Dr Stian Suppersberger Hamre
University of Bergen, Department of Archaeology, History, Cultural Studies and Religion

Osteo- and funerary archaeology: The influence of taphonomy

By Dr. Stian Suppersberger Hamre

Abstract

This paper discusses the importance of taking taphonomy into account when analysing human skeletal remains and how it can influence the composition of skeletal assemblages. The preservation of skeletal material is dependent on both intrinsic and extrinsic factors which can influence the age and sex composition of skeletal collections which in turn may influence cultural interpretations of the material. With a better understanding and description of the preservational status of skeletal samples, and better attention to the placement of skeletal elements during excavation, one will be able to better analyse the material and minimise the chances of being influenced by unforeseen taphonomic factors.

Keywords: taphonomy, osteology, osteoarchaeology, funerary archaeology, skeletal preservation, age bias, sex bias.

Introduction

The examination of human skeletal remains has the potential of providing a lot of information about both individuals and populations of the past and it can easily be argued that there is no better material to serve this purpose (Gowland and Knüsel, 2006). There are, however, some questions which should always be of concern to anyone working with human remains. Are the individuals in the skeletal sample representative of the living population from which they came? Is it possible to draw valid population wide conclusions from the material? Are there biases in the sample? Will potential biases have an effect on your research?

One often sees that different skeletal elements are unevenly represented and also that the age distribution in some assemblages appear to be unnatural and not likely to be representative. In cases like that it might be wise to look for taphonomic explanations for the discrepancies or at least rule out possible natural causes before reaching for cultural solutions. There are many factors which can influence to what extent a skeletal sample is representative of its population, but a sensible starting point is to always consider if taphonomic processes could have created biases in the sample. It is a good approach to try and determine what taphonomic processes have affected the material and to create an understanding of how the these processes have influenced the material before one starts looking for further cultural influences on the composition of the sample. Such an understanding will strengthen any cultural theory drawn from the material and it can also avoid complicated cultural theories folding due to someone later discovering biases due to natural processes.

Taphonomy was first described as an own field of study by Efremov (1940) in 1940 and was defined as “the science of the laws of embedding” and referred to the study of what happens to an organism from death to fossilisation. In the strictest sense of the word, taphonomy is thus devoted to the analysis of post-mortem processes affecting organic remains, but in archaeological terms the definition has been extended to include, not only living organisms, but all materials and can be said to be the study of the transformation of materials into the archaeological record (Bahn, 1992:489). The discussion in this paper will, however, be entirely concerned with the taphonomy affecting the human body and skeleton.

The human body, to which the bones under examination once belonged, has undergone tremendous changes and been subjected to a vast number of deteriorative and altering processes from the time the individual was alive many centuries ago to the time of examination by the anthropologist. During this process a lot of information about the individual is lost and other information is added to the remains. This transformation of the human body has good potential for obscuring and distorting the information drawn from the remains, but has also great potential for providing information which initially was not available. To access this information and to avoid possible problems, it is absolutely necessary to have a working knowledge of how the decomposing body behaves and what effect the different taphonomic agents have on the remains.

This paper will be concerned with different biases which can be the result of natural taphonomic processes and how this can affect conclusions drawn from this kind of material. The importance of taking taphonomy and preservation into account when analysing skeletal samples will be highlighted, and the lack of standardisation with regard to the description of the quality of different skeletal samples will be discussed and suggestions for how to correct this problem will be presented. Finally, a brief discussion of how knowledge of taphonomy and decomposition can provide information about funerary practices will be presented.

What can create a biased sample?

Before one starts the examination of a skeleton or a skeletal sample, and preferably before one even starts excavating the remains, it is of great importance to be familiar with, and understand, the processes affecting the skeletal material from the time of death until the time of examination.

“Bone is one of the strongest biological materials in existence” (White and Folkens, 2000:20) and is, with the exception of teeth, mostly what is available for examination in archaeological contexts. There are, of course, other materials available as one finds the odd brain and lock of hair in archaeological contexts and there are mummified remains, and bog bodies where there is no osseous material preserved. Anyway, the vast majority of human remains from archaeological contexts are bone and teeth. In spite of bone being about as strong as biologically possible, bone is vulnerable to a wide range of taphonomic processes and agents and different skeletal elements vary in their susceptibility to degradation. To understand how the bone interacts with its environment and why skeletons from some sites are very well preserved while completely disintegrated at others, it is necessary to be aware of the basic structure of bone.

