introduction. The purpose of the introduction is to acquaint a reader with the material upon which the report is based. It should summarise the approximate amount of material (eg number of inhumation or cremation burials examined), its date and the type of contexts from which it derives (eg cemetery, settlement, barrow). In addition, the quality of the evidence should be considered; this might entail a discussion of recovery methods, whether a cemetery was excavated in its entirety, taphonomic factors pertaining to the site and other relevant information. Because publication of large fieldwork projects might occur some years after the scientific analyses were completed, the date of the osteological work should be given. Some of this information might be available elsewhere in the site report, but its repetition in the introduction to the bone report will help the reader to form a quick impression of whether the human remains are likely to be of interest without having to wade through the whole site report.

For larger assemblages, the questions to be addressed in the report should be set out so that the reader has an idea of the rationale guiding the work.

Methods. The methods used should always be described so that a reader can understand the way in which results were obtained. Methods should be described in the publication text. References to descriptions held in the project archive or to unpublished sources, such as PhD theses or archive reports are not sufficient. For commonly used techniques, reference to a standard work will suffice. This is likely to be the case for most ageing and sexing techniques, most measurements and non-metric traits, and the recording of some common pathologies. This will lead to simple statements, such as:

In adults, age at death was estimated using dental wear (Brothwell, 1981: Fig. 3.9) and sex was determined using dimorphic aspects of the pelvis and skull (Brothwell, 1981).

In the skulls, measurements were taken according to Brothwell (1981) and the non-metric variants of Berry and Berry (1967) were recorded.

Osteoarthritic changes were identified and recorded using the criteria of Rogers et al (1987).

For more complex or lesser-known techniques a fuller description, together with references, if appropriate, should be given.

Results. The results section will list, tabulate and perhaps present graphically, data generated using the methods described in the previous section. It will also describe, and perhaps illustrate with photographs or radiographs, individual cases showing the more unusual variants and pathological changes and, where possible, will discuss causes for them. Images help to make a report more reader-friendly, but they do add to the expense of publications, so they should be selected with care, bearing in mind the criteria discussed earlier in the section on assessment. The aspects that should normally be covered in a bone report have been listed above, but particular care should be taken to present all data on which conclusions and inferences depend, so that any interpretations offered can be evaluated by a reader.

By its very nature, scientific osteological work generates quantitative data. This includes nominal variables (such as sex, or presence/absence of non-metric traits or pathologies), ordinal (ranked) categories (such as slight, moderate or severe changes in osteoarthritis or other pathologies), and continuous, numeric variables such as osteometric measurements or stable isotope determinations.

With small numbers of burials (fewer than *c* 15–20) results can simply be presented skeleton by skeleton. In such circumstances it is usual to give data on skeletal completeness, age, sex, stature and on the more important pathologies or skeletal variants. The data might be presented as separate paragraphs for each burial, or partially or entirely in table format. Lists of measurements and non-metric traits could be given in an appendix, but more often will remain in the project archive.

With larger assemblages, burial-by-burial lists of results become too cumbersome for organising the main text of the report. The data need to be summarised. For nominal or ordinal data, presentation should normally be in table form, showing, for example, age and sex data (numbers of males and females, numbers in different age classes) and prevalences of common pathologies. For numeric data, measures of central tendency (eg the mean) and spread (eg the standard deviation) should be given, along with the numbers upon which they are based. For most variables, summary data should be given for the sexes separately. If numbers are large, it might be useful to present data in a graph, so that the reader can gain a quick visual impression of trends or patterns. Graphs should be in addition to, and not a substitute for, tabular presentation or summary statistics; for example, data on male and female stature might be presented as bar charts, but means and standard deviations should also be given for each sex. For example:

Table 2 Summary statistics for stature (cm)[1]

males			*females*		
N	*mean*	*sd*	*N*	*mean*	*sd*
169	168.8	5.7	119	157.8	5.1

[1] *N* = number of individuals; *sd* = standard deviation

Prevalences of common pathologies should always be presented as the number of individuals showing a given condition or attribute divided by the total number of individuals for which observations can be made. For example, cribra orbitalia is a condition manifest as pitting of the orbital roofs. It is generally bilateral if it occurs at all. Therefore its prevalence should be expressed relative to the number of individuals showing one or both orbits intact. This means that as well as noting when the condition is present in a skeleton, cases where it is absent need to be distinguished from those where it cannot be scored because the orbital roofs are missing. Similar considerations apply to other common pathologies and to non-metric variants.

