University of Dundee

A Biocultural Analysis of Mortuary Practices in the Later Anglo-Saxon to Anglo-Norman Black Gate Cemetery, Newcastle-upon-Tyne, England

Swales, Diana Mahoney

Published in:
International Journal of Osteoarchaeology

DOI:
10.1002/oa.2729

Publication date:
2018

Document Version
Peer reviewed version

Title: A Biocultural Analysis of Mortuary Practices in the Later Anglo-Saxon to Anglo-Norman Black Gate Cemetery, Newcastle-upon-Tyne, England

Author's Name: Diana Mahoney Swales

Affiliation: 1. Department of Archaeology, University of Sheffield, Sheffield, England, S1 4ET.

2. Centre for Anatomy and Human Identification, School of Science and Engineering, University of Dundee, Dow Street, Dundee, Scotland, DD1 5EH.

Contact details: Diana Swales, Centre for Anatomy and Human Identification, School of Science and Engineering, University of Dundee, Dow Street, Dundee, Scotland, DD1 5EH.

E-mail: d.swales@dundee.ac.uk

Abstract

The lack of grave goods in cemeteries from later Anglo-Saxon England (8th to 11th century AD) has in the past been interpreted as reflecting standardisation of burial rites dictated by Christian doctrine. This study employed a biocultural approach to investigate whether variations in mortuary practices such as burial location, grave form and body disposition within the 8th to 12th-century Black Gate cemetery, Newcastle-upon-Tyne represented alternative mediums of social display.

Skeletal markers commonly associated with early life stress (cribra orbitalia and linear enamel hypoplasia), non-specific stress (tibial periosteal lesions and maxillary sinusitis), oral health (calculus, caries, abscesses and ante-mortem tooth loss) and biomechanical stress (appendicular and spinal degenerative joint disease and trauma) were examined macroscopically on the skeletal remains of 643 individuals. The aim of the analysis was to investigate whether patterns in age, sex and biological stress in the different burial locations, burial types and body positions evidenced social status or socio-cultural relationships between the different mortuary practices.

Demographic and biocultural analysis revealed the inclusion of males, females, non-adults and the elderly in all of the mortuary practices and no evidence for marked inequalities in biological stress between those afforded the different burial practices. The dominant influence for non-significant trends in the stress data was variation in age-structure between different areas of burial. However, non-significant but consistently higher frequencies of stress indicators were observed in graves containing stone inclusions (pillow stones, head-cists and earmuffs) compared to those constructed from stone (cists and rubble cists) and plain burials, all burial practices with a similar mortality profile.

The distribution of age and stress indicators between the mortuary practices placed in the wider socio-cultural context provided a deeper insight into the complex contribution of social relationships, life-course, pragmatism, regional and temporal trends, and cultural and religious beliefs upon treatment of the deceased.

Key words: Early medieval, stress indicators, mortuary archaeology, social-status.

Introduction

Studies addressing relationships between social display in mortuary practices and the age, sex and life histories of the deceased in early medieval Britain (410-1066) have predominantly focused on early Anglo-Saxon grave goods (c. 410-700) (Härke, 1992; Geake, 1997, 1999; Lucy, 1997, 1998; Stoodley, 1999, 2000). The lack of grave goods and subsequent assumed homogeneity of burial practice in later Anglo-Saxon and Anglo-Norman burials has inhibited research into mortuary behaviour during this period (*c.* 800-1100) (Hadley, 2004). However, several scholars have proposed that social differentiation continued to be exhibited from the 8th century throughout the medieval period via diversity in location of the burial within the cemetery, construction of the grave and disposition of the body (Boddington, 1990; Daniell, 1997; Reynolds, 1999; Sullivan, 2004; Williams, 2006).

Archaeological and ethnographic studies of mortuary behaviour have equated variability in financial and labour investment into construction of a grave with social hierarchies and competition within the living community (Parker-Pearson, 1982; Brown, 1995; Kamp, 1998; Peck, 2013). Research specific to later Anglo-Saxon cemeteries has provided convincing evidence that the provision of stone-built cists or rubble-lined graves correlates with high social status (Buckberry, 2007; Hadley, 2007; Craig and Buckberry, 2010). Preferential areas for burial have been identified at a number of later Anglo-Saxon sites, such as Jarrow (Northumberland) (Lowther, 2005) and Barton-upon-Humber (North Lincolnshire) (Rodwell, 2007), where increased densities of burials next to church buildings reflect desire for burial in *locis sanctis* (holy ground) or *ad sanctos* (next to the saints) (Hadley, 2000; Zadora-Rio, 2003). Elaborate interments next to churches and minsters further evidence the prestige of burial next to ecclesiastical buildings (Boddington, 1996; Cramp and Lowther, 2005). Body positions varying from supine-extended have been interpreted as reflecting 'deviant' behaviour and criminality in a number of contexts including deviant and execution cemeteries (Daniell, 2002; Reynolds, 2009; Hadley, 2010). However, the reasons behind mortuary practice can be multifaceted, with numerous factors potentially influencing the manner of interment of the deceased. The use of stone-built cists is often associated with chronological developments within cemeteries. The location of burial within later Anglo-Saxon cemeteries has also been argued to convey cultural significance, with segregation by age indicated by 'eaves-drip' interment of infants alongside church buildings to enable post-mortem baptism by sanctified water running off the roof, such as at Raunds Furnells (Northamptonshire) (Craig-Atkins, 2014), and segregation of religious males in the monastic cemetery at Wearmouth (Northumberland) (McNeil and Cramp, 2005). Body position within the grave has also been linked to family customs (Heighway, 2007) and religious identity (Thompson, 2002; Holbrook and Thomas, 2005) as well as chronological trends (Adams, 1996; Boddington, 1996).

Relationships between biological stress and mortuary practices have been investigated for various archaeological periods (e.g., Robb *et al*., 2001; Peck, 2013). Several studies have identified that within hierarchically ranked societies selective distribution of resources determined by social position and status generates variations in physiological stress, which in turn impact upon the physical development and susceptibility to infectious and deficiency diseases of individuals within that society (Goodman *et al*., 1988; Goodman and Martin, 2002; Bennike *et al*., 2005; Peck, 2013; Temple and Goodman, 2014). However, research is increasingly demonstrating multifaceted influences that stimulate the expression of biological and physiological stress upon the skeleton, including differential fertility (Kinaston *et al.*, 2016), epigenetic inertia (Klaus, 2014), social practices such as weaning (Ash *et al.,* 2016), social and economic change (King *et al.*, 2005) and varying day-to-day physical activities experienced by different social, occupational or gender groups (Robb *et al.,* 2001).

Aims

This study investigated the relationship between age, sex and biological stress and mortuary behaviour in the later Anglo-Saxon to Anglo-Norman Black Gate cemetery to evaluate the viability of the hypothesis that variations in location and construction of the grave and disposition of the body were used to convey social status. The first objective was to identify evidence for segregation according to age and sex between the different burial practices within the cemetery. Secondly, differences in biological stress were examined between individuals interred in theoretically preferential burial locations, burial types and in atypical body positions, compared to those accorded 'standard' burial practices, to identify any differences suggestive of differential resource access or living conditions related to social segregation throughout life.

Materials and method

The Black Gate cemetery

The Black Gate cemetery underlies the keep of the Norman castle in Newcastle-upon-Tyne, north-east England. *The History of the Church of Durham* (1104 - 1107 to 1115), *History of* *the Kings of England* (1129) and the *Life of St Oswin King of Northumbria* (644-651) identify a settlement called Monkchester associated with Newcastle and the castle in 1072 that had been 'laid to waste' by 1074 (Rollason, 2000). There is, however, no archaeological evidence from the area surrounding the castle for such a settlement (Nolan, 2010).

Stratigraphic relationships between graves and built structures, coins within burials (810-985), and radio-carbon dating of skeletal remains (670-1160) indicate interments commenced by the late 7th century and ceased by 1168 (Nolan, 2010). The full extent of the cemetery is unknown but burials have been excavated throughout its projected limits (Fig. 1).

Four burial zones have been excavated: the Compound, Area C, the Railway Arches and Area D (Fig. 1). The physical relationships of these burials with the clay rampart of the 1080 castle and medieval deposits suggest the Compound and Area D to be the earliest interments followed by those beneath the Railway Arches then in Area C. Stone foundations of a church separate Area C and the Railway Arches (Nolan, 2010).

[Figure 1]

The majority of the 660 excavated interments were west-east aligned earth-cut graves containing supine-extended burials without grave goods (Nolan, 2010). More elaborate burials were classified, in accordance with Buckberry (2007), as *Elaborate Grave Types* (stone-built or rubble lined cists) and *Elaborate Grave Variations*. The latter consisted of earth-cut graves containing pillow stones (one or more stones placed below the skull, upon which it rests), earmuffs (large stones placed adjacent to the head, occasionally on both sides) and head-cists (partial or total enclosure of the skull within a stone slab structure). Wooden chest burials (Fig. 2), identified by iron locks in the grave, were classified as *Elaborate Grave Types* due to their association with higher-status cemeteries, such as at York Minster and

Ripon Cathedral (North Yorkshire) (Kjølbye-Biddle,1995; Buckberry, 2007; Craig-Atkins, 2012). When features of both elaborate grave *type* and *variation* were present, such as stone-built cist burial 482 which also contained a head-cist (Fig. 2), the burial was documented as an *Elaborate Grave Type* acknowledging the greatest labour and material investment.

[Figure 2]

Osteological Analysis

Macroscopic osteological analysis was undertaken upon 202 (31.4%) non-adults (aged 17 years or younger) and 441 (68.6%) adults, curated at the University of Sheffield. Good levels of preservation were observed throughout the cemetery with 70.5% (453/643) of individuals more than a quarter complete and 79.5% (511/643) exhibiting only slight cortical erosion (Grades 1 to 3) (McKinley, 2004).

Biological sex of adults was estimated from morphological characteristics of the skull and pelvis (Buikstra and Ubelaker, 1994). Non-adult and adult ages were estimated from skeletal and dental development, growth and degeneration (Miles, 1962; Moorrees *et al*., 1963; Anderson *et al*., 1976; Scheuer *et al*., 1980; Lovejoy *et al*., 1985; Brooks and Suchey, 1990; Hoppa, 1992; Schwartz, 1995). The age categories employed were foetal/neonate (0-1 month), infant (1-12 months), young child (1-5 years), older child (6-11 years), adolescent (12-17 years), young adult (18-24 years), prime adult (c.25-34 years), mature adult (c.35-44 years) and older adult (c.45+ years). The use of such age categories has its limitations (Buckberry, 2015), but is consistent with published literature (Falys and Lewis, 2011).

Early-life physiological and dietary stress was evaluated from the frequency of cribra orbitalia and linear dental enamel hypoplasias (LEH). Cribra orbitalia is commonly ascribed to nutritional deficiency, typically of iron or vitamin B12, resulting from mal- or under-nutrition or insufficient uptake of such nutrients from a sufficient diet due to the body's natural defence against chronic diarrhoeal disease and parasitic infections commonly associated with childhood diseases (Walker *et al.*, 2009). LEHs are commonly used as a non-specific physiological response to extrinsic environmental stressors such as disease or nutritional deficiency (Ash *et al.*, 2016). Defects form on the area of the crown developing at the time the disruption occurs, therefore, reflecting non-specific early-life stress episodes (Ogden *et al.*, 2007). Cribra orbitalia and LEH were recorded following Steckel *et al*. (2006).