Bone is a composite of two different components: an organic component and an inorganic mineral component. The first component is mainly the protein collagen which constitutes about 90% of the organic part of bone (White and Folkens, 2000:25). Collagen molecules intertwine to form flexible, slightly elastic fibres in bone. The collagen of mature bone is stiffened by a dense inorganic filling of hydroxyapatite, which is the second main component of bone. Crystals of this mineral, a form of calcium phosphate, impregnate the collagen matrix and it is this weave of protein and minerals which give bone its amazing properties (White and Folkens, 2000:25) of incredible strength and flexibility. To illustrate the value of the combination of these materials and to understand the effect on bone when subjected to different environments, one can imagine two simple experiments. The mineral component gives bone its hardness and rigidity. When soaked in acid to dissolve these minerals, a bone becomes a flexible, rubberlike structure. On the other hand, when a bone is heated to combust the organic collagen it becomes extremely brittle and crumbles (White and Folkens, 2000:25).

So, what factors influence the preservation of bone? Bone preservation is influenced by both intrinsic and extrinsic factors. Intrinsic factors include the chemistry, size, shape, structure and density of bone, along with pathological changes to bone structure. Extrinsic factors include ground water, soil type, temperature and air, along with the nature of local flora and fauna, and human activity. Of all the intrinsic factors, bone mineral density is considered to be the most significant and soil chemistry is considered to be the most influential extrinsic factor in bone diagenesis (Buckberry, 2000). In an archaeological context, the bones will in the vast majority of cases be buried or otherwise covered with soil, which will thus have the greatest influence on bone preservation. Soils are made up of mineral and organic matter, water and air, with differing soil types composed of differing ratios of these elements. Of the different properties of soil, the pH value has the biggest influence on bone preservation (Gordon and Buikstra, 1981), with preservation generally being better in soils with a neutral or slightly alkaline pH. Acidic, free draining soils such as sand and gravel result in bad skeletal preservation, as it dissolves the inorganic mineral component of bone. In extreme cases, this may result in the human remains only being detectable as shadows in the sand.

Grave depth is another variable that will affect preservation. With bodies buried at depths of less than a foot, decompositional odours will penetrate the soil and reach the above ground, and thus attract insects and other animals (Rodriguez, 1997). Carrion scavenging animals will dig up and expose corpses buried at such shallow depths in order to feed on the soft tissues and bones (Rodriguez, 1997). Carnivores and small burrowing animals may remove or disturb bone, or destroy it by gnawing (Haglund, 1997a, Haglund, 1997b, Klippel and Synstelien, 2007), which may cause the bone to be more susceptible to decay. In cases where scavenging has taken place, it has been noted that the smaller bones are most often disturbed, and that spongy, marrow rich bone is generally preferred for gnawing (Gill-King, 1997). Another way bone may be lost or damaged is through modern ploughing. The shallower graves will naturally be more at risk for this kind of damage which could possibly cause biases in a skeletal sample. It might be worth investigating burial depths to see if systematic differences exist. Small children’s graves may not always have been dug as deep as the larger adult graves. Wilson and Hurst (1967) mention a couple of cases were burials have been damaged by ploughing, but no real evidence of any bias is evident from these reports, but Buckberry (2000) mentions an example from the Watchfield cemetery in Oxfordshire, where many juvenile graves were shallower than those of adults, and therefore more likely to be damaged by ploughing or machine stripping before archaeological excavation.