For dental diseases, for example caries or ante-mortem tooth loss, prevalences should be given with respect to total teeth (or tooth positions in the case of tooth loss) as well as according to the presence or absence of these conditions in individuals. Similarly, frequent pathological conditions that affect individual bones, such as fractures, should be quantified with respect to total bones in the assemblage, as well as giving the frequencies for individuals. Prevalences for individuals are needed in order to conduct statistical analyses: observations on several bones or teeth from a given individual cannot be considered independent for statistical purposes, so frequencies reported with respect to total bones or teeth do not form a valid basis for statistical significance testing. As most archaeological skeletons are to a greater or lesser extent incomplete, the number of individuals with a given skeletal disease is likely to be significantly underestimated, because diseased as well as undiseased elements might not survive. The degree to which the proportion of affected individuals is underestimated increases with decreasing skeletal survival. Expressing frequencies with respect to total bones (or teeth) overcomes this difficulty and provides a check on patterns expressed with respect to individuals when two assemblages (or sub-samples of a single assemblage) are compared.

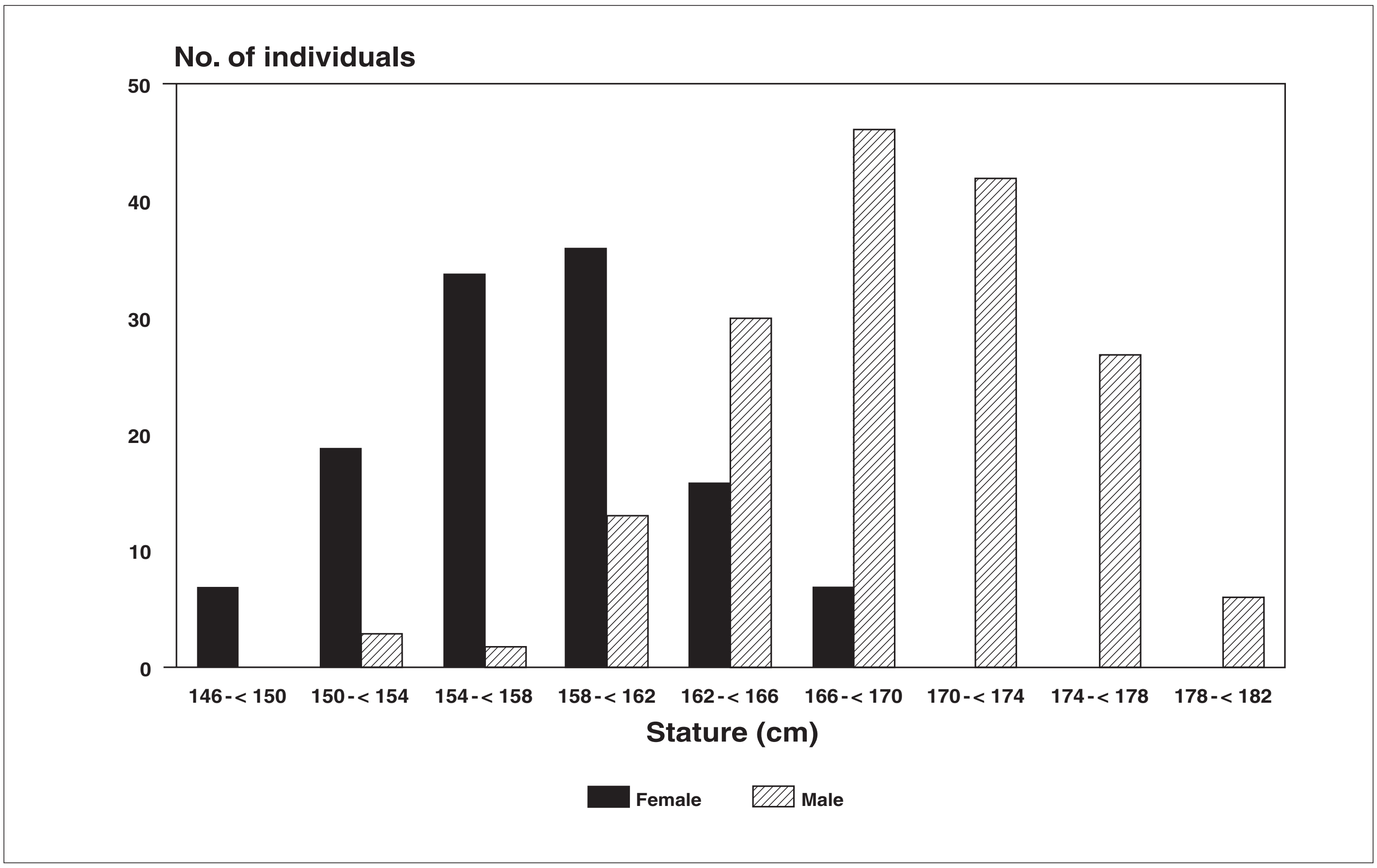

Figure 3 Bar chart showing stature.

Figure 4 The head of the late Bronze Age body found in the well immediately after excavation, Bradley Fen, Cambridgeshire. (© Cambridge Archaeological Unit)

An inventory of bones and teeth should be compiled for each individual as part of the skeletal recording process, and it is simple, once data are computerised, to provide total counts for assemblages.

In addition to providing a firm base for subsequent analyses, adequate presentation of disease prevalence data will help ensure that data generated can be used by other researchers.

For the more unusual pathologies there should be good, concise description of lesions, together with photographs or radiographs if appropriate, and this should then provide a basis for diagnosis. For example:

Skeleton NA197 (male, 50+ yrs, phase 1–2). There is extensive destruction of the right acetabulum and sub-chondral bone (Figure 5). The margins of the lytic (destroyed) area are fairly smooth trabecular bone. Radiography indicates no sign of sclerosis. There is post-depositional damage to the head of the right femur, but it is clear that there was some ante-mortem lytic activity. There is some well remodelled sub-periosteal bone on the femoral neck and in the region of the lesser trochanter. The presence of a lytic lesion showing little perifocal reactive bone at a major joint is suggestive of tuberculosis.

