Life and Death in an Early Bronze Age community from Hili, Al Ain, UAE

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Summary
The Early Bronze Age collective pit-grave, Hili N produced the largely undisturbed and well-preserved, though disarticulated, fragmented and commingled, remains of over 700 individuals. Such a large number of individuals provides a useful basis for compiling a biological profile of the community served by the tomb. While the condition of the remains made the osteological analysis challenging, some interesting indications of health in an Early Bronze Age community at the end of the Umm an-Nar period have emerged. In this paper the evidence for dental disease, anaemia and other diseases, trauma, mortality profiles, stature, and other non-specific indicators of skeletal stress are considered. These results provide a basis to observe and compare the evidence from other sites and periods in prehistoric Arabia, so that a picture of health and disease among early populations in the area can be developed.

Keywords: anthropology, palaeopathology, Bronze Age, Arabia, collective grave

Introduction

The Early Bronze Age, pit-grave, Tomb N, from Hili, Al Ain, United Arab Emirates (UAE), dating to the end of the Umm an-Nar period, has been described elsewhere in detail (see, for example, Méry *et al*. 2001, 2004, 2008). A further account will not be repeated here other than briefly. Hili N is unusual in that it was a pit grave, rather than, more typical for the period, an upstanding circular tomb. The grave, 2.5m deep, 4m long and 2m wide, had approximately 1.75 metres depth of human remains and artefacts (Haddu 1989; Méry *et al*. 2001) and dates to the very end of the Umm an-Nar period (Méry *et al*. 2008).

The site was excavated in two phases: the first series of excavations took place from 1984 to 1989, and were carried out by a team from the Department of Antiquities and Tourism (DAAT), Al Ain, directed by one of the authors (W.Y.T.) (Haddu 1989). A second series of annual campaigns occurred from 1998 to 2006. The purpose of the second phase was to excavate a section left *in situ* following the initial excavations (Fig. 1) (Méry *et al*. 2001, 2008). The second campaign was a joint project undertaken by the French Mission in the UAE and DAAT and was co-directed by two of the authors (S.M. and W.Y.T.). The human remains were examined by one of the authors (K.M.), also in two phases: 1) those remains

Figure 1. Hili N in the 1980s. Note the unexcavated section (arrows). This is the area excavated in the Phase 2 excavations.

Figure 2. Hili N in 1984, prior to excavation. Note the covering slabs.

retrieved from the phase 1 excavations; and 2) those from the most recent joint campaign. The phase 1 anthropological analysis formed part of the research for a PhD thesis presented to the University of Edinburgh (McSweeney 2003). This brief paper incorporates the anthropological findings from both campaigns.

Condition of the Remains

The aim of most human skeletal analyses is to create, as accurately as possible, a biological profile of the individual or group of individuals being examined. Any interpretation of skeletal analysis will inevitably have inherent inaccuracies and one of the greatest impediments to proper interpretation is bias in the sample. It is never possible to be certain that a whole community is present in a skeletal assemblage. However, a collective grave such as Hili N provides an opportunity to capture a greater proportion of the dead in a population than burial in spatially distributed individual graves, where parts of the cemetery may have been destroyed, or left unexcavated. Furthermore, a subterranean as opposed to an upstanding monument, depending on the environmental conditions, may also help to optimise preservation; graves that are invisible in the landscape are less likely to have been disturbed, an unfortunate fate of many of the upstanding Umm an-Nar tombs. In addition, as can be seen from the presence of roofing slabs in the photograph in Fig. 2, Hili N was undisturbed and, apart from some damage to the deposits in the upper layer (Haddu 1989), the contents were intact; an intact grave further helps to maximise the potential information that can be extracted. It is quite likely therefore, and this has been borne out by the results of the anthropological analysis, that the skeletal contents of Hili N accurately represent the local community that used the grave.