As mentioned above, intrinsic factors also play an important role in bone preservation. Structural properties inherent in the bones themselves can determine the rate of preservation for certain skeletal elements and in this respect, age and sex biases may also be present. To start with biases due to differentiated preservation, this mainly affects the skeletal elements with low bone density and particularly fragile areas of the skeleton. Due to their fragile nature, facial bones are often very poorly preserved and the same applies to the subscapular fossa of the scapula. Two other elements which are generally poorly preserved are the sternum and the sacrum. This can be explained by the low bone density and high proportion of cancellous bone of these elements (Boaz and Behrensmeyer, 1976). The last element for which poor preservation often is a problem is the os coxa. The pelvic bones are usually well represented but often in a fragmented state. The best represented parts of the os coxae are the acetabulum and the greater sciatic notch (Bello and Andrews, 2006), while the pubic area is much more poorly preserved and also shows low representation. These preservational problems with the pelvic region are causing the greatest amount of problems as these bones are central in the determination of sex and estimation of age at death.

The above mentioned skeletal elements are the ones which are poorly preserved but generally well represented. Some other elements are normally well preserved when present, but are often poorly represented. This is especially the case for the patella and the bones of the hand and feet (Bello and Andrews, 2006), with the possible exception of the calcaneus and talus. There are two likely explanations for the underrepresentation of these bones: excavational bias and animal scavenging. It is well documented that different animals scavenge on, and move bones from the decomposing corpse (e.g.Haglund, 1997a, Haglund, 1997b, Klippel and Synstelien, 2007, Ubelaker, 1997). This is, however, most applicable when the body has been left exposed during the period of decomposition. It has already been mentioned that shallow graves can be affected by carrion scavenging animals, but the animal removal of bones from graves in a cemetery contexts is not likely to have been a problem. Especially with coffin burials, this is likely to be a problem of very little significance. In spite of this, the representation of different skeletal elements in cemetery samples is not equal. Some of this can be explained by the difference in the preservational qualities inherent in different skeletal elements, but not all, as some interesting observations made about the preservation and representation of the hand and foot bones show. Hand and foot bones generally show a low representation in cemetery samples and this cannot be explained by their preservational qualities. In fact, these bones are generally very well preserved and usually complete when present. The good state of preservation of the hand and foot bones has been associated with the reduction of the medullary cavity (Guthrie, 1967) which facilitates the complete preservation of these bones even in very fragmented and damaged collections (Bello and Andrews, 2006). Differential representation also occurs between the different bones of the hands and feet. In the collections examined by Bello and Andrews (2006), they found that metacarpals and metatarsals were generally better represented than carpal and tarsal bones and that the frequency of the different phalanges was directly related to their dimensions, with proximal phalanges being more abundant than middle phalanges, and middle phalanges being more abundant than distal phalanges. This observation may suggest a consistent relationship between size and recovery and that the size of a bone could, to a greater extent, be a determining factor in its representation than preservational factors. On the background of this, one will probably have to look at excavational and curatory practices to explain why these bones are missing.

This misrepresentation does not only affect different skeletal elements, but may also affect groups of individuals. Several studies have shown that sub-adult skeletons are less well preserved and possibly underrepresented in different skeletal samples (Bello and Andrews, 2006, Bello et al., 2006, Buckberry, 2000, Guy et al., 1997, Walker et al., 1988). In Guy et al.'s (1997) discussion of infant taphonomy, it is argued that there is a difference in the structure and composition of bones between infants and older individuals, and this is suggested as a reason for an underrepresentation of infants in archaeological cemetery samples. They (Guy et al., 1997) base this on infant bones being poorly structured, having a low mineral and high water content and therefore being poorly protected against chemical and mechanical degradation. The situation is, however, likely to be somewhat more nuanced than this. Another study of bone density during childhood and adolescence (Rauch and Schoenau, 2001) shows that the bone mineral density in cortical bone decreases after birth to a low point during the first year of life and thereafter increases towards adulthood. A study of the Spitalfields collection (Bello and Andrews, 2006) suggests that this should not be seen as a difference between infant and adult remains, but rather as continuous and age progressive. They divided the sample into three age groups: 0-4 years, 5-19 years, and adults, and used six classes for grading a skeleton's level of preservation. The study found that the individuals in the youngest age group had the highest presence among the worst preserved remains. The representation got gradually less as one considered skeletons of better preservation and was nearly absent in the group containing perfectly preserved skeletons. The skeletons of the older individuals showed a different pattern as they had a high representation in the groups of good preservation. These studies suggest that sub-adults, and maybe especially children less than a year old, may be underrepresented in skeletal collections, but there is other evidence that preservational biases also affects other age groups. Walker et al. (1988) compared the burial records with data from the skeletal remains excavated from a cemetery and made a very interesting discovery. According to the burial records, the majority of the buried individuals were infants, children and elderly adults. The skeletal remains, on the other hand, showed a clear majority of young adults. This is in agreement with the other studies with regard to sub-adult individuals being underrepresented, but it also seems clear that elderly individuals are underrepresented due to poor preservation. This can be explained by skeletal mass starting to decrease after the age of about 40-50 years (Garn, 1970).