Many larger reports consist of a main text plus an appendix containing a catalogue of burials, so that osteological observations can be linked to particular skeletons. This is particularly useful to osteological researchers using the collection after the report has been published, as it helps them to identify particular skeletons of interest. The contents of the burial catalogue vary somewhat between authors, but they generally comprise skeletal completeness, sex, age, stature and the presence of any noteworthy pathological conditions or variants. It is also useful to include basic contextual data, such as the phase, location of the burial or presence of a coffin. For deposits of cremated bone the type of deposit (eg urned cremation) and whether the context was truncated might be specified. If space permits, the appendix might also include detailed descriptions of pathological findings in individual burials. Other burial-by-burial details, such as lists of measurements and non-metric traits, often remain in archive rather than forming part of the publication text.

Analysis and discussion. In this section, the quantitative data should be analysed and interpreted. If the data appear to show patterning then statistical tests should be conducted to validate that patterning, in order to provide a firm basis for subsequent interpretations. For example, if a sex imbalance is claimed, it must be shown to be statistically significant. Similarly, patterning in disease prevalences or differences in stature within a burial group should be verified using appropriate statistical tests. Statistically significant results are more likely to be obtained with large assemblages, but there are statistical analyses that can validate some patterns in small assemblages (eg 5–10 burials). For even smaller assemblages the material should simply be described and broader inferences avoided. Further notes on inferential statistics are given in an addendum.

Once patterning in the data has been validated, any interpretations offered should be supported by lines of reasoning and should include suitable references.

The effects of age must be taken into account when interpreting disease prevalences. In general, skeletal pathologies represent a cumulative record of 'insults' suffered during life; assemblages with a higher proportion of older individuals will (other things being equal) tend to show a greater prevalence of skeletal pathologies. In addition, some diseases, such as osteoarthritis, generally only occur in older adults. Bone disease is rarely observed in infants and young children; so the presence of large numbers of these young individuals in an assemblage will tend to 'dilute' the prevalences of most pathologies.