Non-specific skeletal responses to exogenous and endogenous stressors can inform about living environments and infectious and inflammatory conditions experienced during and at the end of life. Non-specific stress was quantified by the manifestation of periosteal reactions on the tibial shafts, from here referred to as tibial periosteal new bone (TPNB) (Lewis, 2002; Weston, 2008) and within the maxillary sinus (Boocock *et al*., 1995). Upper respiratory tract infections are a primary cause of maxillary sinus infections but they can also result from allergies, pollutants and irritants within domestic and external environments, poor hygiene and congenital predisposition (Lewis *et al.,* 1995; Roberts, 2007). Only maxillary sinuses exposed by post-mortem damage were included within this analysis. Sinuses expressing evidence for dental infections encroaching into the cavity were excluded.

Dental diseases provide evidence for diet, general health, oral hygiene, food preparation techniques and cultural behaviours (Fields *et al.* 2009; Meller *et al.* 2009). To investigate variation in diet or oral hygiene practices the presence of dental calculus, carious lesions, periapical lesions and ante-mortem tooth loss (AMTL) were recorded both as present and absent and as a proportion of the total number of observable teeth and tooth sockets.

The initiation and severity of degenerative joint disease can be influenced by numerous factors, aside from advancing age, including biomechanical stress and physical activity (Weiss and Jurmain 2007; Rojas-Sepulveda *et al.* 2008). Appendicular joints and the superior and inferior discal surfaces of each vertebral body were analysed for marginal osteophyte formation, porosity and eburnation following Steckel *et al*. (2006).

Accidental injuries predominantly occur in long bones, consequently, elevated levels of physical activity may manifest as fractures to the lower limb, distal radius, clavicles and ribs (Larsen, 1997). All skeletal elements were examined for evidence of peri-mortem and healed fractures to detect prevalence or patterns indicative of accidental, violence or occupation related activity.

To reduce the complexity of data generated, and accommodate the lack of published true prevalence rates available for early medieval burial assemblages (Roberts and Cox, 2003), the statistical analysis included herein is presented as crude prevalence rates i.e., the number of individuals for which the lesion could be observed. To enable future comparison of this study Tables 3-5 include true prevalence rate data for all lesions save for linear enamel hypoplasia, calculus, spinal degenerative joint disease and trauma, which were recorded in the original study by presence or absence and severity.

Statistical analysis

Comparisons between presence and absence of pathological lesions for total population, males, females, non-adults and adults between each of the burial locations, burial types and body positions employed the non-parametric Pearson's chi-squared test of independence (χ^2). When counts for specific variables were less than 5 a Fisher's Exact test was employed.

All statistical analyses were executed using SPSS version 18.0. The threshold for rejection of the null hypothesis was 0.05. If the Chi-squared test result reached statistical significance when using a two-by-two contingency table a Yates correction for continuity was calculated to ensure the result was significant.

A significance value of 0.05 returns a significant result in 5% of tests regardless of the data (Robb *et al.*, 2001). This error is compounded when, as in this instance, large numbers of statistical tests are run on a single dataset. To address possible false negatives, significant results not corresponding with a real trend were omitted. The data produced for Area D was not included in the statistical analysis due to the small number of individuals recovered.

Results

Distribution of Burial Types

Elaborate burials were very few in number, totalling only 36 (Table 1), and they were only present in Area C and the Railway Arches (Fig.1). The absence of elaborate burial types in the Compound resulted in a statistically significant difference relative to both Area C (χ^2 = 18.347, P = <0.001) and the Railway Arches (χ^2 = 13.625, P = <0.001). Segregation of elaborate grave types in Area C and elaborate grave variations (plus the chest burials) beneath the Railway Arches returned a significant difference in burial provisioning between the two burial zones (grave types (χ^2 = 10.856, P = 0.001; grave variations (χ^2 = 3.834, P = 0.050).

Amongst the 613 burials for which burial position could be determined, the significant majority of interments in Area C (82.2%) (χ^2 = 121.041, P = <0.001) and the Railway Arches (82.0%) (χ^2 = 222.618, P = <0.001) were supine (Table 1). However, in the Compound a slightly greater representation of right-sided (44.5%) over supine burials (43.4%) resulted in a significantly greater presence of non-supine burials (χ^2 = 6.116, P = 0.013). A further variation was a small number of individuals interred on their left side (3.8%), prone (2.6%) or flexed (1.0%), with no discernible pattern regarding their location within the cemetery.

[Table 1]

Palaeodemography

The mortality data for the entire assemblage (Table S1) show an attritional profile characterised by the greatest number of deaths amongst the very young and elderly, and comparable numbers of adult males (40.4%, 178/441) and females (39.2%, 173/441).

The Compound (males: 43.6%, females: 56.4%) and Railway Arches (males: 48.3%, females: 51.7%) contained equivalent percentages of males and females. In contrast, Area C exhibited a significantly greater proportion of male (70.6%) to female (29.4%) interments (χ^2= 17.294, P = <0.001) (Table 2).

[Table 2]

Even though children less than one year at time of death were present throughout the cemetery, there was a higher concentration of foetal, neonate and infant burials adjacent to the walls of the church, resulting in a significantly greater number of non-adult (59.4%) to adult (40.6%) burials in Area C (χ^2 = 9.000, P = 0.003). This contrasts with the higher proportions of adults to non-adults observed in the Compound (adults: 65.0%, non-adults: 35.0%; χ^2 = 50.156, P = <0.001) and Railway Arches (adults: 74.8%, non-adults: 25.2%; χ^2 = 1.816, P = <0.001) (Table 2).

Consideration of burial type provision for individuals of different age and sex revealed no evidence for segregation. Nearly all elaborate burials (i.e. those constructed from or containing stone and chest burials) were represented in both adult and non-adult interments (Table 2). Chest burials were the exception, both instances of which were recovered from older adult interments. All elaborate grave types and variations were present in older adult graves.

There was no significant difference in each of the body disposition categories (supine, prone, left side, right side and flexed) between non-adults and adults or males and females (Table 2). Females were more greatly represented than males in burials on the left (males: 27.3%, females 72.7%) and right side (males: 43.7%, females 56.3%) and in a flexed position (males: 33.3%, females 66.7%). In contrast, males were more typically interred supine (males: 54.0%, females 46.0%) or prone (males: 63.6%, females 36.4%).

Stress Indicators

Tables and Figures 3-5 contain data pertaining to stress indicators and their prevalence relative to mortuary practices within the Black Gate cemetery.

[Table 3]
[Figure 3]

Overall, there were no significant differences in prevalence of any of the stress indicators between the Compound, Railway Arches and Area C for the total, adult or the non-adult population or males and females. However, maxillary sinusitis and all the dental and degenerative joint diseases occurred less frequently in Area C relative to the other burial areas. Of the early-life stress indicators cribra orbitalia exhibited consistent levels for the total population in each burial location, varying by only 8% between burial locations, whereas levels of total LEH were noticeably lower in the Compound, due to the low female prevalence (35.5%). Trauma was most prevalent in Area C.

[Table 4]
[Figure 4]

When observing the relationships between stress indicators and burial type there were no significant differences observed for the number of individuals exhibiting indicators of early-life stress (cribra orbitalia and LEH), non-specific infection and inflammation (maxillary sinusitis and TPNB) or dental disease (dental calculus, caries, periapical lesions and AMTL) either overall or between non-adults and adults or the sexes. The only significant observations were recorded for spinal degenerative joint disease (SDJD) and trauma. The greater frequency of SDJD observed in plain burials in comparison to elaborate burial types was statistically significant (χ^2= 5.011; P = 0.025). This statistical significance derives from significantly greater frequencies of SDJD observed in plain burials in comparison to elaborate grave types (stone, rubble and chest burials) (χ^2= 10.140; P = 0.001). In contrast, a significantly greater presence of trauma (χ^2= 7.213, P = 0.007) was observed in elaborate compared to plain burials (χ^2= 5.011, P = 0.025). All of the traumatic injuries were healed fractures to long bones, ribs and clavicles.

Individuals interred with elaborate variations (such as head-cists) exhibited seven of the stress indicators (cribra orbitalia, LEH, maxillary sinusitis, calculus, caries, appendicular and spinal degenerative joint disease) more frequently than those in elaborate grave types constructed from stone or containing chests and plain burials. Only TPNB was most prevalent in elaborate grave types (Table 4). Plain burials exhibited the highest frequencies of dental abscesses and ante-mortem tooth loss.

[Table 5]
[Figure 5]

No consistent trends in stress indicator frequency were observed between the different body positions (Table 5). The only statistically significant result was the high percentage of total AMTL observed in prone and flexed burials compared to supine, left-sided and right-sided interments (χ^2= 13.142, P = 0.011).

Chi-square (χ^2) statistical analysis identified a significant positive trend between advancing age at death from foetal to older adult and increase in prevalence of cribra orbitalia (P = <0.001), calculus (P = <0.001), abscesses (P = <0.001), AMTL (P = <0.001), appendicular (P = <0.001) and spinal (P = <0.001) DJD and trauma (P = 0.042). The same trend was also observed for abscesses (P = <0.001), AMTL (P = <0.001), ADJD (P = <0.001) and SDJD (P = <0.001) from young adults through to older adults. There were no statistically significant differences between males and females for any of the stress indicators, save for AMTL whereby females showed a significantly higher prevalence compared to males for the total population (males: 25.0%, females: 37.5%; χ^2 = 4.443, P = 0.035) and mature adults (χ^2 = 6.256; P = 0.012).

Discussion

The biocultural analysis revealed few statistically significant differences in biological stress or age and sex distribution between stone-built cists, interment of the deceased in preferential locations adjacent to religious structures, or positioning of the body supine, flexed or on their side as opposed to prone, which has been linked to social exclusion, criminality and deviancy. However, non-significant trends in stress indicators relative to mortuary practice suggest consideration of influences beyond a linear and hierarchical status framework is necessary. For example, the unique presence of stone-built cist burials and high frequency of male and non-adult interments in Area C coupled with lower frequencies of stress indicators relative to the other burial areas. Also, the high frequencies of stress indicators recorded for elaborate grave variations in comparison to elaborate grave types and plain earth-cut graves.

The limited number of stone-built graves, rubble-cists and chest burials and graves containing stone inclusions, such as pillow stones (n = 36) potentially represent preferential mortuary practices reflecting higher social and socio-economic status of the deceased. In processualist mortuary archaeology theory (Binford, 1971; Parker-Pearson, 1982; Brown, 1995) greater cost of materials and labour investment into elaborate burials is often interpreted as reflecting higher socio-economic status. The status presented may, however, not be directly of the deceased, but more reflective of the status of those burying the dead, which in turn informs about socio-cultural relationships of the living (Hodder, 1980; Parker-Pearson, 1982; Robb *et al.*, 2001).

Robb (2002) identifies a cultural equivalence to the osteological paradox whereby the deceased of any specific age or sex group may not have possessed equivalent social status as a living person of that demographic. Further theories explaining variability in mortuary behaviour, particularly regarding the use of stone in early medieval burial practices, include development of community relationships, competitive display, personhood, and mnemonics of memory (Kamp, 1998; Williams, 2006; Maldonado, 2016).