Based on these studies there seems to be a strong correlation between age-related changes in the skeleton and the likelihood of an individual's remains being represented in the archaeological record. This correlation is generally related to the mineral content in bone fluctuating with age and thus making the bones more susceptible to degradation. Although, this will be the case under any burial condition, independent of external factors influencing the preservation of the bones, this will not necessarily have a significant effect on the representation of the different age groups. In situations where the burial environment is favourable for skeletal preservation, one will see a difference in preservational quality corresponding to different age groups, but there will be little or no influence on the representation of the different groups. The problem only becomes evident when the preservational environment is less favourable. Then, the skeletons showing the worst preservation under good conditions will be very poorly preserved or completely disintegrated. Thus, significant biases towards a skeletal population of young to middle aged adults may be created.

It has also been suggested that preservational factors may affect the sexes differently (Bello and Andrews, 2006, Bello et al., 2006, Bennike, 1985). Weiss (1972) demonstrated a systematic sexual bias in skeletal samples of about 12% in favour of males. This has been partly explained by the comparatively rapid disintegration of lightly built female skeletons (Bennike, 1985) and it has also been suggested that the disappearance of female skeletons from the archaeological record is particularly affecting postmenopausal women who experience osteoporosis after the cessation of ovarian function (Raisz, 1982). The study by Walker et al. (1988), however, suggests that this claimed expedited disintegration of the elderly female skeleton does not affect the sex composition of skeletal samples. Their study shows a good correspondence between the sex distribution presented in the burial records and the sex distribution in the skeletal sample. The sexual bias in skeletal samples as reported by Weiss (1972) is more likely to be the product of biases inherent in the sexing techniques rather than sexual differences in bone composition.

With regard to osteoporosis, it is well established that postmenopausal women are prone to developing this condition, but men also suffer similar effects in old age. Osteoporosis is defined as a condition of reduction of total bone mass per unit volume while retaining a normal ratio of bone mineral to bone matrix (Krane and Holick, 1991). This definition will fit several different circumstances and conditions. Osteoporosis is, however, generally used to describe a form of age related bone loss without any obvious aetiology (Aufderheide and Rodriguez-Martin, 1998:314). This affects both sexes above the age of 60 and features loss of both trabecular and cortical bone. In general, bone mass peaks in the mid-thirties. Thereafter bone remodelling continues but the bone formation/resorption ratio is gradually altered from its previous equilibrium by continued resorption but lagging formation (Aufderheide and Rodriguez-Martin, 1998:314). Women normally suffer a substantial acceleration of this phenomenon during the postmenopausal state while the change in men is more gradual. Over a lifetime women lose about 35% of their peak cortical bone mass and about half of their trabecular bone while men lose about two thirds of these values (Aufderheide and Rodriguez-Martin, 1998:315). On the basis of this and the study by Walker et al. (1988) there is no reason to suggest that factors inherent in bone should cause sexual biases with regard to preservation of the adult and elderly skeleton. For the sub-adult skeleton, however, the evidence seems to be different. In the Spitalfields sample, female skeletons in the 0-4 years age group, are generally less well preserved and represented than male skeletons (Bello and Andrews, 2006). The study suggests that the threshold between poorer and better states of preservation, probably due to bone mineralisation, should be set to around 1 year for males and around 4 years for females (Bello and Andrews, 2006).