Furthermore, as was shown by the Phase 2 excavations that revealed hundreds of articulated body parts, Hili N was a place of primary deposition, and not, as may have been otherwise assumed from the apparent state of disarticulation, an ossuary for the secondary deposition of remains initially buried elsewhere (Méry *et al*. 2004). Skeletal remains from primary burials are more likely to be complete than those that have been redeposited; in the latter, smaller bones often become lost and under-represented in the skeletal assemblage (Mays 1998). The risk of sample bias was therefore minimal; however, the

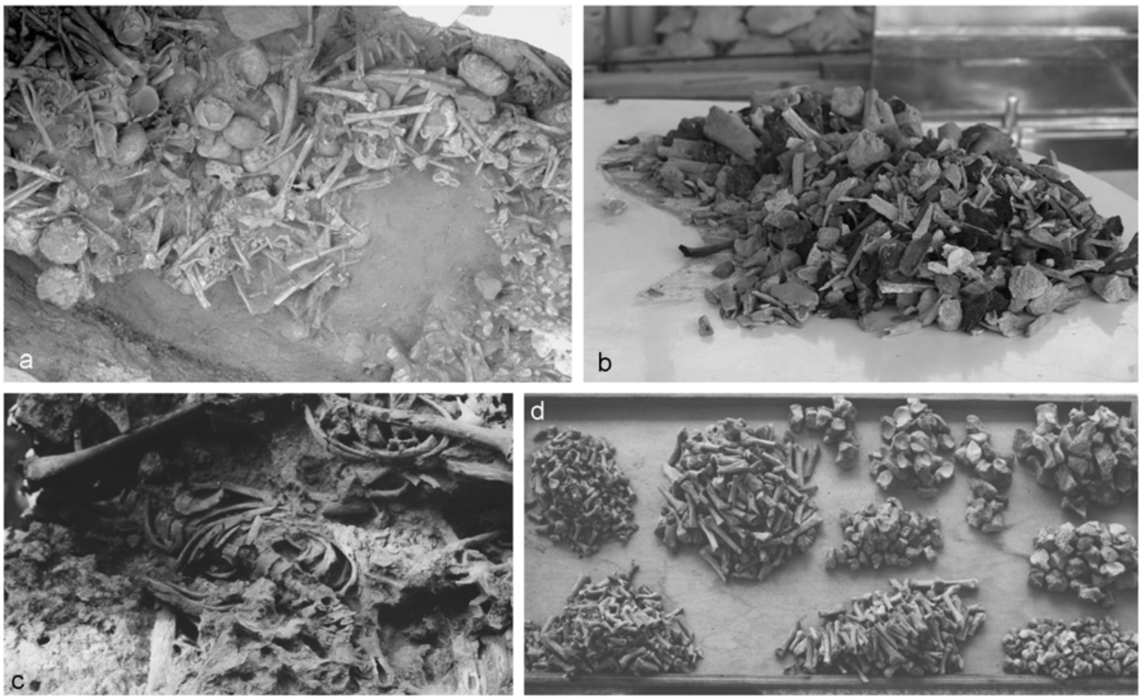

Figure 3. Hili N remains: (a) *in situ* commingled skeletal material; (b) fragmentary remains; (c) articulated spine and thorax; (d) complete foot bones in the process of being sorted.

extracted data was constrained by the nature of the Hili N skeletal material, which was extremely fragmented and commingled (Fig. 3a and 3b). While bone tissue was generally well preserved thanks to a favourable environment, unfortunately, many bones, especially the larger skeletal elements, had been reduced to small fragments, probably as a result of rearrangement of the remains within the internal space of the tomb. Consequently, there were only a small number of complete long bones and very few intact skulls. Dental remains were also in poor condition. While mandibular, and to a lesser extent, maxillary fragments had survived fairly well, most of the teeth that had been *in situ* at the time of death, had been lost *post mortem*, and the crowns of the few teeth that were still *in situ* in the socket had largely become damaged.

On the contrary, many smaller bones, such as those of the hand and foot (Fig. 3d), patellae and vertebrae, as well as immature bones, had survived mostly intact. The fact that the sub-adult population amounted to 43% of the total is testimony to the good survival of immature bone (see below). It appears that smaller bones were protected from fragmentation because their size and shape allowed them to slip into spaces between larger bones.

Methodology

Huge volumes of commingled and fragmentary remains (hundreds of thousands of complete and incomplete bones) that could not be reassembled into individual skeletons necessitated an entirely different methodology to that normally applied to the osteological analysis of discrete inhumations. Ideally, when assessing age at death, sex or the presence of disease, the full skeleton should be examined and a consensus arrived at from various strands of evidence. Although the improved retrieval methods used in the Phase 2 excavations optimised the recovery and collation of articulating bones (Méry *et al.* 2001), in most cases, each bone from the Hili N skeletal assemblage had to be viewed in isolation. This means that estimations of demographic details will be less informative than that obtained from complete skeletons. Notwithstanding this constraint, a vast amount of anthropological data have been extracted that can help build a picture of the Hili N community.