Burial Type and Location

The increasing complexity of the Black Gate burials appears to follow the chronological development of the cemetery, reinforced by later radiocarbon dates for stone-built cists BG368 (808-973), BG375 (960-1160) and BG580 (960-1160) (Nolan, 2010). Stone-built cists of similar date have been recovered from Wharram Percy (950-1050) (Heighway, 2007), Raunds Furnells (978-1040) (Boddington, 1996), and York Minster (8-12th century) (Phillips,

1995) further suggesting them to be a later development in Northumbria. The confinement of chest burials within the Railway Arches, proposed to pre-date Area C, concurs with Craig-Atkins (2014) who argues interments within wooden chests are characteristic to the north of England between the 7th and 9th century. However, irrespective of the chronological development of 'elaborate' burials, their distinctiveness and rarity within the Black Gate cemetery signifies them as atypical from the 'norm' within each burial zone.

Segregation of stone-built cists, and predominance of non-adults and male adults in Area C to the south-east of the church corresponds with similarly segregated burials at Wearmouth, interpreted as a monastic burial ground (McNeil and Cramp, 2005), and the slightly later cemetery of St Andrew's, Fishergate (York), where religious elites were interred in a monastic cemetery to the east and secular elites within and adjacent to religious buildings (Sullivan, 2004). Therefore, it is conceivable that some of the Area C adult male burials may have been religious brethren. However, it is possible that stone-built cists and a similarly high concentration of males and non-adults bordered the northern wall of the church, but have been destroyed (Nolan, 2010). A comparable distribution of burials was observed at Raunds Furnells where a greater proportion of non-adults (54.1%) to adults (45.9%) and males (61.9%) to females (38.1%) was observed in the 'central zone' surrounding the church, which, as at Black Gate, was the only area containing stone-built cists (Boddington, 1996). The 'central zone' at Raunds contained several burials with decorated grave covers and stone crosses, including the grave of the founder of the church and cemetery, thus, burials in Area C may include elite lay persons, and not necessarily be a burial ground for monastic brethren alone.

The significantly greater presence of non-adults in Area C results from a high concentration of foetal, neonate and infant burials adjacent to the walls of the church attributed to the religious practice of eaves-drip burial at other later Anglo-Saxon churches such as at Raunds Furnells, Whithorn (Galloway) and Wharram Percy (North Yorkshire) (Craig-Atkins, 2014).

Burial Type: Elaborate Grave Types and Variations

Equal representation of males and females in stone-built and rubble cists and interred with stone inclusions appears to corroborate the hypothesis that later Anglo-Saxon societies began to transfer from male dominated social hierarchies to social systems centred on familial and kin relationships (Hadley, 2004; Sayer, 2013). Indeed, small localised clusters of elaborate and intercutting burials, such as stone-built cists to the north-west and chests to the north-east at York Minster (Buckberry, 2007) and the aforementioned burials at Raunds Furnells have been interpreted as family groups (Boddington, 1996; Hadley, 2004). Female interments in preferential locations and elaborate burials potentially reflect wealth acquired through marriage. Widows of high social status males inherited the wealth and eminence of their husbands, for instance the Anglo-Saxon Chronicle entry for 672 states 'Cenwealth died, and his queen Seaxburh reigned one year after him' (Savage, 1982).

Crawford (1999) refers to drawings of children in the *Harley Psalter,* an illustrated copy of the Psalms dating to the mid-11th century, where they were depicted smaller than adults and wearing 'short tunics' instead of cloaks as evidence that children (individuals aged less than 10 years) in the Anglo-Saxon period were regarded as distinct from adults (Crawford, 1999). This interpretation is compounded by the different activities children engaged in and their separate legal rights, focussed primarily on their protection (Kuefler, 1991; Crawford, 1999, 2000). Therefore, interment of children in elaborate burials is unlikely a direct reflection of their personal status in life.

It is possible that the burials do, in some instances, symbolise individual social identity. For example, documentary evidence indicates females held social status independent of male relatives. Unmarried women had the right to partake in business, own land and write wills and contracts, such as the will of Wynflaed (c.950) (Sayer, 2013) and Bede documents in *Ecclesiastical History* that Abbess Hilda ruled over both men and women at the double monasteries of Whitby and Hartlepool (Dietrich, 1979).

The presence of elaborate graves characterised by stone components and wooden chests throughout all age categories, but higher prevalence amongst older adults, supports Buckberry's (2007) interpretation that later Anglo-Saxon elaborate burial was preferentially accorded, but not confined, to older members of the population. The inclusion of non-adults and older adults – particularly females – in elaborate graves suggests there was no exclusion of the young and old 'non-active' members of the community (Bello and Andrews, 2006). Older adults may have contributed greatly to society throughout their lives and continued to do so up until death therefore it is essential to consider their roles throughout their entire life-course, not at the static moment of death (Robb, 2002; Gowland, 2006).

Body Position

The high frequency of right-sided burials within the Compound possibly reflects chronological trends. Lowther (2005) assigns the majority rite of right-sided burial amongst the pre-Norman interments at Wearmouth and equal numbers of supine and right-sided burials at Jarrow to a regional chronological trend (Cramp and Lowther, 2005; Lowther, 2005).

Inter-cutting of graves was common in cemeteries from the 9th century, and has been attributed to increased familiarity with, and subsequent decreased fear of, the dead due to increased urbanisation and the resultant apposition of churchyards and burial grounds to domestic settlements (Cherryson, 2007). Boddington (1996) observed that 'Final Phase' burials at Raunds Furnells rarely inter-cut, whereas 21% of later burials cut an earlier grave, which he ascribed to necessity in response to increasing demand. Furthermore, at Addingham, North Yorkshire, there were no inter-cutting burials dating to the 9th century but graves were often reused in the 10th-century (Adams, 1996).

Restricted space within the grave may account for right sided and flexed adult burials. Such positioning could have been necessary to enclose the body within the confines of graves cut narrow to limit inter-cutting or within narrow coffins or chests. The latter was suggested for a flexed chest burial at York Minster (Buckberry, 2004) and is observed in the two flexed wooden chest burials at Black Gate (Fig.2). Even though the scapulae and clavicles are missing from adult chest burial BG644 medial constriction of the upper arms is evident, there is no medial displacement of the patellae and the entirety of the skeleton, including the slightly flexed legs crossed at the ankles and flexion of the metacarpals respects a definite boundary anteriorly, posteriorly and distally. This 'boxed in' appearance is also observed in adult chest burial BG619 and is consistent with burial in a 'narrow coffin' (Duday and Guillon, 2006; Harris and Tayles, 2012).

The occurrence of 16 prone burials throughout the Black Gate cemetery implies they were not burials of criminals, which were typically segregated within cemeteries or buried in designated burial grounds (Reynolds, 2009; Hadley, 2010). The presence of prone burials, some of which were provisioned with stone markers and stones placed around the head in the same manner as the rest of the interments, within cemeteries of later Anglo-Saxon religious communities at Wearmouth (McNeil and Cramp, 2005) and Jarrow (Lowther, 2005) further undermines the argument that such interment represents damnation or disrespect.

Thompson (2002) theorised prone burials symbolise the prostrate position of monks praying before the altar upon the death of a brother. However, no supporting evidence is provided and this does not explain prone burials in lay contexts. Within the Black Gate cemetery prone burials were not confined to Area C, which would be the most likely location of burials of brethren associated with a pre-exiting monastery, and they included females (36.4%), undermining a monastic association. Prone burials are yet to be clearly understood and deserve further consideration beyond the capabilities of this paper.

Biological Stress Indicator Analysis

Stress indicators are manifestations upon the skeleton and dentition of impaired cellular response to systemic biological stress resulting from extrinsic physical and social environment impacts upon the body, such as mal- and under-nutrition, overcrowded or unhygienic living conditions, bacterial infections and emotional distress (Goodman *et al.* 1988, Ribot and Roberts 1996; Goodman and Martin 2002; Klaus, 2014; Piperata *et al.*, 2014). The extent to which these environmental stressors affect an individual is determined by a combination of factors, including biologically controlled resistance related to age, sex and socio-economic and cultural influences (Goodman *et al.* 1988). Social inequality is often ascribed as the main reason for disparities in physiological disruption representing stress within populations (Temple and Goodman, 2014). Consequently, it was hypothesised that individuals buried in preferential locations, atypical grave types (e.g. stone-built cists and wooden chests), or body positions differing from the majority supine-extended burials in plain earth cut graves would display distinct frequencies of stress indicators.

In agreement with DeWitte and Stojanowski (2015) the current biocultural study considered historical and archaeological data alongside a range of stress indicators to reflect various aspects of the life experience and to enable the impact of the osteological paradox on the Black Gate assemblage to be assessed.

Superficially, lower frequencies of dental disease and non-specific infection rates and DJD observed in Area C, suggested to be a location for preferential burial due to the proximity of burials next to a church and the unique presence of stone-built cists, is in agreement with this being a group shielded from environmental, nutritional and physiological stresses affecting those within the rest of the cemetery. In accordance with the 'osteological paradox' (Wood *et al.,* 1992) it is possible that individuals interred in Area C were less resistant to stress than those interred elsewhere and consequently died before dental and skeletal manifestations occurred. Due to the nature of the burials it is unlikely this is the case. Wood *et al.* (1992) themselves identified that the osteological paradox addresses intricacies of biological data and is not a uniformly applicable concept and that further complexities associated with concepts of physiological and social age exist and need to be considered.

Longevity of life and the associated accumulation of lesions greatly impacts the prevalence of many stress indicators within populations (Temple and Goodman, 2014; Wilson, 2014). The low frequency of dental disease within Area C relative to the rest of the cemetery could be interpreted as deriving from a less carbohydrate dependent diet or better oral hygiene practices (DeWitte and Bekvalac, 2010). However, the high number of non-adults would have had insufficient time for lesions to develop, resulting in a lower frequency. Indeed, Jackes (2011) cites research confirming carious lesions accumulate at a standard rate with age. Similarly, the age accumulative nature of degenerative joint disease explains their low prevalence in Area C within which only 14.7% of the population are older adults compared with 26.4% and 27.5% in the Railway Arches and Compound respectively. Moreover, significantly greater frequencies of AMTL in prone and flexed burials are a consequence of small sample sizes and the high percentage of older adults (prone = 37%; flexed = 50%).

The lower frequency of maxillary sinusitis observed in Area C most likely reflects the large number of neonates and infants lacking fully formed sinuses (Lewis, 2002) who would also have been excluded from 'industrial' activities involving hearths and the subsequent smoke inhalation.

It is important to incorporate the life course (the duration of life from conception to death) into interpretations of skeletal stress indicators, considering social and cultural ages, which may be obscured by biological categorisation, such as 'non-adult' and 'adult' (Gowland, 2006; Gowland and Redfern, 2010). The similar frequencies of cribra orbitalia throughout all areas of burial and LEH in Area C and the Railway Arches suggest uniform childhood experiences in those locations.