Having gone through various processes affecting the human body from death to recovery as skeletal remains, it becomes clear that one of the major factors creating biases in a skeletal sample is inherent in the bones themselves. There seems to be no factor more influential with regard to bone preservation than a bone’s mineral content and bone mass. Although, this is related to age, and to some extent sex, and may have a significant influence on the age composition of skeletal samples, there are several other factors, mainly pathological, which can cause similar alterations to bone chemistry. Thus, pathology can also influence preservation. There are many pathological conditions which are interesting in this respect, but possibly the most important group of medical conditions here are conditions related to the parathyroid glands. These glands produce parathyroid hormone which maintains the blood calcium level within the normal range by stimulating the release of calcium and phosphorous from bone, increasing phosphorus excretion and calcium reabsorption in the kidneys, and stimulating the kidneys to synthesise vitamin D which, in turn, increase calcium and phosphate absorption from the intestines (Kronenberg, 1993).

The most obvious condition to be caused by a malfunction of the parathyroid glands is hyperparathyroidism where there is an increased production of parathyroid hormone. Other relevant conditions are vitamin D deficiency which causes rickets and ostemalacia, and osteogenesis imperfecta which is caused by defective collagen formation. Haematological disorders are also relevant as they cause cortical thinning which can make bones vulnerable to degradation. Other conditions can indirectly have similar effects on bone. These are conditions which lead to immobilisation, like strokes, spinal injuries and other diseases and injuries which cause paralysis. Prolonged immobilisation will lead to bone resorption and demineralisation (Demirbag et al., 2005).

Standardisation of description of preservation

Despite this huge variation in bone preservation and the obvious need to take this into consideration in skeletal studies, there is little standardisation in the literature with regard to describing the preservational state of skeletal samples. With only few exceptions, the preservational state of skeletal samples is described in very subjective terms like “good”, “poor”, “excellent”, “varied”, “rather poor”, and many more variations. This prohibits any comparison between samples as there is no accurate meaning behind these words, and the same description may vary in meaning between collections. This is potentially a problem, especially when assessing the quality and validity of statements made on the basis of skeletal samples of which one has no first-hand experience. The accuracy of statements about ancestry, sex, age, stature and pathology are all affected by the preservational and representational status of the material. The same goes for demographic studies and theories based on the demographic composition of skeletal samples. So, why is there no common standard for the description of skeletal preservation? This is not a particularly easy question to answer as the call for standardisation has a long standing in physical anthropology. Eighteenth, nineteenth and early twentieth century scholars like Blumenbach, Morton, Hrdlicka, Martin, and Hooton were all concerned with the standardisation of measurements (Buikstra and Ubelaker, 1994:3). At that time the main focus of physical anthropology was on racial typology and was to a great extent concerned with the description of past and present people. The situation changed dramatically in the 1950s when Sherwood Washburn’s key paper “The new physical anthropology” (Washburn, 1951) marked a significant shift of focus in the discipline. Washburn (1951) advocated an emphasis on function and adaptation rather than on isolated traits and typology, the incorporation of all evidence in theoretical proposals, and an openness to new methods as ways to solve old and new problems. This new approach opened up for the wide variety of research directions we have today, ranging from basic anatomical descriptions, to studies of occupational stresses, palaeopathological investigations, and a variety of molecular approaches. This change led to varied and highly specialised research topics and data collection protocols became equally varied and specialised (Buikstra and Ubelaker, 1994:3). This lack of standardisation became a central topic of discussion at the 15th annual meeting of the American Paleopathology Association in 1988. These discussions were the beginning of what led to a workshop on standardisation in 1991 and the publication of “standards for data collection from human skeletal remains” in 1994 (Buikstra and Ubelaker, 1994). This work on standardising the data collection was largely triggered by and a reaction to the Native American Graves Protection Act which was passed in 1990. With the increasing call for repatriation of skeletal remains it was necessary to have comparable data for skeletal material which could never be re-examined. There is a similar situation in Norway with the decisions made in the 1990s about repatriation of Sami skeletons and transfer of jurisdiction over all Sami material to the Sami parliament (Schanche, 2002).

These standards are largely in use today and especially metric data follow set standards and are generally comparable between samples. Other types of descriptions have not managed to reach the same level of standardisation, and with regard to preservation, the scoring systems have not yet caught on. The reason for this is unclear, but maybe there is a lack of understanding that this is significant information, maybe the scoring systems are not well enough known, or maybe it is due to practical reasons. A proper objective recording of preservation is, of course, more time consuming than a simple subjective description.