Biological Profile of the Hili N Community

Based on counts of the most commonly occurring bone element, the petrous part of the temporal bone, it has been estimated that a minimum of 700 individuals were buried in the Hili N pit-grave.

High sub-adult mortality is indicated (43%), and of this proportion 58% had died before the age of 5 years. According to Lewis (2007), the period that a child is most at risk is 6 months to 3 years and this concurs with the Hili N results. The assessment of adult age at death was disappointing; only about 13% could be placed into a specific age category: young, middle, or old adulthood. Most that could be said of the majority of adults was that they had reached adulthood, so the extent of adult longevity could not be precisely explored. However, as the evidence for skeletal degeneration appears low, this may indicate that, in general, most adults did not live into advanced adulthood.

Sex was assessed (albeit tentatively in the absence of intact skulls and pelvic bones, the most sexually diagnostic areas of the skeleton) largely on the basis of secondary sexual morphological traits. Females and probable females accounted for 44% of the total; males and probable males for 40%, and 16% of adults were sexually non-dimorphic, i.e., their dimensions fell between the ranges for modern males and females. Although limited, these results does not suggest that there was any bias towards either sex in the grave.

Stature, calculated on the basis of metatarsal lengths, less reliable than that based on complete limb bones (the most common method of assessing height), indicated an average female height of 157.7 cm, with a range of 147.8 cm to 163.5 cm, and an average of 171.1 cm, with a range of 164.6 cm to 183.4 cm for males. These, relatively small, average heights are very similar to that of other contemporaneous populations in the Arabian Peninsula, suggesting the methods used may not have had too detrimental an effect on the accuracy of the results (McSweeney 2003; McSweeney forthcoming).

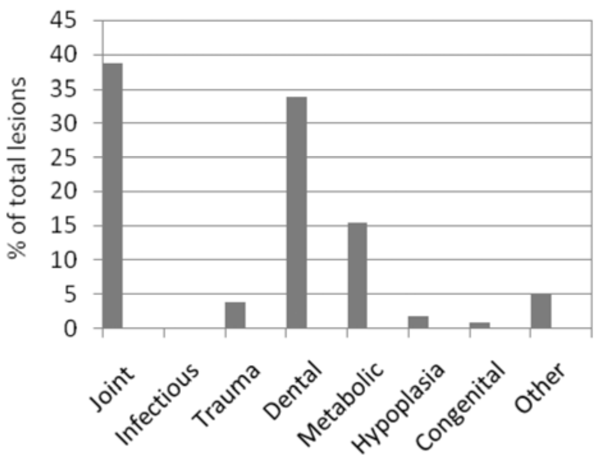

Figure 4. Hili N pathological lesions noted according to type as a percentage of total.

Pathology

Identified pathological lesions have been collated and roughly grouped according to the classification of disease, i.e., trauma, joint disease, metabolic disease, dental disease, dental hypoplasia (not a disease as such, but a manifestation of non-specific skeletal stress), congenital anomalies and a miscellaneous category that includes conditions of unclear aetiology (Fig. 4). The use of these categories of disease is not intended to convey a firm diagnosis of the lesions; they are simply a means by which similar types of lesions, of *possibly* the same aetiology, can be analysed.