The Black Gate prime adult females are more frequently affected by AMTL (12.5% greater) and caries (21.3% greater) than males, the latter of which returns a statistically significant result. Higher rates of dental caries in females are commonly attributed to behavioural factors such as sexual division of labour and differential consumption of food, such as females snacking on foodstuffs during preparation (Larsen, 1995). However, it is more probable that the high prevalence of prime adult females exhibiting caries compared to males is a physiological characteristic. Clinical studies have shown that women are more susceptible to periodontal disease during pregnancy due to hormonal changes and this may have had a subsequent impact upon the later loss of teeth (Lukacs and Largaespade, 2006).

When age is taken into consideration the stress indicator study revealed a homogenous contributing population lacking statistically significant variability in either physiological or nutritional stress, dental disease, or trauma. The lack of significant differences in biological stress in elaborate grave types and variations relative to plain burials is consistent with the observations of Craig and Buckberry (2010) in their study of stress in comparable burial practices at Raunds Furnells.

The scarcity of statistically significant correlation between burial provision and stress may be a consequence of the small sample sizes available for the atypical mortuary practices. Alternative explanations for the lack of statistically valid variability include firstly, the diet and general wellbeing of all social groups was to a minimum required standard preventing manifestation of stress upon the skeleton. Secondly, stress indicators were not sensitive enough to detect variability between different social groups. Thirdly, burial type and body disposition are not related to status of the deceased. These are all considered by Robb *et al.* (2001) as explanations for a lack of correlation between biological and social status in the medieval Pontecagnano cemetery (Italy).

Historical sources document variation in access to plant and animal foods between social groups due to variable access to land in early medieval England (Woolgar *et al.,* 2006). However, the diet of the poor may have been supplemented by naturally occurring fruits and fish (Müldner and Richards, 2007; Mays and Beavan, 2012), wild game (Groves, 2011) and donations of leftovers and alms from monasteries and noble estates. For example, in approximately 1005 Aelfric instructs the monks of Eynsham to provide three paupers who were regularly fed in the monastery with the same foods as consumed by the monks (Jones, 2006). Furthermore, cereal based foods such as bread produced from mixtures of rye, wheat or barley and broths were available to everybody, just in varying qualities (Dyer, 2000). Consequently, the basic diet may have been sufficient for all social groups to meet their nutritional requirements.

The comparable distribution of older age categories between plain and elaborate grave variations and grave types suggests variation in stress indicators between burial types represent actual differences in health not the accumulative effects of advancing age. The greater frequencies of cribra orbitalia, LEH, maxillary sinusitis, calculus, caries, ADJD and SDJD amongst those interred with elaborate grave variations may indicate distinct social groups intermediate to plain burials and elaborate grave types, consuming slightly different diets and subjected to different physical and environmental stresses to those interred in plain burials, or experienced the same stresses but were able to survive periods of insult for longer, and therefore manifest stress upon the skeleton.

An alternative explanation for the lower frequencies of stress indicators in plain and elaborate grave types, and possibly for the lack of statistically significant variation in stress between the three burial categories is that the plain burials may also have contained wooden coffins, which may equate to chest burials and rubble cists in later Anglo-Saxon burials. A similar argument is presented by Sullivan (2004) who states coffins were intermediary to plain and stone coffins within St Andrew's, Fishergate.

The significantly greater prevalence of trauma, predominantly ante-mortem fractures to the long bones and clavicles, in elaborate burials may indicate those accorded burials in stone-built or rubble cists, wooden chests or with stone inclusions, were engaged in elevated levels of physical activity and experienced a greater risk of trauma from falls and accidents (Judd and Roberts, 1999; Steckel *et al.,* 2002) than the occupants of plain burials. There are no published analyses of trauma for later Anglo-Saxon or early Norman burial practices to compare these results, rendering interpretation conjectural. However, the distribution of fractures in elaborate burials may reflect specific occupational or recreational activities during day-to-day living involving a greater risk of trips or injury. Indeed, hunting was the preserve of higher-status individuals (Groves, 2006) and would result in skeletal trauma. Roberts and Cox (2003) and Judd and Roberts (1999) explored the relationship between skeletal trauma and occupational stresses associated with farming in the late Anglo-Saxon period and concluded farming posed a greater number of traumatic risks to those involved than the craft activities undertaken in the urban settlements. This may indicate that 'elite' status within the Black Gate population may have been acquired by those active in physically demanding trades, such as metal working and farming, which produced goods of high commercial and economic value. The high prevalence of sinusitis (particularly amongst males interred in elaborate grave variations) may reflect involvement in different employment tasks than the rest of the population. This supports the hypothesis that elaborate grave types and elaborate grave variations may represent distinct socio-economic groups and that status in later Anglo-Saxon Northumbria could have been acquired as well as inherited.

Conclusion

The variability of mortuary practices within the Black Gate cemetery challenged the assumption of homogeneity of later Anglo-Saxon burial. Evidence was present for selective burial of a limited number of individuals in stone-built and rubble cists and wooden chests; a high concentration of these elaborate burials, males and infants adjacent to a church; and deliberate variations in body position. Variation in body position and elaborate burial types appear to be chronological and regional trends linked to pragmatism and changing attitudes to the corporeal body. However, the small number of elaborate burials and individuals interred prone or flexed suggests deliberate selection of the individuals bestowed such practices.

The few statistically significant differences in stress between burial locations and body positions demonstrate clear associations with age. However, non-significant trends in biological stress between burial types, which exhibited a similar age composition, coupled with the location of burials suggest graves containing pillow stones, earmuffs and head-cists possibly represent intermediate 'status' burials between elaborate grave types and plain burials potentially linked to occupation or kin groups. It must be noted, however, that the interpretations of demographic and physiological stress data are based on small sample sizes and are suggestions based on historical evidence and interpretations from comparative sites. This study emphasises the impact of age-composition on comparative samples and the influences beyond hierarchical social status, such as the life course, socio-cultural relationships, chronological and regional trends on mortuary practices and their biocultural interpretation.

Acknowledgements

The author would like to thank Dr Pia Nystrom and Professor Dawn Hadley for their supervision of the PhD research project from which the data presented in this study derives and the anonymous reviewers for their constructive comments. A very special thank you is also accorded to John Nolan of Northern Counties Archaeological Services, and the late

Barbara Harbottle whose kind assistance and generosity with knowledge has been invaluable. This research was funded by the University of Sheffield Fee Bursary and Incentive Award Scheme for doctoral research.

Literature Cited

Adams, M. 1996 Excavations of a pre-conquest cemetery at Addingham, West Yorkshire. *Medieval Archaeology* **40**: 151-191.

Anderson, D.L., Thompson, G.W. and Popovich F. 1976 Age attainment of mineralization stages of the permanent dentition. *Journal of Forensic Sciences* **21**: 191-200.

Ash, A., Francken, M., Pap, I., Tvrdý, Z., Wahl, J. and Pinhasi, R. 2016 Regional differences in health, diet and weaning patterns amongst the first Neolithic farmers of central Europe. *Nature: Science Reports* **6**: 29458.

Bello, S. and Andrews, P. 2006 The intrinsic pattern of preservation of human skeletons and its influence on the interpretation of funerary behaviours. In: Gowland, R. and Knüsel, C. (Eds.) *The Social Archaeology of Funerary Remains*. Oxford: Oxbow. pp. 1-13.

Bennike, P., Lewis, M.E., Schutkowski, H. and Valentin, F. 2005 Comparison of child morbidity in two contrasting medieval cemeteries from Denmark. *American Journal of Physical Anthropology* **128**: 734-46.

Binford, L.R. 1971 Mortuary Practices: Their study and their potential. *Approaches to the Social Dimensions of Mortuary Practices*. Memoirs of the Society for American Archaeology, No. 25. pp. 6-29.

Boddington, A. 1990 Models of burial, settlement and worship: the Final Phase reviewed. In: Southworth, E. (Ed.) *Anglo-Saxon Cemeteries: A Reappraisal*. Stroud: Sutton Publishing. pp. 177-99.

Boddington, A. 1996 *Raunds Furnells: The Anglo-Saxon Church and Churchyard*. London: English Heritage.

Boocock, P., Roberts, C.A. and Manchester, K. 1995 Maxillary sinusitis in Medieval Chichester, England. *American Journal of Physical Anthropology* **98**: 483-95.

Brooks, S. and Suchey, J.M. 1990 Skeletal age determination based on the os pubis: a comparison of the Acsádi-Nemeskéri and Suchey-Brooks method. *Human Evolution* **5**: 227-38.

Brown, J. 1995 On mortuary analysis—with special reference to the Saxe-Binford research program. In: L.A. Beck (Ed.), *Regional Approaches to Mortuary Practices*. New York: Plenum.

Buckberry, J.L. 2004 *A Social and Anthropological Analysis of Conversion Period and later Anglo-Saxon Cemeteries in Lincolnshire and Yorkshire*. University of Sheffield. Unpublished PhD thesis.

Buckberry, J.L. 2007 On sacred ground: social identity and churchyard burial in Lincolnshire and Yorkshire. c. 700-1100 A.D. In: Williams, H. and Semple, S. (Eds.) *Anglo-Saxon Studies in Archaeology and History No.14*. Oxford: Oxford University Press. pp. 119-29.

Buckberry, J.L. 2015 the (mis)use of adult age estimates in osteology. *Annals of Human Biology* **42**(4): 323-331.

Buikstra, J.E. and Ubelaker, D.H. 1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas: Arkansas Archaeological Survey.

Cherryson, A.K. 2007 Disturbing the dead: urbanisation, the Church and the post-burial treatment of human remains in early medieval Wessex. In: Semple, S. and Williams, H. (Eds.) *Anglo-Saxon Studies in Archaeology and History No.14.* Oxford: Oxbow. pp. 130-42.

Craig, E. and Buckberry, J.L. 2010 Investigating social status using evidence of biological status: a case study from Raunds Furnells. In: Buckberry, J.L. and Cherryson, A.K. (Eds.) *Burial in Later Anglo-Saxon England c. 650-1100 A.D.* Oxford: Oxbow. pp. 128-42.

Craig-Atkins, E. 2012 Chest burials: A middle Anglo-Saxon funerary rite from Northern England. *Oxford Journal of Archaeology* **31**(3): 317-37.

Craig-Atkins, E. 2014 Eavesdropping on short lives: eavesdrip burials and the differential treatment of children one year of age and under in early Christian cemeteries. In: Hadley, D. and Hemer, K. (eds.) *Medieval Childhood: Archaeological Approaches*. Childhood in the Past Monograph Series: Volume 3. pp. 95-113.

Cramp, R. and Lowther, P. 2005 The Jarrow pre-Norman burial ground. In: Cramp, R. *Wearmouth and Jarrow Monastic Sites: Volume 1.* Swindon: English Heritage. pp. 76-90.

Crawford, S. 1999 *Childhood in Anglo-Saxon England*. Stroud: Sutton Publishing.

Crawford, S. 2000 Children, grave goods and social status in early Anglo-Saxon England. In: Sofaer-Derevenski, J. (Ed.) *Children in Material Culture.* London: Routledge. pp. 169-79.

Daniell, C. 1997 *Death and Burial in Medieval England 1066-1550*. London: Routledge.

Daniell, C. 2002 Conquest, crime and theology in the burial record: 1066-1200. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales*. London: The Society for Medieval Archaeology. pp. 241-54.