There are several different systems for scoring preservation, but there are three different indices which should be promoted for describing the quality of skeletal samples: the anatomical preservation index, the bone representation index, and the qualitative bone index. These indices were first presented by Bello et al. (2006). The anatomical preservation index is a preservation score assessing the quantity of osseous material present. This index expresses the ratio between the score for preservation for each single bone and the skeleton's total anatomical number of bones. The scores for preservation are arranged in six classes:

Class 1: Bone absent

Class 2: 1-24% of bone preserved

Class 3: 25-49% of bone preserved

Class 4: 50:74% of bone preserved

Class 5: 75-99% of bone preserved

Class 6: Bone completely preserved

The qualitative bone index is scored according to the same classes, but evaluates a different feature of the bones. This index describes the preservational quality of the cortical surfaces of the different bones. These two indices describe different aspects of the skeletal samples' preservation, while the last index describes the samples' quantitative quality. The bone representation index measures the frequency of each bone in the sample. This is the ratio between the actual number of bones recovered during excavation and the total number of skeletal elements that should have been present.

All these indices require the examination of all the different skeletal elements which makes it quite time consuming to implement. Unfortunately, this does not go very well with the normal time and money constraints involved in such analyses, and often it may not be possible to carry out the full analysis of preservation and representation. In such circumstances there are some easy modifications that can be made which will save a significant amount of time without losing too much information. This can be done by treating the hands and feet and the costal cage as single elements, and the vertebral column could be treated as three elements: a cervical, a thoracic and a lumbar.

These simplified versions of the indices will produce a satisfactory picture of the preservation and representation of skeletal samples, and will be a great improvement on how things have been done and are done at the moment. The standards should, all the same, be kept high and a full examination should be carried out when practically possible.

Information provided by detailed field examination

So far, the emphasis has been on how taphonomic processes can create biases and disturbances in skeletal samples. Now, it is time to shift focus and the remainder of this paper will be concerned with how knowledge of taphonomy and decomposition can provide information about funerary practices. Many topics can be informed by a detailed examination of the skeleton in the field when combined with good knowledge of decompositional processes. These can be questions about whether or not the grave is primary or secondary, or if it has been disturbed. A field examination can also give information about funerary architecture and in some cases the field examination can help diagnosing pathological conditions, and in graves with multiple interments the burial chronology can be determined (Duday, 2006). To illustrate this, the following discussion will be concerned with two burial features which are often noted and commented on in mediaeval Christian burial contexts: the placement of the head and hands. These features are often given cultural and symbolic importance, but the influence of decomposition is rarely considered.

Let's start with the position of the head. Does the skull face the way it does because it was deliberately placed that way or is it the random result of decomposition? The orientation of the head can change as a result of the weight of the cranium when the decay of the cranio-vertebral attachments places it in an unstable position (Duday, 2006). The reason for the orientation of the skull can be determined by an examination of the cervical vertebrae in the field. In the living person or fresh cadaver, rotation of the head also involves the cervical vertebrae. Upon decomposition, initial disarticulation most often affects the intervertebral space between the atlas and the axis, or the axis and C3 (Duday, 2006). It is, therefore, crucial to observe the position of the superior-most cervical vertebrae. Continuity amongst them will attest to the original rotation of the head while on the contrary, a dislocation at a single intervertebral space will act to indicate rotation due to taphonomic processes (Duday, 2006).

The placement of the hands can also be affected by the decomposing body, depending on where they were originally placed. Typologies have been developed on the basis of hand placement, particularly popular in Scandinavia, but little attention has been given to the effect of decomposition. If the hands were originally placed on the body, their placement is likely to be affected. The body goes through several stages of decomposition which will not be discussed in detail, but after a while, endogenous putrefactive bacteria produce gas and the body starts to bloat (Knight, 1996) and oftentimes this causes the body to explode and collapse (Duday, 2006). This is likely to affect the placement of the hands if they were placed on the abdomen and pelvic area. The ribs also move from their original position. The position of the ribs deviate inferiorly, a deviation which becomes more accentuated with the rupture of the intercostal, costo-sternal and costo-vertebral attachments

(Duday, 2006). This will affect the placement of hands originally placed on the chest. The exact post-mortem movement of the hands will have to be further investigated and methods for determining their original placement should be developed if one is to place great emphasis on this for typological, cultural or symbolic purposes.