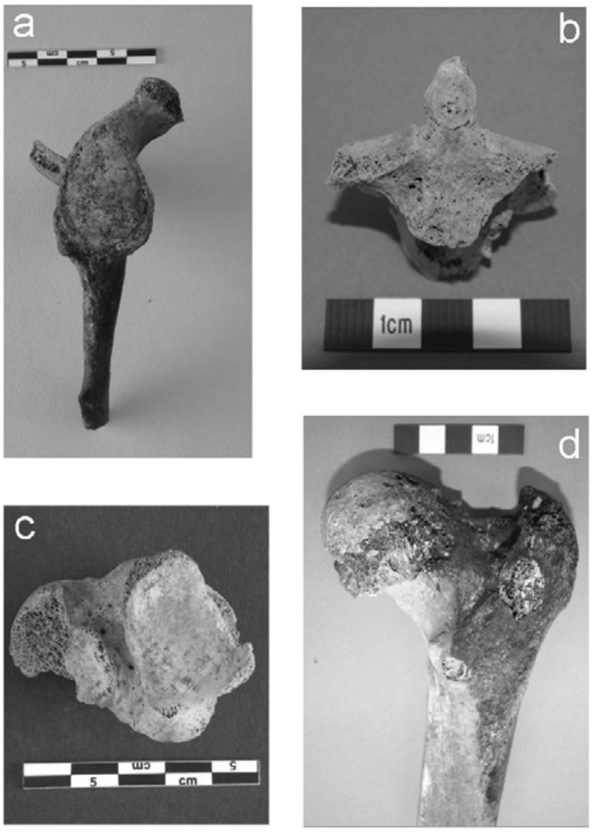

Figure 5. Hili N Joint disease: (a) right scapula showing osteoarthritis of the shoulder; (b) arthritis of the neck; (c) talus with lipping around the talocalcaneal joint of the foot; (d) mushroom-shaped femoral head and marginal lipping is indicative of osteoarthritis of the hip.

Joint Disease

The most frequently occurring lesions (38.6%) were recorded at the joints (Fig. 5). While this may seem high, it should be remembered that: 1) frequencies are based on affected bones and do not represent individuals; (2) vertebral osteophytosis (lipping), a normal development in the ageing process are included; and (3) there are 24 vertebrae in the spine and it is normal for individuals to have more than one spinal joint affected. Other diseased joints, according to percentage frequency, were the feet and ankles (36%), knees (23%), mandible (10%), hands (10%), elbows (7%) and hips (3%).

While there are many different types of diseases that can affect the joints, the most common in modern clinical medicine is osteoarthritis, a degenerative condition, closely associated with activity and ageing, and it is osteoarthritis that has been most commonly found on skeletal remains (Roberts and Manchester 2005: 105). Diagnosing a specific joint disease from disarticulated remains is difficult, especially as the pattern of distribution of joints affected is crucial to diagnosis (Rogers & Waldron 1995), but osteoarthritis is the most likely cause. Its presence may be significant; in modern medicine the disease is uncommon in individuals below the age of 40 years (Waldron 2009). Although we can never be sure that this pattern would have been the same in the past, it does give some insight into the longevity of some of the individuals.

Recent clinical evidence has shown that the most common joints for osteoarthritis to develop are the main weight bearing joints, the hip and the knee, and those of the hands (Waldron 2009: 31). The relative frequencies indicated above are likely to at least partly to reflect the condition of the skeletal material and not just clinical significance. For example, the low level of lesions at the hip (3%) is probably due to the relatively poor survival of pelvic bones and femurs. Of note, ankle and foot bones were more commonly affected than hand bones and had the commonest skeletal area involvement other than the spine. This is particularly interesting in view of the fact that osteoarthritis of the feet and ankles occurs relatively infrequently in modern medicine (Waldron 2009). The aetiology of osteoarthritis although multifactorial, is strongly associated with activity, and in the case of foot bones is probably associated with mobility.

Infectious Disease

There was very little evidence for infectious disease. Most types of infectious disease are short-lived and leave no trace on the skeleton, although some chronic infectious diseases, such as tuberculosis and leprosy, may do. In the absence of articulated skeletons, no chronic infectious diseases were identified. Two examples of middle ear disease, one case of osteomyelitis, and several occurrences of non-specific inflammation of bone (periostitis) were noted.

Figure 6. Hili N: sample of traumatic lesions: (a) healed Colles fracture of the distal radius; (b) healed skull fracture; (c) healed mid-shaft fracture of the humerus.

Trauma

Some examples of trauma can be seen in Fig. 6. Healed fractures were most commonly found on the smaller bones, such as those of the hand and foot, ribs, vertebrae and clavicles. The infrequency of fractures on other bones, such as the limbs or skulls, is very likely to be reflective of the *post mortem* fragmentation of these bones.

It is very likely that most of the healed fractures had occurred as a result of everyday accidents. While, fractures of the cranium, face, ribs, and forearm, often associated with interpersonal violence, were noted, these were largely of low frequencies, and while some violent incidents no doubt occurred in Bronze Age Hili, as in any community, there is no reason to suppose that this was widespread.