For cremations there is usually some discussion of funerary practices, for example facets of pyre technology such as firing temperatures or evenness of burning of remains, or other aspects such as the amount of bone that was collected from the pyre for deposition.

Figure 5 Right ilium of burial NA197, showing lytic (destructive) changes at the acetabulum, probably due to tuberculosis.

Comparative data from other sites should be discussed in the analysis–discussion section of the report. Comparative data should be carefully chosen in order to put the results into context or to address more specific questions.

Conclusions and summary. For longer reports, it might be difficult for the non-osteologist reader to judge which findings are the most important. A final section should therefore draw together the major findings and conclusions.

Inclusion of the report in the project publication

When the osteological report has been completed, the Project Manager will collate it with the other components of the project text. The Project Manager and the Project Osteologist should liaise closely over the parts of the main publication text that draw upon the findings of the osteological report so as to avoid errors of fact and interpretation. When the completed site report has been submitted to the project sponsor, independent academic referee(s) should be sought to pass their opinions on the quality of the manuscript and to suggests ways in which it might be improved. If there is a substantial human bone component then the osteological aspects should be reviewed by an independent referee qualified to do this. The Project Osteologist might need to make revisions after this review has been done. He/she should also proofread his/her contribution before publication. Timings and costings for these tasks need to be built into the project design.

Relevant documents

English Heritage *A Database of Archaeological Sites Yielding Human Remains in England.* (Continually updated, available in electronic form only, from Simon Mays at English Heritage.)

English Heritage 1991 *Management of Archaeological Projects*. London: English Heritage

English Heritage 1998 *Implementation Plan for Exploring Our Past 1992*. London: English Heritage

English Heritage 2002 *Environmental Archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation.* Centre for Archaeology Guidelines. Swindon: English Heritage

Mays, Simon 1991 *Recommendations for Processing Human Bone from Archaeological Sites*. Ancient Monuments Lab Rep 124/91. London: English Heritage

Roberts, C and McKinley, J 1993 *Excavation and Post-excavation Treatment of Cremated and Inhumed Human Remains*. Inst Fld Archaeol Techn Pap 13. Oxford

Addendum: A note on inferential statistics

Data analytical techniques are be divided into three categories: descriptive, exploratory and inferential (Robb 2000). Descriptive and exploratory techniques aim to summarise data through tabulation, summary statistics, and various graphical and pictorial methods. These procedures might reveal apparent patterning in data. The role of inferential statistical techniques is to provide an objective test of the validity of any such patterns by determining whether they are 'statistically significant'. By convention, a pattern is regarded as statistically significant if there is a less than 5% chance of it having arisen as a result of random fluctuations.

Study of recent published British osteological reports indicates that, of the three types of data analytical techniques identified above, inferential statistical tests are particularly underused. Even basic procedures such as *chi*-square are often omitted. Many inferential statistical procedures are available, but experience has shown that for the purposes of osteological reports, even a fairly restricted battery of techniques is sufficient to cope with most requirements. The aim of this note is to provide a brief guide to the circumstances under which basic statistical tests should be used in osteological reporting. It is not a substitute for consulting a good statistical textbook, several of which have been written with the archaeologist in mind (see bibliography). Most of the statistical tests mentioned in this note are readily calculated by hand, and they also feature in most statistical packages available for computers.

Choice of statistical tests

The statistical test(s) chosen to assess the validity of apparent data patterning depends both upon the level of measurement of the variables and on the organisation of the data in hand.

Levels of measurement

For the present purposes three levels of measurement are distinguished: nominal, ordinal and continuous.

Nominal. Data are simply divided into two or more categories. For example:

- male and female
- remodelled and unremodelled pathological lesions
- presence/absence of a pathological condition

Ordinal. The data are divided into categories that can be rank ordered according to some criterion. For example:

- 'young', 'middle' and 'old' age categories for adult skeletons
- slight, moderate and severe categories of pathological lesions
- categories 1–5 for scoring mental eminence morphology

Continuous. Truly numeric data with meaningful distance between values. For example:

- bone measurements
- age at death measured in years

It is important to know whether or not continuous data conform to a normal distribution, as this will affect the choice of statistical tests. Although standard statistical methods (eg the Kolmogorov-Smirnov test for normality or normal probability plots – Fletcher and Lock 1991) are available to determine this, in general measures of inherent biological variation between individuals (for example, most bone measurements and parameters derived directly from them (eg stature)), have a normal distribution. Aspects that are not measures of inherent phenotypic variation (eg age at death in years) will not usually be normally distributed.