It is clear that a lot of information can be extracted from these kinds of analyses, but it all depends on the work carried out in the field. This is information which is lost as soon as the skeleton is removed from the grave and the only way to make use of this knowledge is to put much more emphasis on the examination of the skeleton in the field. This will require that anthropologists are employed in the field and that the anthropologist is trained in this kind of examination. A set of standards for field examination of skeletal material should be developed with an emphasis on the placement and orientation of the different skeletal elements. This, more thorough examination, is more time consuming than the practice normally carried out, and with the time constraints on archaeological excavations, this may not always be practically possible. However, to retrieve this information, there are no short cuts which can be taken. Rather, a decision will have to be made as to whether or not one is willing and interested in the information a thorough field examination can give.

Conclusion

To sum up, there should be little doubt about the importance and value of taking taphonomy into account. On a general note, the failure to consider the post-mortem alterations to the skeletal sample can lead to conclusions being made on false premises. As taphonomic processes can systematically influence the preservation and representation of different age groups, this can have a significant impact on palaeodemographic studies and any other study incorporating the individuals' estimated ages. The differential preservation of the sexes seems to mainly apply to the younger of the sub-adult individuals and will thus, have little importance in most skeletal studies as the sex determination of pre-pubertal individuals are highly inaccurate and generally not carried out. The knowledge of decomposition and anatomy can also provide much information about burial practices if the time and effort is awarded to a proper examination of the skeleton in the field.

Unfortunately, little regard has been paid to describing the preservation of skeletal samples and no standards exist, and thus no proper comparisons can be made between skeletal collections. This should change and a suggestion for a scoring system has been presented. The application of this system is time efficient and will provide useful and understandable descriptions of the quality of skeletal samples. It has also been argued that a more detailed field examination of skeletons will provide a lot of information normally not accessed. This will probably require more time to be spent in the field, but time is very rarely in excess at archaeological excavations. However, time can be saved with the development of better recording forms and more efficient recording methods, and field work should concentrate on documenting what will be lost after removal. Any work which can be carried out later is best carried out in the laboratory.

References

AUFDERHEIDE, A. C. & RODRIGUEZ-MARTIN, C. 1998. *The Cambridge Encyclopedia of Human Paleopathology,* Cambridge, Cambridge University Press.

BAHN, P. 1992. Collins Dictionary of Archaeology. *In:* BAHN, P. (ed.) *Collins Dictionary of Archaeology.* Glasgow: Harper Collins Publishers.

BELLO, S. & ANDREWS, P. 2006. The intrinsic pattern of preservation of human skeletons and its influence on the interpretation of funerary behaviours. *In:* GOWLAND, R. & KNÜSEL, C. (eds.) *Social Archaeology of Funerary Remains.* Oxford: Oxbow Books.

BELLO, S. M., THOMANN, A., SIGNOLI, M., DUTOUR, O. & ANDREWS, P. 2006. Age and sex bias in the reconstruction of past population structures. *American Journal of Physical Anthropology,* 129**,** 24-38.

BENNIKE, P. 1985. *Paleopathology of Danish Skeletons: A Comparative Study of Demograpgy, Disease and Injury,* Copenhagen, Akademisk Forlag.

BOAZ, N. T. & BEHRENSMEYER, A. K. 1976. Hominid taphonomy: transport of human skeletal parts in an artificial fluviatile environment. *American Journal of Physical Anthropology,* 45**,** 53-60.

BUCKBERRY, J. 2000. Missing, presumed buried? Bone diagenesis and the under-representation of Anglo-Saxon children. Available: http://www.assemblage.group.shef.ac.uk/5/buckberr.html [Accessed 21.09.2010].

BUIKSTRA, J. E. & UBELAKER, D. H. 1994. *Standards for Data Collection from Human Skeletal Remains*, Arkensas Archaeological Survey Research Series.