Dental Disease

The condition of jaw bones varied from small fragments, consisting of one or two tooth places, to complete mandibles. As indicated above most of the jaw fragments were edentulous, either because the teeth had fallen out of their sockets *post mortem*, or had been lost during life, or both. A large number of loose teeth were also present, although these were far less in number than empty tooth sockets. Many of these loose teeth had become damaged and were also in poor condition.

Figure 7. Hili N: Dental disease: (a) typical mandible from Hili N. The right hemi-mandible has sockets for both incisors, the canine and first premolar, indicating that these teeth had been *in situ* at the time of death, but had subsequently fallen out of their sockets *post mortem*. Healed bone at the sites for the second premolar and all three molars (arrow), point to these teeth being lost some time before death; (b) mandible fragment with dental abscess; (c) deciduous molar with carious lesion.

Despite the poor condition of the dentition, a high frequency of dental disease was evident. The most striking factor was the prevalence of *ante mortem* tooth loss; 64% of all adult jaw fragments had missing teeth. A typical mandible had anterior teeth present at the time of death (although lost *post mortem*) and the posterior teeth missing *ante mortem* (Fig 7a). The cause of the high level of tooth loss in the Hili N individuals is not entirely clear from the surviving evidence. The aetiology of tooth loss might normally be deduced from an examination of surviving teeth and jaws. For example, if the caries rate of the surviving dentition is high, then it may be deduced that the *in vivo* loss is probably as a result of dental decay. However, with the Hili N remains, not only are those teeth lost during life not available for examination, but, with some rare exceptions, the dentition that had been present at death had mostly been lost *post mortem* (Fig. 7a).

Similar patterns of tooth loss have been reported from other prehistoric Gulf populations. It has been assumed by many that such loss is a consequence of the development of caries as a result of eating dates (for example, Bondioli, Coppa & Macchiarelli 1998; Nelson *et al*. 1999; Hojgaard, 1984).

There is no unequivocal direct evidence to show that caries was the main cause of tooth loss at Hili N. As indicated above, one method of assessing the contribution of caries to tooth loss is to examine the frequency of caries in the surviving teeth. If there was a high prevalence of caries, it would be reasonable to assume that tooth decay was a major contributory factor. Unfortunately, those teeth that had not been lost during life have not survived very well. Of the surviving teeth belonging to both adults and children, 6% were carious (Fig. 7c). This overall caries rate appears to be quite moderate. In a survey of caries frequency from ten sites in Arabia from different periods ranging from the Mesolithic to the Islamic, Littlejohn & Frolich (1993) found caries rates to range from 0% to 25%. Of Bronze Age sites examined, Umm an-Nar Island had a caries rate of 2.4%. The highest frequency, 25%, was based on only 28 teeth from 'Site 5', Ras al Khaimah, in the northern Emirates, dating to 100 BC - 100 AD. In Iron Age Oman, Nelson *et al.* (1999), who claimed that high levels of caries and *ante mortem* tooth loss were due to the consumption of dates, observed a caries rate per tooth of 18.4% for 141 teeth; a corrected rate of 32.4% of 182 teeth was calculated to take account of missing teeth. This assumes that the missing teeth were lost as a result of decay.

A caries rate of 6.0% for all teeth from Hili N, although higher than the 2.4% observed on Umm an-Nar Island , is therefore quite moderate when compared with other Gulf sites. In general, the rates given in the publications mentioned above are based on much smaller populations than Hili N and relative tooth survival appears to be much better. Therefore, although clearly a factor, the relative importance of the caries rate at Hili N, based on such proportionally few teeth, is less than conclusive. Dental disease is accepted as being highly complex with a number of interlinked causes and manifestations. Lukacs (1989) suggested that the various causal factors in dental disease should be thought of in terms of whether they are primary or secondary. The primary causes of *ante mortem* tooth loss are caries, calculus and attrition, while other conditions, ultimately leading to tooth loss, are secondary. Thus, the pathway of eventual tooth loss from the three primary causes and subsequent secondary causes was said to be (Lukacs 1989: 265):

1) Caries → pulp exposure → abscess → resorption → tooth loss
2) Calculus accumulation → periodontal disease → abscess → resorption → tooth loss
3) Attrition → pulp exposure → abscess → resorption → tooth loss.