Dawson, H. 2017 Precious Things: Examining the Status and Care of Children in Late Medieval England through the Analysis of Cultural and Biological Markers. In Powell, L., Southwell-Wright, W., and Gowland, R. (eds.) Care in the Past: Archaeological and Interdisciplinary Perspectives. Oxbow Books. Oxford. pp. 53-69.

Dewitte, S.N. and Bekvalac, J. 2010 Oral health and frailty in the medieval English cemetery of St Mary Graces. *American Journal of Physical Anthropology* **142**(3): 341-54.

DeWitte, S.N. and Stojanowski, C.M. 2015 The Osteological Paradox 20 years later: Past perspectives, future directions. *Journal of Archaeological Research* **23**:397-450.

Dietrich, S.C. 1979 An Introduction to Women in Anglo-Saxon Society (c. 600-1066). In: Kanner, B. (Ed.) *The Women of England: From Anglo-Saxon Times to the Present.* London: Mansell Publishing. pp. 32-56.

Duday, H., Guillon, M., 2006. Understanding the circumstances of decomposition when the body is skeletonized. In Schmitt, A., Cunha, E., Pinheiro, J. (eds.), Forensic Anthropology and Medicine: Complementary Sciences from Recovery to Cause of Death. Humana Press Inc. Totowa.pp. 117–157.

Dyer, C.C. 2000 *Everyday Life in Medieval England*. London: Hambledon. 2nd edition.

Falys, C.G. and Lewis, M.E. 2011 Proposing a Way Forward: A Review of Standardisation in the Use of Age Categories and Ageing Techniques in Osteological Analysis (2004–2009). International Journal of Osteoarchaeology **21**: 704-716.

Fields, M., Herschaft, E.E., Martin, D.L. and Watson, J.T. 2009 Sex and the agricultural transition: dental health of early farming females. *Journal of Dentistry and Oral Hygiene* **1**(4): 42-51.

Geake, H. 1997 *The Use of Grave-Goods in Conversion-Period England, c.600-c.850.* British Archaeological Reports British Series 261. Oxford: Tempus Repartum

Geake, H. 1999 Invisible kingdoms: The use of grave-goods in seventh-century England. In: Dickinson, T. and Griffiths, D. (Eds.) *Anglo-Saxon Studies in Archaeology and History 10.* Oxford: Oxford University School of Archaeology. pp. 203-15.

Goodman, A.H. 1993 On the interpretation of health from skeletal remains. *Current Anthropology* 34: 281-288.

Goodman, A.H., Brooke-Thomas, R., Swedlund, A.C., and Armelagos, G.J. 1988 Biocultural perspectives on stress in prehistoric, historical and contemporary population research. *Yearbook of Physical Anthropology* **31**: 169-202.

Goodman, A.H. and Martin, D.L. 2002 Reconstructing health profiles from skeletal remains. In: Steckel, R.H. and Rose, J.C. (Eds.) *The Backbone of History: Health and Nutrition in the Western Hemisphere.* Cambridge: Cambridge University Press. pp. 11-60.

Gowland, R.L. 2006 Ageing the past: examining age identity from the funerary evidence. In: Gowland, R.L. and Knüsel, C. (Eds.) *Social Archaeology of Funerary Remains.* Oxford: Oxbow Books. pp. 152-68.

Gowland, R.L. and Redfern, R. 2010 Childhood Health in the Roman World: Perspectives from the Centre and Margin of the Empire. *Childhood in the Past* **3**: 15-42.

Groves, S. 2011 Social and biological status in the Bowl Hole early medieval burial ground, Bamburgh, Northumberland. In: Petts, D. and Turner, S. (Eds.) *Early Medieval Northumbria: Kingdoms and Communities, AD 450-1100*. Turnhout, Belgium: Brepols Publishers. pp. 241-266.

Hadley, D.M. 2000 Burial practices in Northern Danelaw: c. 650-1100. *Northern History* **36**: 199-216.

Hadley, D.M. 2004 Negotiating gender: family and status in Anglo-Saxon burial practices, c. 600-950. In Brubaker, L. and Smith, J.M.H (Eds.) *Gender in the Early Medieval World East and West, 300-900*. Cambridge: Cambridge University Press. pp. 301-23.

Hadley, D.M. 2007 The Garden gives up its secrets: the developing relationship between rural settlements and cemeteries c. 800-1100. In Semple, S. and Williams, H. (Eds.) *Anglo-Saxon Studies in Archaeology and History No.14.* Oxford: Oxbow. pp. 194-203.

Hadley, D.M. 2009 Burial, belief and identity in later Anglo-Saxon England. In Gilchrist, R. and Reynolds, A. (Eds.) *Reflections*: *Fifty Years of Medieval Archaeology.* London: Society for Medieval Archaeology. pp. 465-88.

Hadley, D.M. 2010 Burying the socially and physically distinctive in later Anglo-Saxon England. In Buckberry, J.L. and Cherryson, A.K. (Eds.) *Burial in Later Anglo-Saxon England c. 650-1100 AD.* Oxford: Oxbow. pp. 103-16.

Hadley, D.M. and Buckberry, J.L. 2005 Caring for the dead in late Anglo-Saxon England. In: Tinti, F. (Ed.) *Pastoral Care in Late Anglo-Saxon England.* Woodbridge: Boydell. pp. 121-47.

Härke, H. 1992 Changing symbols in a changing society: the Anglo-Saxon weapon burial rite in the seventh century. In: Carver M.O.H. (Ed.) *The Age of Sutton Hoo.* Woodbridge: Boydell. pp. 149-65.

Harris, N.J. and Tayles, N. 2012 Burial containers – A hidden aspect of mortuary practices: Archaeothanatology at Ban Non Wat, Thailand. *Journal of Anthropological Archaeology* **31**: 227-239.

Heighway, C. 2007 The attributes of burials. In: Mays, S., Harding, C. and Heighway, C. (Eds.) *Wharram: XI The Churchyard*. York: English Heritage. pp. 216-42.

Hodder, I. 1980 Social structure and cemeteries: A critical appraisal. In: Rahtz, P., Dickinson, T. and Watts, L. (Eds.) *Anglo-Saxon Cemeteries, 1979*. British Archaeological Reports British Series 82. Oxford: Tempus Repartum.pp. 161-69.

Holbrook, N. and Thomas, A. 2005 An early-medieval monastic cemetery at Llandough, Glamorgan: excavations in 1994. *Medieval Archaeology* 49: 1-92.

Hoppa, R.D. 1992 Evaluating human skeletal growth: an Anglo-Saxon example, *International Journal of Osteoarchaeology* **2**: 275-88.

Jones, C.A. 2006 *Aelfric's Letter to the Monks of Eynsham*. Cambridge Studies in Anglo-Saxon England 24. Cambridge: Cambridge University Press.

Jackes, M. 2011 Representativeness and bias in archaeological skeletal samples. In: Agarwal, S.C. and Glencross, B.A. (Eds.) Social Bioarchaeology. Blackwell Studies in Global Archaeology 14. Chichester: Wiley-Blackwell Publishing Ltd. pp. 107-46.

Judd, M.A. and Roberts, C.A. 1999 Fracture trauma in a medieval British farming village. *American Journal of Physical Anthropology* **109**: 229-43.

Kamp, K.A. 1998 Social Hierarchy and Burial Treatments: A Comparative Assessment. *Cross-Cultural Research* 32: 79-115.

Kinaston, R.L., Roberts, G.L., Buckley, H.R. and Oxenham, M. 2016 A bioarchaeological analysis of oral and physiological health in the South Coast of New Guinea. *American Journal of Physical Anthropology* **160**: 414-426.

King, T., Humphrey, L.T. and Hillson, S. 2005 Linear enamel hypoplasias as indicators of systemic physiological stress: Evidence from two known age-at-death and sex populations from postmedieval London. *American Journal of Physical Anthropology* **128**: 547-559.

Kjølbye-Biddle, B. 1995 Iron-bound coffins and coffin-fittings from the pre-Norman cemetery. In: Phillips, D. and Heywood, B. *Excavations at York Minster Volume 1: from Roman Fortress to Norman Castle: Part 1: The Site.* London: HMSO. pp. 489-521.

Klaus, H.D. 2014 Frontiers in the bioarchaeology of stress and disease: cross-disciplinary perspectives from pathophysiology, human biology, and epidemiology. *American Journal of Physical Anthropology* **155**: 294-308.

Kuefler, M.S. 1991 A wryed existence: attitudes towards children in Anglo-Saxon England. *Journal of Social History* **24**(4): 823-34.

Larsen, C.S. 1995 Biological changes in human populations with agriculture. *Annual Review of Anthropology* **24**: 185-213.

Larsen, C.S. 1997 *Bioarchaeology: Interpreting Behaviour from the Human Skeleton*. Cambridge: Cambridge University Press.

Lewis, M.E. 2002 *Urbanisation and Child Health in Medieval and Post-Medieval England: An assessment of the morbidity and mortality of non-adult skeletons from the cemeteries of two urban and two rural sites in England (AD 850-1859)*. British Archaeological Reports. British Series 339. Oxford: Archaeopress.

Lewis, M.E., Roberts, C.A. and Manchester, K. 1995 Comparative study of the prevalence of maxillary sinusitis in later medieval urban and rural populations in northern England. *American Journal of Physical Anthropology* **98**: 497-506.

Lovejoy, C.O., Meidl, R.S., Pryszbeck, T.R. and Mensford, R. 1985 Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of skeletal age at death. *American Journal of Physical Anthropology* **68**: 15-28.

Lovell, N.C. 1997 Trauma analysis in paleopathology. *Yearbook of Physical Anthropology* **40**: 139-70.

Lowther, P. 2005 The Jarrow Pre-Norman Burial Ground. In Cramp, R. *Wearmouth and Jarrow Monastic Sites:* Volume 1. York: English Heritage. pp. 173-86.

Lucy, S. 1997 Housewives, warriors and slaves? Sex and gender in Anglo-Saxon burials. In: Moore, J. and Scott, E. (Eds.) *Invisible People and Processes. Writing Gender and Childhood into European Archaeology.* Leicester: Leicester University Press. 150-68.

Lucy, S. 1998 *Early Anglo-Saxon cemeteries of East Yorkshire*. British Archaeological Reports. British Series 272. Oxford: Tempus Repartum.

Lukacs, J.R. and Largaespada, L.L. 2006 Explaining sex differences in dental caries prevalence: Saliva, hormones, and "life-history" etiologies. *American Journal of Human Biology* **18**(4): 540-55.

Maldonado, A. 2016 Materialising the afterlife: the long cist in early medieval Scotland, In Russell, A., Pierce, E., Maldonado, A. and Campbell, L. (eds.) *Creating Material Worlds The Uses of Identity in Archaeology*. Oxbow Books Ltd., Oxford. pp.39-62.

Mays, S. and Beavan, N. 2012 An investigation of diet in early Anglo-Saxon England using carbon and nitrogen stable isotope analysis of human bone collagen. *Journal of Archaeological Science* **39**: 867-874.

McKinley, J. 2004 Compiling a skeletal inventory: disarticulated and co-mingled remains In: Brickley, M. and McKinley, J. 2004 *Guidelines to the Standards for Recording Human Remains*. Institute For Archaeologists Paper No. 7.

McNeil, S. and Cramp, R. 2005 The Wearmouth Anglo-Saxon Cemetery. In: Cramp, R. *Wearmouth and Jarrow Monastic Sites.* Volume 1. Swindon: English Heritage. pp. 77-90.