DEMIRBAG, D., OZDEMIR, F., KOKINO, S. & BERKARDA, S. 2005. The relationship between bone mineral density and immobilization duration in hemiplegic limbs. *Annals of Nuclear Medicine,* 19**,** 695-700.

DUDAY, H. 2006. L'archéothanatologie ou l'archéologie de la mort (Archaeothanatology or the archaeology of death). *In:* GOWLAND, R. & KNÜSEL, C. (eds.) *Social Archaeology of Funerary Remains.* Oxford: Oxbow Books.

EFREMOV, J. A. 1940. Taphonomy: New branch of paleontology. *Pan-American Geologist,* LXXIV**,** 81-93.

GARN, S. 1970. *The Earlier Gain and the Later Loss of Cortical Bone,* Springfield, Charles C. Thomas.

GILL-KING, H. 1997. Chemical and ultrastructural aspects of decomposition. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

GORDON, C. C. & BUIKSTRA, J. E. 1981. Soil pH, bone preservation, and sampling bias at mortuary sites. *American Antiquity,* 46**,** 566-571.

GOWLAND, R. & KNÜSEL, C. J. 2006. Introduction. *In:* GOWLAND, R. & KNÜSEL, C. (eds.) *Sicial Archaeology of Funerary Remains.* Oxford: Oxbow Books.

GUTHRIE, R. D. 1967. Differential preservation and recovery of pleistocene large mammal remains in Alaska. *Journal of Paleontology,* 41**,** 243-246.

GUY, H., MASSET, C. & BAUD, C.-A. 1997. Infant taphonomy. *International Journal of Osteoarchaeology,* 7**,** 221-229.

HAGLUND, W. D. 1997a. Dogs and coyotes: postmortem involvement with human remains. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

HAGLUND, W. D. 1997b. Rodents and human remains. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

KLIPPEL, W. E. & SYNSTELIEN, J. A. 2007. Rodents as taphonomic agents: Bone gnawing by brown rats and gray squirrels. *Journal of Forensic Sciences,* 52**,** 765-773.

KNIGHT, B. 1996. The Pathophysiology of Death. *Forensic pathology.* 2nd ed. London: Arnold.

KRANE, S. M. & HOLICK, M. F. 1991. Metabolic bone disease. *In:* WILSON, J. D., BRAUNWALD, E. & ISSELBACHER, K. J. (eds.) *Harrison's Principles of Internal Medicine.* New York: McGraw-Hill.

KRONENBERG, H. M. 1993. Parathyroid hormone: Mechanism of action. *In:* FAVUS, M. J. (ed.) *Primer on the Metabolic Bone Disease Disorders of Mineral Metabolism.* New York: Raven Press.

RAISZ, L. G. 1982. Osteoporosis. *Journal of the American Geriatrics Society,* 30**,** 127-138.

RAUCH, F. & SCHOENAU, E. 2001. Changes in bone density during childhood and adolescence: An approach based on bone's biological organization. *Journal of Bone and Mineral Research,* 16**,** 597-604.

RODRIGUEZ, W. C. 1997. Decomposition of buried and submerged bodies. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

SCHANCHE, A. 2002. Knoklenes verdi: Om forskning på og forvaltning av skjelettmateriale fra samiske graver. *Samisk Forskning og Forskningsetikk.* Oslo: De Nasjonale Forskningsetiske Komiteer.

UBELAKER, D. H. 1997. Taphonomic applications in forensic anthropology. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

WALKER, P. L., JOHNSON, J. R. & LAMBERT, P. M. 1988. Age and sex biases in the preservation of human skeletal remains. *American Journal of Physical Anthropology,* 76**,** 183-188.

WASHBURN, L. S. 1951. The new physical anthropology. *Transactions of the New York Academy of Sciences, Series 2,* 13**,** 258-304.

WEISS, K. M. 1972. On the systematic bias in skeletal sexing. *American Journal of Physical Anthropology,* 37**,** 239-250.

WHITE, T. D. & FOLKENS, P. A. 2000. *Human Osteology,* San Diego, Academic Press.

WILSON, D. M. & HURST, D. G. 1967. Medieval Britain In 1966. *Medieval Archaeology,* 11**,** 262-319.