The modest Hili N caries rate does not provide *prima facie* evidence for caries being the main cause of tooth loss. Besides caries, dental abscesses (Fig. 7b), calculus, periodontal disease and advanced attrition were also frequent occurrences at Hili N. Therefore, as there was evidence for all three primary causes in the Hili dental remains, *in vivo* tooth loss at Hili is most likely to be multifactorial and not simply the result of tooth decay. Regardless of the cause, it is clear that most individuals suffered from very poor dental health that must have reflected on everyday life. The high levels of dental infection that were clearly present, whether the result of caries, advanced attrition, or periodontal disease, must have had a detrimental effect on the general well-being of the population and in some cases may even have been fatal.

Anaemia

Secondary effects of haemolytic anaemia, in the form of expansion and pitting of the cranial vault (porotic hyperostosis) and in the orbital roofs (cribra orbitalia), were found on many hundreds of fragments. These manifestations can occur alone or together. It has been claimed that the development of porotic hyperostosis indicates a more severe expression of the condition (Blom *et al*. 2005). The preponderance of these lesions indicates that the condition was common in the community. Unfortunately because of the disarticulated and fragmented condition of the Hili N crania, it is not possible to estimate an accurate number of individuals affected. Assessments of other Umm an-Nar period skeletal assemblages have indicated frequencies of cribra orbitalia of 37.2%, 33.3 % and 18% of individuals affected at Al Sufouh, Mowaihat and Unar 2, respectively (Blau 2001) and a prevalence within this range in the Hili N population is not unreasonable.

Anaemia is a general term for a variety of conditions that result in a reduction in the number of red blood cells. Bony changes occur as a result of the need for expansion of the spaces occupied by red marrow to allow for the compensatory production of red blood cells. It is accepted that such changes only occur during childhood because of the greater need for red blood cell production during growth (e.g. Stuart-Macadam 1985; Mays 1998: 143), i.e., the lesions, regardless of whether they are visible in

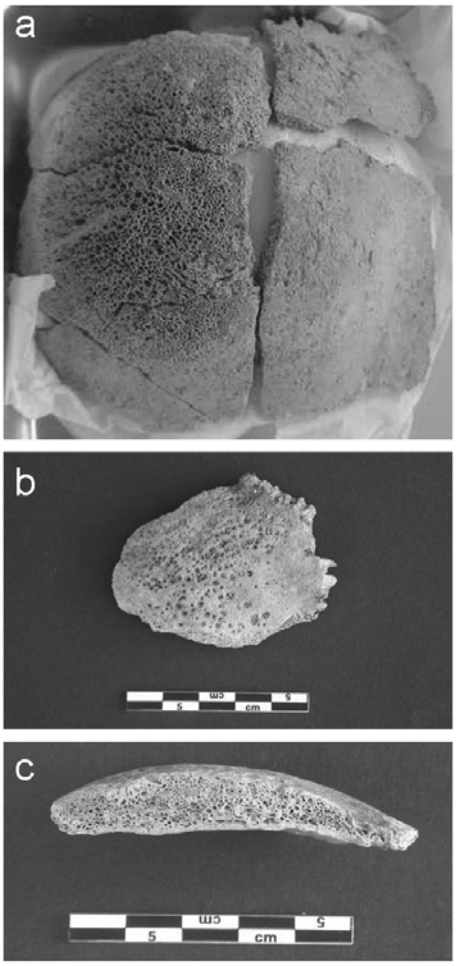

Figure 8. Examples of porotic hyperostosis at Hili N: (a) complete but fragmentary parietal with active changes; (b) fragment of parietal showing healing lesions; (c) profile view of a fragment of parietal showing expansion of vault thickness.

sub-adults or adults are expressions of childhood anaemia. It was clear that a large proportion of the affected fragments belonged to children, although the nature of the Hili N material meant that the true age of these individuals at the time of death could not be accurately assessed. In very young children the lesions were mostly active, indicating that the period of stress was ongoing at death (Fig. 8a); while in older children and adults the lesions had healed (Fig. 8b) and in some cases the bone had partly remodelled. Blom *et al*. (2005), in a study of pre-Columbian Peruvian skeletal assemblages, found a direct relationship between death in childhood and porotic hyperostosis and this appears to be true of the Hili N children.