Types of data organisation

Three types of data organisation are considered here: one sample, two samples and more than two samples.

One sample. One-sample procedures involve testing whether the parameters of the data differ from those given in the literature for some large population or from those expected on theoretical grounds. For example:

Figure 6 A late Bronze Age body found head first down a well on the Fen edge, Bradley Fen, Cambridgeshire. (© Cambridge Archaeological Unit)

Does the sex ratio differ from 1:1? Does the prevalence of diffuse idiopathic skeletal hyperostosis (DISH) differ from that reported in a modern population? Is the mean male stature different from that in modern British males?

Two independent samples. Two-sample procedures involve testing for differences between two sub-samples in the data, or by comparing the data with published data from one other site. For example: Does the sex ratio at the site under study differ from that found for skeletal material excavated from a nearby site? Is stature different in male burials inside and outside the church? Is the prevalance of DISH different in males and females?

More than two independent samples. For example: Does bone density vary across young, middle and old adult age groups? At a multi-period site, does stature vary across Saxon, medieval and post-medieval groups?

The table below gives a guide to some of the statistical tests, which should be used according to the level of measurement and the organisation of the data.

Table 3 Some statistical tests and the circumstances under which they may be used according to the level of measurement and the organisation of the data

data organisation		*level of measurement*	
	nominal	*ordinal*	*continuous*
one sample	*chi*-square[s,d,m] binomial[t]	Kolmogorov-Smirnov[f&l]	*t*-test (normal distribution)[d,m,f&l] median test (non-normal distribution)[f&l]
two samples	*chi*-square[s,d,f&l,m]	Kolmogorov-Smirnov[s,f&l] Mann-Whitney test[m,f&l]	*t*-test (normal distribution)[s,f&l,d,m] Mann-Witney test (non-normal distribution)[m,f&l]
more than two samples	*chi*-square[s,d,f&l,m]	Kruskal-Wallis test[m]	analysis of variance (normal distribution)[d,m] Kruskal-Wallis test (non-normal distribution)[m]

Notes: Superscripts indicate recommended sources for details of the tests concerned: d = Drennan 1996; f&l = Fletcher and Lock 1991; m = Madrigal 1998; s = Shennan 1997; t = Thomas 1976.

Two examples to illustrate the use of the above table are:

- Comparing the prevalence of cribra orbitalia (recorded in individuals as present or absent) with that reported from another site. Presence/absence scores are data at the nominal level of measurement. This is a two-sample problem. The table indicates that under these circumstances a *chi*-square test should be used and that details of this procedure are presented in Shennan 1997, Drennan 1996, Fletcher and Lock 1991 and Madrigal 1998.
- Cranial index has been computed for Anglo-Saxon and late medieval crania from a single site. Is mean cranial index different for these two sub-samples? Cranial indices are data at the continuous level of measurement. As they are aspects of phenotypic variability the measurements probably have a normal distribution. Normal distribution could be confirmed directly, using a normal probability plot. This is a two-sample problem and therefore, according to the table, the *t*-test is appropriate, further details on which are found in the same sources as for example 1.

Osteological reports frequently deal with small numbers – often fewer than ten individuals, but this need not preclude the use of inferential statistics to validate any putative patterns. Procedures such as the *t*-test, and the Mann-Whitney, binomial and Kolmogorov-Smirnov tests are appropriate for small samples, although the likelihood of attaining a statistically significant pattern diminishes with decreasing sample size. For the *chi*-square test the statistic requires a continuity correction – known as Yates' correction (Madrigal 1998) – when sample size is small, or else it should be replaced by Fisher's exact test (Blalock 1972), which permits exact probabilities of obtaining a particular pattern to be determined. Both of these tests are valid only for 2 × 2 cross-tabulations.

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Cover figure Examining and measuring human bones in the laboratory.
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