Meller, C., Urzua, I., Moncada, G. and von Ohle, C. 2009 Prevalence of oral pathologic findings in an ancient pre-Columbian archaeological site in the Atacama Desert. *Oral Diseases* **15**: 287-94.

Miles, A. 1962 Assessment of age of a population of Anglo-Saxons from their dentition. *Proceedings of the Royal Society of Medicine* **55**: 881-6.

Moorrees, C.F.A., Fanning, E.A. and Hunt, E.E. 1963 Age variation of formation stages for ten permanent teeth, *Journal of Dental Research* **42**: 1490-502.

Müldner, G. and Richards, M.P. 2007 Diet and Diversity at later medieval Fishergate: the isotopic evidence. *American Journal of Physical Anthropology* **134**: 162-74.

Nolan, J. 2010 The early medieval cemetery at the Castle, Newcastle-upon-Tyne. *Archaeologia Aeliana* **39**: 147-287.

Ogden, R.A., Pinhasi, R. and White, W.J. 2007 Gross enamel hypoplasia in molars from subadults in a 16th–18th century London graveyard. *American Journal of Physical Anthropology* **133**: 957-966.

Parker-Pearson, M. 1982 Mortuary Practices, symbols and ideology: an ethnoarchaeological study. In: Hodder, I. (Ed.), *Symbolic and Structural Archaeology*. Cambridge: Cambridge University Press. pp. 99-113.

Peck, J. 2013 Status, health and lifestyle in Middle Iron Age Britain: A bioarcheological study of elites and non-elites from East Yorkshire, Northern England. *International Journal of Paleopathology* **3**: 83-94.

Phillips, D. 1995 Description of burial rites. In: Phillips, D. and Heywood, B. 1995 *Excavations at York Minster Volume 1: from Roman Fortress to Norman Castle: Part 1: The Site.* HMSO. London. pp. 82-92.

Piperata, B.A., Hubbe, M. and Schmeen, K.K. 2014 Intra-population variation in anemia status and its relationship to economic status and self-perceived health in the Mexican family life survey: implications for bioarchaeology. *American Journal of Physical Anthropology* **155**: 210-220.

Reynolds, A. 1999 *Later Anglo-Saxon England: Life and Landscape*. Stroud: Tempus.

Reynolds, A. 2009 *Anglo-Saxon Deviant Burial Customs*. Oxford: Oxford University Press.

Ribot, I. and C, Roberts. 1996 Study of non-specific stress indicators and skeletal growth in two medieval sub-adult populations. *Journal of Archaeological Science* **23**: 67-79.

Robb, J., Bigazzi, R., Lazzarini, L., Scaraini, C. and Sonego, F. 2001 Social 'status' and biological 'status': a comparison of grave goods and skeletal indicators from Pontecagnano. *American Journal of Physical Anthropology* **115**: 213-22.

Robb, J. 2002 Time and Biography: Osteobiography of the Italian Neolithic lifespan. In: Hamilakis, Y., Pluciennik, M. and Tarlow, S. (Eds.) *Thinking Through the Body: Archaeologies of Corporeality*. New York: Kluwer Academic/Plenum Publishers. pp. 153-171.

Roberts, C.A. 2007 A Bioarcheological Study of Maxillary Sinusitis. *American Journal of Physical Anthropology* **133**: 792-807.

Roberts, C. and Cox, M. 2003 *Health and Disease in Britain*. Stroud: Sutton Publishing.

Rodwell, W. 2007 Burial archaeology. In: Waldron, T. *St Peter's, Barton-upon-Humber, Lincolnshire: A Parish Church and its Community.* Volume 2: The Human Remains. Oxford: Oxbow. pp.15-32.

Rojas-Sepúlveda, C., Ardagna, Y. and Dutour, O. 2008 Paleoepidemiology of vertebral degenerative disease in a Pre-Columbian Muisca series from Colombia. *American Journal of Physical Anthropology* **135**(4): 416-430.

Rollason, D. 2000 *Symeon of Durham: Libellus de Exordio Atque Procursu Istius, hoc est Dunhelmensis, Ecclesie: Tract on the Origins and Progress of This the Church of Durham.* Oxford Medieval Texts. Oxford: Oxford University Press.

Savage, A. 1982 *The Anglo-Saxon Chronicles: The Authentic Voices of England, From the Time of Julius Caesar to the coronation of Henry II.* London: Macmillan and Co.

Sayer, D. 2013 Laws, funerals and cemetery organisation: the seventh-century Kentish family. In Sayer, D. and Williams, H. (eds.) *Mortuary Practices and Social Identities in the Middle Ages*. Liverpool University press. pp. 141-169.

Scheuer, J.L., Musgrave, J.H. and Evans, S.P. 1980 The estimation of late foetal and perinatal age from limb bone length by linear and logarithmic regression. *Annals of Human Biology* **7**(3): 257-65.

Schwartz, J.H. 1995 *Skeleton Keys: An Introduction to Human Skeletal Morphology, Development and Analysis.* Oxford: Oxford University Press.

Steckel, R.H., Rose, J.C., Larsen, C.S. and Walker, P.L. 2002 Skeletal health in the western hemisphere from 4000 BC to the present. *Evolutionary Anthropology* **11**: 142-55.

Steckel, R.H; Larsen, C.S; Sciulli, P.W and Walker, P.L. 2006 *The Global History of Health Project: data collection codebook*. Available from: http://global.sbs.ohio-state.edu/european_module.htm

Stoodley, N. 1999 Burial rites, gender and the creation of kingdoms: The evidence from seventh-century Wessex. In: Dickinson, T. and Griffiths, D. (Eds.) *Anglo-Saxon Studies in Archaeology and History 10*. Oxford: Oxford University School of Archaeology. pp. 99-107.

Stoodley, N. 2000 From the cradle to the grave: age organization and the early Anglo-Saxon burial rite. *World Archaeology* **31**(3): 456-72.

Sullivan, A. 2004 Reconstructing relationships among mortality, status, and gender at the Medieval Gilbertine priory of St. Andrew, Fishergate, York. *American Journal of Physical Anthropology* **124**: 330-45.

Temple, D.H. and Goodman, A.H. 2014 Bioarcheology Has a "Health" Problem: Conceptualizing "Stress" and "Health" in Bioarcheological Research. *American Journal of Physical Anthropology* **155**: 186-191.

Thompson, V. 2002 Constructing salvation: a homiletic and penitential context for Late Anglo-Saxon burial practice. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early*

Medieval England and Wales. The Society for Medieval Archaeology. London: publisher. pp. 229-40.

Thompson, V. 2004 *Death and Dying in Later Anglo-Saxon England*. Woodbridge: Boydell.

Walker, P.L., Bathurst, R.R., Richman, R., Gjerdrum, T. and Andrushko, V.A. 2009 The causes of porotic hyperostosis and cribra orbitalia: a reappraisal of the iron-deficiency-anemia hypothesis. *American Journal of Physical Anthropology* **139**(2): 109-25.

Weiss, E. and Jurmain, R. 2007 Osteoarthritis revisited: a contemporary review of aetiology. *International Journal of Osteoarchaeology* **17**: 437-50.

Weston, D. 2008 Investigating the specificity of periosteal reactions in pathology museum specimens. *American Journal of Physical Anthropology* **137**(1): 48-59.

Williams, H. 2006 *Death and Memory in Early Medieval Britain*. Cambridge: Cambridge University Press.

Wood, J.W., Milner, G.R., Harpending, H.C. and Weiss, K.M. 1992 The osteological paradox: problems of inferring health from skeletal samples. *Current Anthropology* **33**(4): 343-70.

Woolgar, C.M., Serjeantson, D. and Waldron, T. 2006 Conclusion. In: Woolgar, T., Serjeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition*. Oxford: Oxford University Press. pp. 267-80.

Zadora-Rio, E. 2003 The making of churchyards and parish territories in the early-medieval landscape of France and England in the 7th-12th centuries: A reconsideration. *Medieval Archaeology* **47**(1): 1-19

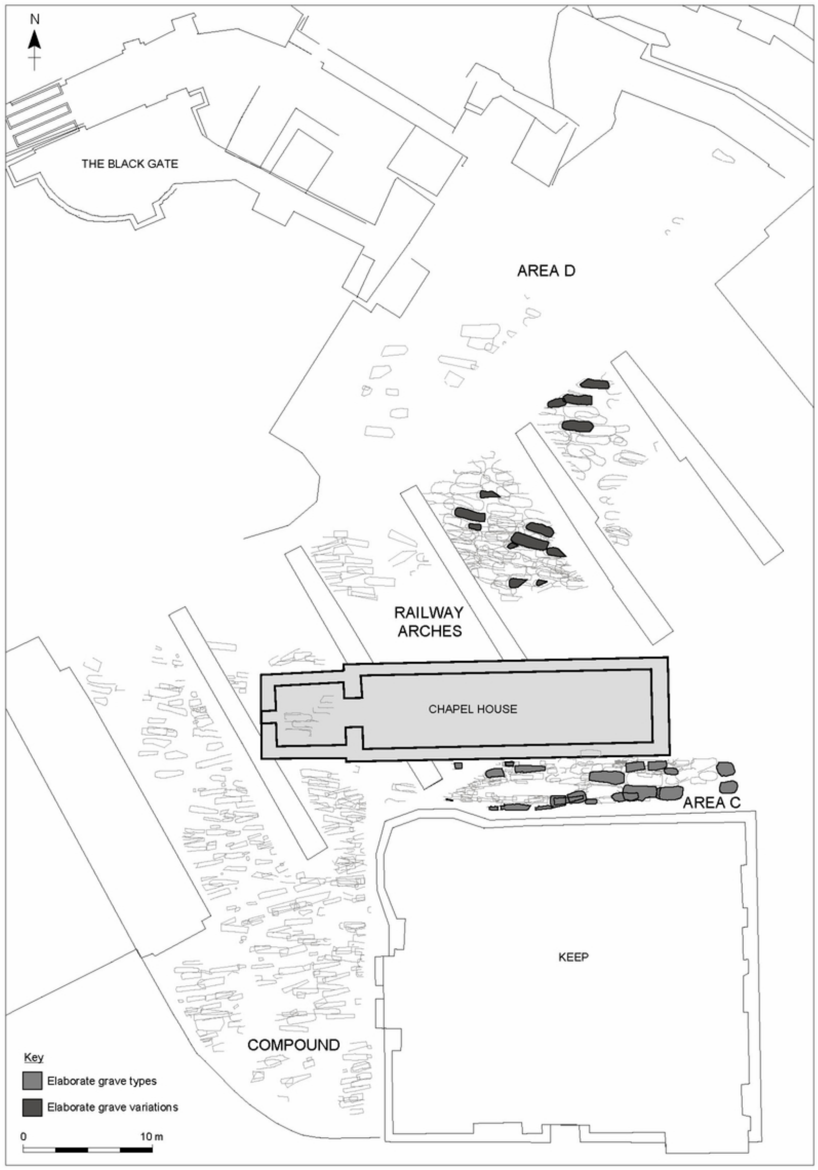

Figure 1. Distribution of elaborate burial types. Adapted from Nolan (2010). Image by C. Swales.