Anaemia has been attributed to a number of causes such as genetic abnormalities, weaning, insufficient iron in the diet, gastrointestinal parasitizes and bacterial infection. It is also claimed to be an adaptive response to malaria. Genetic anaemias such as thalassaemia and sickle cell anaemia, which are prevalent in the United Arab Emirates today, were considered but ruled out on the basis that the post-cranial skeletal changes that are normally found in these diseases were not present.

Dental Hypoplasia

Dental hypoplasia is a caused by a cessation in the development of dental enamel during childhood while the teeth are forming. They occur following periods of malnutrition or illness and commonly manifest as a horizontal ridge on the enamel. Such linear lesions, if not removed by advanced attrition or decay, can remain on the teeth for life. By assessing the position of the lesions, the age of the child when the period of stress occurred can be calculated. The presence of several hypoplastic lesions in the same dentition, as was frequently found on the Hili N teeth, indicate recurrent periods of stress.

Hypoplastic lesions were noted on about 10% of teeth available for examination. More than half of these were from immature individuals. Dental hypoplasia has been linked with decreases in longevity (Goodman & Armelagos 1989) and as the majority of the affected individuals did not survive into adulthood, the presence of these stress markers do appear to be reflective of the poor health during childhood suffered by some members of the population. A direct link with poor nutrition or disease during childhood, however, cannot be established, as hypoplasia may be a consequence of either.

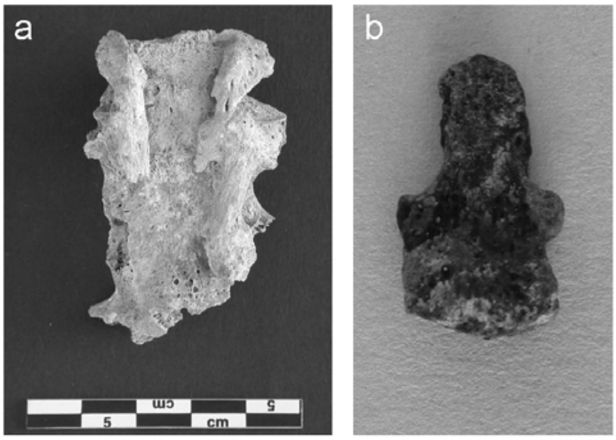

Figure 9. Examples of congenital anomalies from Hili N: (a) fragment of sacrum with open sacral crest indicating the presence of spina bifida occulta; (b) congenital fusion of the middle and distal phalanges of the toe.

Congenital Conditions

Congenital conditions include a number of diseases and anomalies that range from the very minor to those that are not viable with life. As is the case with most archaeological skeletal assemblages very little congenital disease was identified at Hili N. It is unlikely that children born with severe conditions would have survived. Some minor developmental anomalies were identified and two examples are shown in Fig. 9. Fig. 9a shows an example of spina bifida occulta, a neural arch defect that can be developmental or genetically determined and occurs in most populations (e.g. 2.7% in early British skeletal material; Brothwell & Powers 1968). Another frequently occurring skeletal anomaly was congenital fusion of the middle and distal phalanges of the toe (Fig. 9b). This is considered to be a fairly common skeletal variant (George 2001).