70x98mm (300 x 300 DPI)

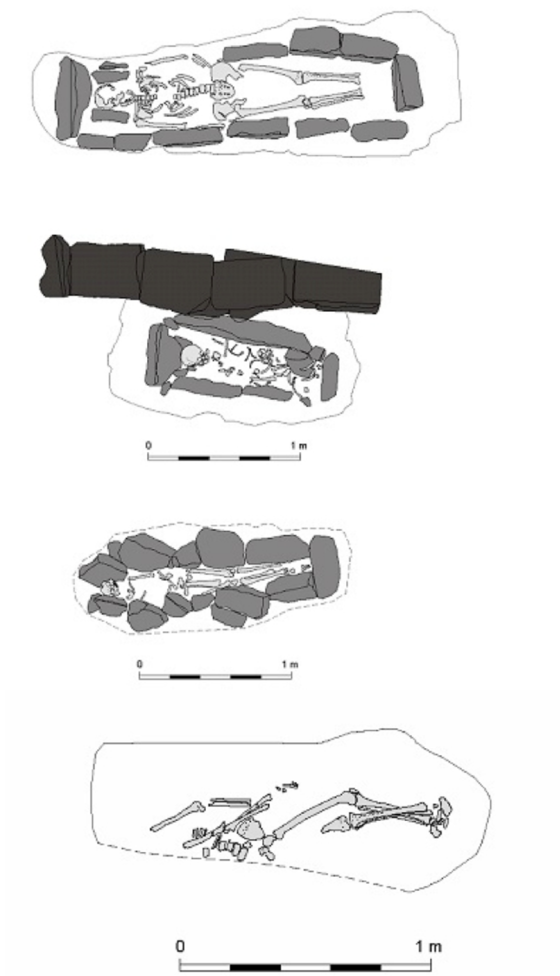

Figure 2. Stone cists (adult BG482 and young child BG478), rubble cist (adult BG523) and chest burial (adult BG644). Adapted from photographs provided by John Nolan, Northern Counties Archaeological Services. Image by C. Swales.

169x170mm (300 x 300 DPI)

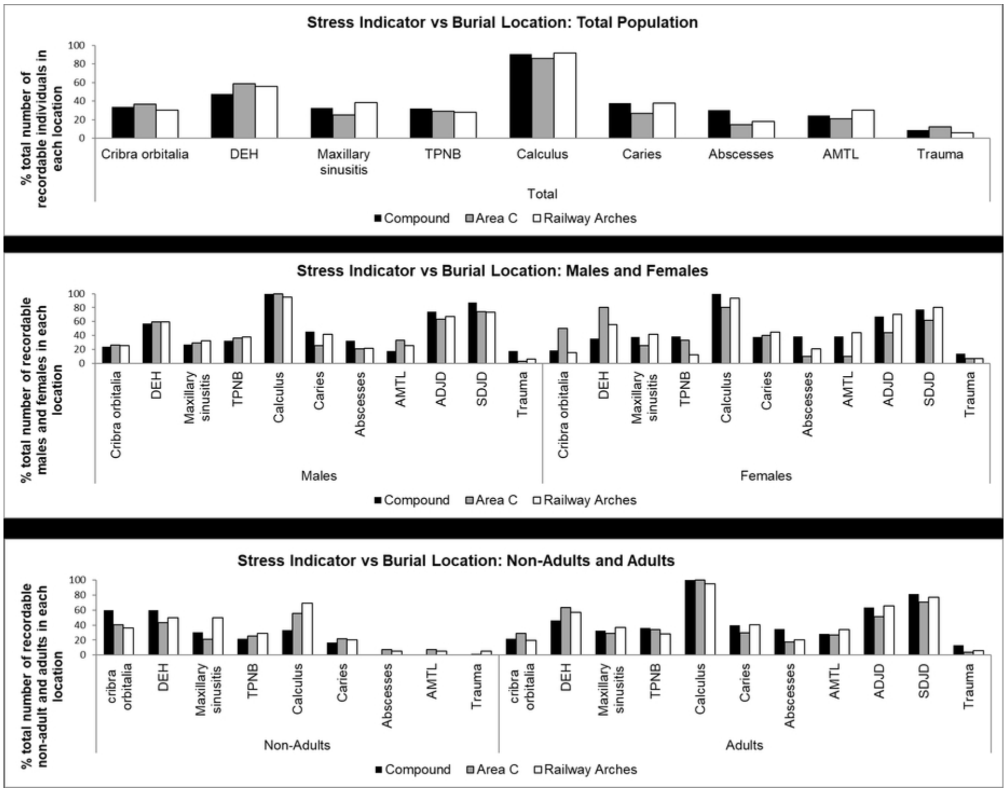

Figure 3. The prevalence of each stress indicator for each burial location for the total population, males and females, non-adults and adults.

78x61mm (300 x 300 DPI)

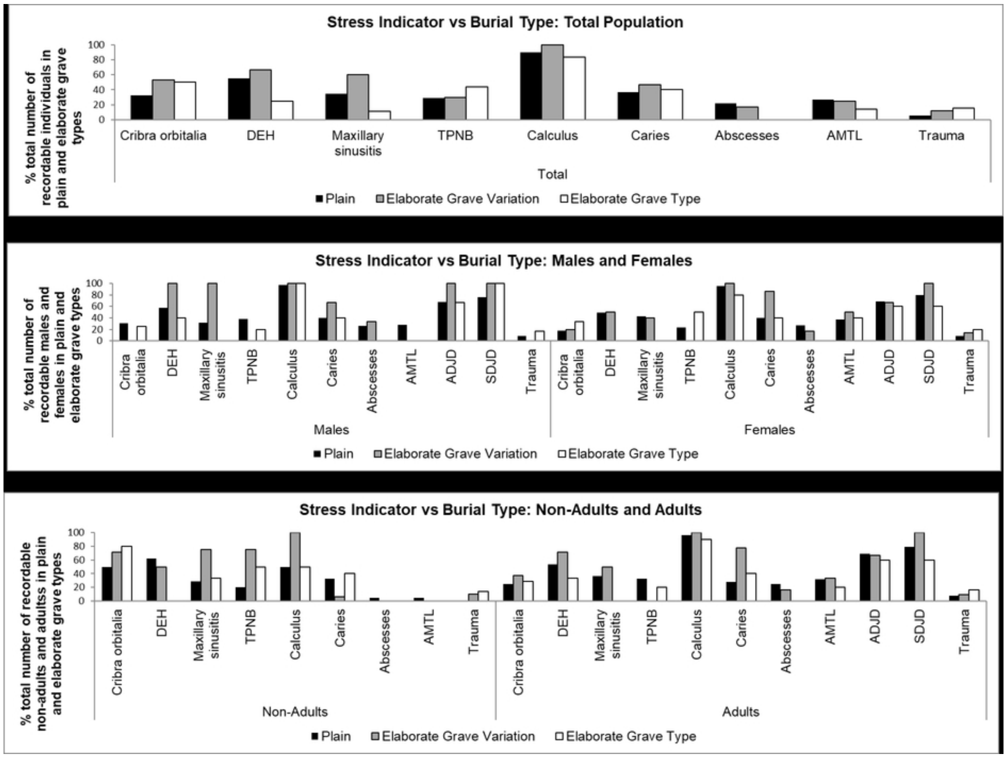

Figure 4. The prevalence of each stress indicator for each burial type for the total population, males and females, non-adults and adults.

79x59mm (300 x 300 DPI)

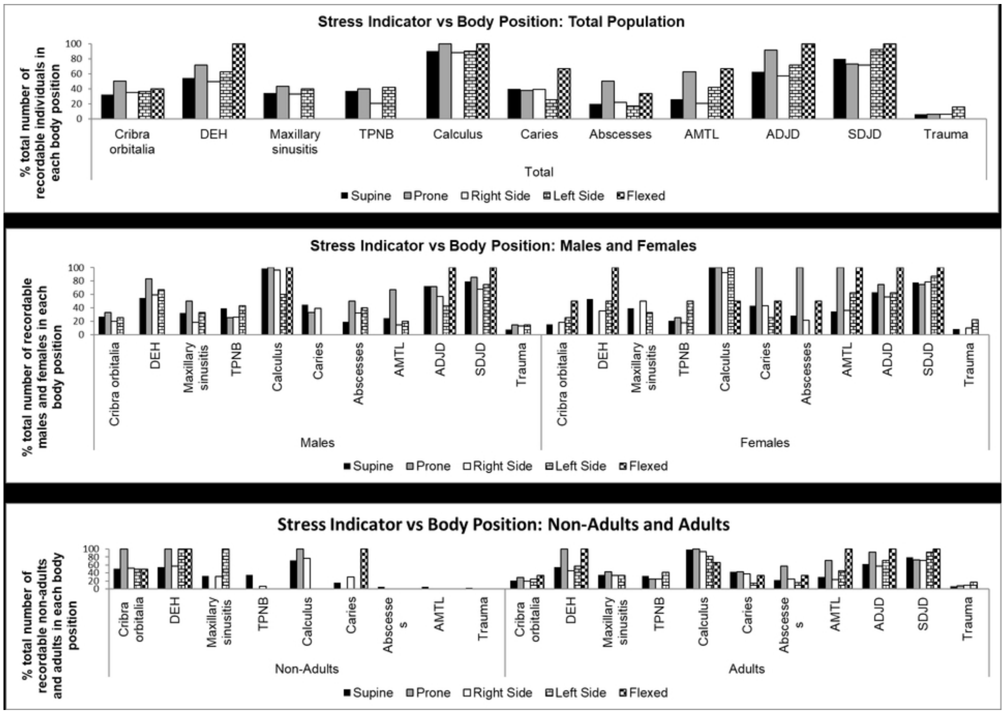

Figure 5. The prevalence of each stress indicator for each body position for the total population, males and females, non-adults and adults.

81x57mm (300 x 300 DPI)

	Compound		Area C		Railway Arch		Area D		Total	
	N	%	N	%	N	%	N	%	N	%
Plain Graves										
Earth-cut	125	*71.4*	120	*79.5*	234	*87.0*	17	*94.4*	496	*80.9*
Coffin	50	*28.6*	15	*9.9*	15	*5.6*	1	*5.6*	81	*13.2*
Elaborate Burials										
Elaborate Grave Variations										
Pillow Stone	0	*0.0*	2	*1.3*	2	*0.7*	0	*0.0*	4	*0.7*
Earmuffs	0	*0.0*	0	*0.0*	9	*3.3*	0	*0.0*	9	*1.5*
Head Cist	0	*0.0*	0	*0.0*	4	*1.5*	0	*0.0*	4	*0.7*
Elaborate Grave Construction										
Chest	0	*0.0*	0	*0.0*	2	*0.7*	0	*0.0*	2	*0.3*
Rubble Cist	0	*0.0*	1	*0.7*	3	*1.1*	0	*0.0*	4	*0.7*
Stone Cist	0	*0.0*	13	*8.6*	0	*0.0*	0	*0.0*	13	*2.1*
Total	**175**	***100.0***	**151**	***100.0***	**269**	***100.0***	**18**	***100.0***	**613**	***100.0***
Body Position										
Supine	75	*43.3*	120	*82.2*	223	*82.0*	17	*94.4*	435	*71.4*
Prone	10	*5.8*	3	*2.0*	3	*1.1*	0	*0.0*	16	*2.6*
Left Side	10	*5.8*	4	*2.7*	8	*2.9*	0	*0.0*	22	*3.6*
Right side	77	*44.5*	18	*12.3*	36	*13.2*	0	*0.0*	131	*21.5*
Flexed	1	*0.6*	1	*0.7*	2	*0.7*	1	*5.6*	5	*0.8*
Total	**173**	***100.0***	**146**	***100.0***	**272**	***100.0***	**18**	***100.0***	**609**	***100.0***

% of total burials = 612

Table 1. Distribution of burial practices throughout the Black Gate cemetery.