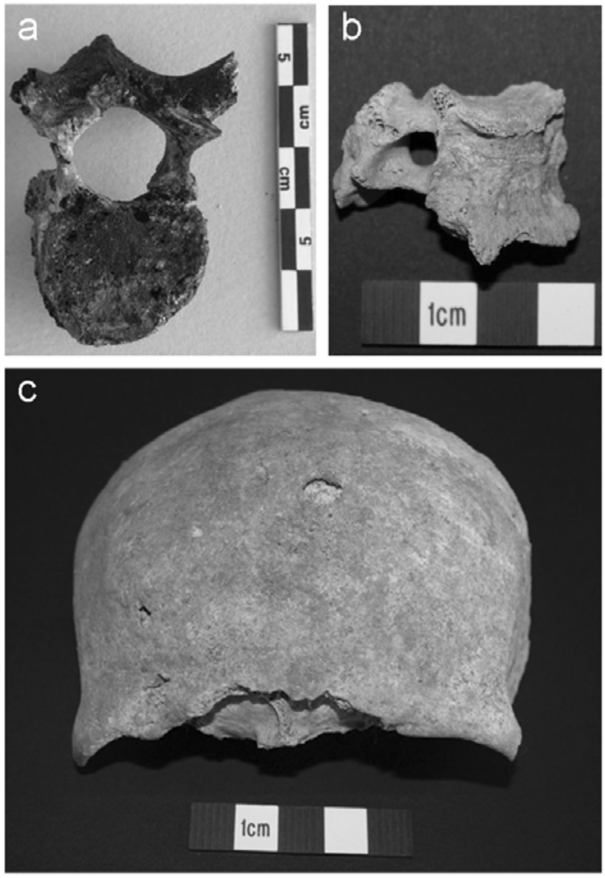

Figure 10. Some diseases of unknown aetiology from Hili N: (a) asymmetrical lumbar vertebra indicating the presence of scoliosis of unknown cause; (b) additional bony growth resulting in fused vertebrae – possibly ankylosing spondylitis; (c) perforations on the external surface of the skull, a possible case of multiple myeloma (a type of cancer of plasma cells).

Miscellaneous Diseases

Any assessment of disease based on skeletal analysis will be limited by a number of factors. It is often not possible to arrive at a conclusive diagnosis, largely because of the non-specific nature of bony lesions. As the anatomical distribution of lesions can aid diagnosis the inherent difficulties were compounded by the absence of articulated skeletons in the Hili N assemblage. Some conditions that must remain unknown or implied are shown in Fig. 10.

Conclusions

Despite the high degree of fragmentation, the large volume and relatively undisturbed nature of the human bone assemblage of the Hili N pit-grave suggests that it is probably representative of the community that used the tomb and this has enabled the building of a picture of life and death of a community that lived at the end of the Umm an-Nar period.

The pit-grave contained the remains of more than 700 individuals. A large percentage (43%) of the individuals was sub-adult; a rate of child mortality to be expected in a prehistoric society. Among the adults there was no evidence of bias towards either sex. These factors indicate that there was no selectivity among the Hili N remains and that the grave was a burial place for the whole community. Radiocarbon dating has indicated that the tomb was in use for around 100 to 200 years (Méry *et al.* 2008), which would indicate a mortality rate of between 3.5 to 7 individuals per year. Assuming that the majority of the dead in the community were indeed buried in the pit grave, the community at any one time would have been quite small, probably around 100 individuals or less.

A relatively high level of disease was noted. Several individuals, the actual number difficult to assess, suffered from some form of metabolic disease, indicated by porotic hyperostosis and cribra orbitalia. The absence of characteristic post-cranial lesions means that it is unlikely that diseases such as scurvy, rickets or one of the genetic anaemias was the cause. The skeletal changes may be manifestations of iron deficiency anaemia, although, if so, it should not be assumed that this was the result of the dietary insufficiency of iron; such deficiencies may also be due to disease processes. According to Stuart-Macadam (1991), however, the presence of porotic hyperostosis may also be indicative of a natural protective response to pathogens, common in tropical and sub-tropical regions, and may not necessarily be indicative of disease *per se*.

Dental health was extremely poor; sixty-four per cent of adult jaw fragments had teeth missing *ante mortem*. The rate was similar to that of some other prehistoric populations in the Gulf, where caries was related to the consumption of dates. The poor survival of teeth that had been *in situ* at the time of death and widespread tooth loss during life meant that the cause of tooth loss in the Hili N population could not be clearly established. An overall caries prevalence rate of 6%, especially in the light of the widespread *in vivo* molar loss, does, however, indicate that dental decay was a factor. Tooth loss was often accompanied by a high frequency of periodontal disease and dental abscesses, both of which can ultimately result in tooth loss; this implies a multifactorial origin.

The impression gained from the analysis of the Hili N group is of a population of fairly small stature, with some evidence for stress. This is clear from the high rate of child mortality, indications of young adult age at death, a fairly high frequency of hypoplasia, evidence for widespread anaemia, and very poor dental health. The highest mortality rate was in children between the ages of three months and 4 years. High mortality in this age group is normally taken as a key indicator of poor nutrition in under-developed countries today. However, poor nutrition and disease are often inextricably interlinked and it is not possible to relate the findings from Hili N to poor nutrition alone, although this may have played a part.

Acknowledgements

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