	Compound		Area C		Railway Arches		Area D		Supine		Prone		Left		Right		Flexed		Plain Burial		Elaborate Grave Variation		Elaborate Grave Type	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Foetal/Neonate	7	*4.4*	14	*10.9*	4	*1.6*	0	*0.0*	20	*5.4*	0	*0*	0	*0.0*	3	*2.5*	1	*16.7*	24	*4.8*	0	*0.0*	1	*5.6*
Infant	13	*8.1*	27	*21.1*	8	*3.3*	0	*0.0*	31	*8.4*	1	*6.25*	1	*4.8*	12	*9.9*	1	*16.7*	45	*9*	3	*16.7*	1	*5.6*
Young Child	20	*12.5*	22	*17.2*	24	*9.9*	1	*6.2*	42	*11.4*	2	*12.5*	3	*14.3*	17	*14.0*	0	*0.0*	62	*12.4*	2	*11.1*	3	*16.7*
Older Child	10	*6.2*	9	*7.0*	9	*3.7*	3	*18.7*	18	*4.9*	1	*6.25*	1	*4.8*	9	*7.4*	1	*16.7*	27	*5.4*	1	*5.6*	2	*11.1*
Adolescent	6	*3.7*	4	*3.1*	16	*6.6*	2	*12.5*	23	*6.3*	0	*0*	0	*0.0*	5	*4.1*	0	*0.0*	26	*5.2*	2	*11.1*	0	*0.0*
Young Adult	11	*6.9*	8	*6.2*	16	*6.6*	0	*0.0*	22	*6.0*	0	*0*	1	*4.8*	11	*9.1*	0	*0.0*	33	*6.6*	0	*0.0*	1	*5.6*
Prime Adult	23	*14.4*	16	*12.5*	45	*18.6*	0	*0.0*	60	*16.3*	2	*12.5*	3	*14.3*	18	*14.9*	0	*0.0*	79	*15.8*	3	*16.7*	3	*16.7*
Mature Adult	26	*16.2*	9	*7.0*	56	*23.1*	6	*37.5*	73	*19.8*	4	*25*	5	*23.8*	12	*9.9*	0	*0.0*	85	*17*	1	*5.6*	3	*16.7*
Older Adult	44	*27.5*	19	*14.8*	64	*26.4*	4	*25.0*	79	*21.5*	6	*37.5*	7	*33.3*	34	*28.1*	3	*50.0*	119	*23.8*	6	*33.3*	4	*22.2*
Total	**160**	***100***	**128**	***100***	**242**	***100***	**16**	***100***	**368**	***100***	**16**	***100***	**21**	***100***	**121**	***100***	**6**	***100***	**500**	***100***	**18**	***100***	**18**	***100***
Males	44	*43.6*	36	*70.6*	83	*48.3*	6	*66.7*	122	*54.0*	7	*63.6*	3	*27.3*	31	*43.7*	1	*33.3*	157	*52.3*	3	*30*	6	*54.5*
Females	57	*56.4*	15	*29.4*	89	*51.7*	3	*33.3*	104	*46.0*	4	*36.4*	8	*72.7*	40	*56.3*	2	*66.7*	143	*47.7*	7	*70*	5	*45.5*
Total	**101**	***100***	**51**	***100***	**172**	***100***	**9**	***100***	**226**	***100.0***	**11**	***100.0***	**11**	***100***	**71**	***100***	**3**	***100***	**300**	***100***	**10**	***100***	**11**	***100***
Non-adults	56	*35.0*	76	*59.4*	61	*25.2*	6	*37.5*	134	*36.4*	4	*25*	5	*23.8*	46	*38.0*	3	*50.0*	184	*36.8*	8	*44.4*	7	*38.9*
Adults	104	*65.0*	52	*40.6*	181	*74.8*	10	*62.5*	234	*63.6*	12	*75*	16	*76.2*	75	*62.0*	3	*50.0*	316	*63.2*	10	*55.6*	11	*61.1*
Total	**160**	***100***	**128**	***100***	**242**	***100***	**16**	***100***	**368**	***100***	**16**	***100***	**21**	***100***	**121**	***100***	**6**	***100***	**500**	***100***	**18**	***100***	**18**	***100***

Table 2. Demographic composition of burial practices within the Black Gate cemetery.

Burial Location												
Cribra Orbitalia												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**34/101**	**33.7**	**58/176**	**32.9**	**28/76**	**36.8**	**48/125**	**38.4**	**41/135**	**30.4**	**72/232**	**31.0**
Males	7/29	24.1	11/51	21.6	5/19	26.3	11/33	33.3	12/47	25.5	22/83	26.5
Females	7/38	18.4	12/69	17.4	2/4	50.0	5/8	62.5	8/53	15.1	15/94	16.0
Adults	15/69	21.7	25/124	20.2	7/24	29.2	16/41	39.0	20/102	19.6	38/179	21.2
Non-adults	19/32	59.4	33/52	63.5	21/52	40.4	32/84	38.1	21/33	36.4	34/53	64.1
Linear Enamel Hypoplasias (LEH)												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**33/69**	**47.8**	n/a	n/a	**20/34**	**58.8**	n/a	n/a	**62/111**	**55.8**	n/a	n/a
Males	16/28	57.1	n/a	n/a	13/22	59.1	n/a	n/a	25/42	59.5	n/a	n/a
Females	11/31	35.5	n/a	n/a	4/5	80.0	n/a	n/a	26/47	55.3	n/a	n/a
Adults	27/59	45.8	n/a	n/a	17/27	63.0	n/a	n/a	53/93	57.0	n/a	n/a
Non-adults	6/10	60.0	n/a	n/a	3/7	42.9	n/a	n/a	9/18	50.0	n/a	n/a
Tibial Periosteal Reactions												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**32/100**	**32.0**	**55/197**	**27.9**	**26/89**	**29.2**	**37/166**	**22.3**	**47/167**	**28.1**	**85/338**	**25.1**
Males	8/25	32.0	14/48	29.2	8/22	36.4	11/38	28.9	19/51	37.3	36/100	36.0
Females	13/34	38.2	22/68	32.3	3/9	33.3	3/16	18.7	7/58	12.1	14/118	11.9
Adults	26/72	36.1	46/142	32.4	14/41	34.1	19/75	25.3	37/132	28.0	69/267	25.8
Non-adults	6/28	21.4	9/55	16.4	12/48	25.0	18/91	19.8	10/35	28.6	16/71	22.5
Maxillary Sinusitis												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**27/83**	**32.5**	n/a	n/a	**10/40**	**25.0**	n/a	n/a	**34/88**	**38.6**	n/a	n/a
Males	8/30	26.7	n/a	n/a	5/17	29.4	n/a	n/a	13/40	32.5	n/a	n/a
Females	12/32	37.5	n/a	n/a	1/4	25.0	n/a	n/a	14/34	41.2	n/a	n/a
Adults	21/64	32.8	n/a	n/a	6/21	28.6	n/a	n/a	27/74	36.5	n/a	n/a
Non-adults	6/19	30.0	n/a	n/a	4/19	21.1	n/a	n/a	7/14	50.0	n/a	n/a
Calculus												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**78/86**	**90.7**	n/a	n/a	**37/43**	**86.0**	n/a	n/a	**134/146**	**91.8**	n/a	n/a
Males	33/33	100.0	n/a	n/a	24/24	100.0	n/a	n/a	57/60	95.0	n/a	n/a
Females	41/41	100.0	n/a	n/a	8/10	80.0	n/a	n/a	60/64	93.8	n/a	n/a
Adults	74/74	100.0	n/a	n/a	34/34	100.0	n/a	n/a	123/130	94.6	n/a	n/a
Non-adults	4/12	33.3	n/a	n/a	5/9	55.6	n/a	n/a	11/16	68.8	n/a	n/a
Caries												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**33/87**	**37.9**	**97/1799**	**5.4**	**13/49**	**26.5**	**42/995**	**4.2**	**59/157**	**37.6**	**161/2824**	**5.7**
Males	15/33	45.5	40/695	5.8	6/24	25.0	9/459	2.0	26/62	41.9	59/1223	4.8
Females	15/40	37.5	43/751	5,7	4/10	40.0	5/150	3.3	29/65	44.6	84/1067	7.9
Adults	31/78	39.7	83/1492	5.6	10/34	29.4	14/609	2.3	55/136	40.4	143/2355	6.1
Non-adults	2/12	16.7	11/183	6.0	3/14	21.4	28/382	7.3	4/20	20.0	11/210	5.2
Abscesses* (*permanent tooth sockets only)												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**27/90**	**30.0**	53/2046	**2.6**	**7/48**	**14.6**	**13/913**	**1.4**	**27/150**	**18.0**	**42/3192**	**1.3**
Males	11/34	32.4	21/918	2.3	5/24	20.8	9/555	1.6	13/60	21.7	19/1493	1.3
Females	16/42	38.1	32/1073	3.0	1/10	10.0	2/190	1.1	13/64	20.3	21/1351	1.5
Adults	27/78	34.6	53/2046	2.6	6/34	17.6	11/745	1.5	26/130	20.0	40/2909	1.4
Non-adults	0/12	0.0	0/158	0.0	1/14	7.1	2/168	1.2	1/20	5.0	2/283	0.7
Ante-Mortem Tooth Loss (AMTL)												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	

	N	%	N	%	N	%	N	%	N	%	N	%
Total	**22/90**	**24.4**	**59/2204**	**2.7**	**10/48**	**20.8**	**37/913**	**4.0**	**45/150**	**30.0**	**150/3192**	**4.7**
Males	6/34	17.6	13/918	1.4	8/24	33.3	35/555	6.3	15/60	25.0	67/1493	4.5
Females	16/42	38.1	46/1073	4.3	1/10	10.0	1/190	0.5	28/64	43.8	80/1351	5.9
Adults	22/78	28.2	59/2046	2.9	9/24	26.5	36/745	4.8	44/130	33.8	148/2909	5.1
Non-adults	0/12	0.0	0/158	0.0	1/14	7.1	1/168	0.6	1/20	5.0	2/283	0.7
Appendicular Degenerative Joint Disease (ADJD)												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**72/114**	**63.2**	**269/784**	**34.3**	**34/66**	**51.1**	**114/356**	**32.0**	**129/197**	**65.5**	**416/1256**	**33.1**
Males	32/43	74.4	106/318	33.3	21/33	63.6	76/210	36.2	52/77	67.5	177/558	31.7
Females	35/52	67.3	154/418	36.8	7/16	43.8	33/109	30.3	60/85	70.6	200/612	32.7
Spinal Degenerative Joint Disease (SDJD)												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**75/92**	**81.5**	**n/a**	**n/a**	**36/51**	**70.6**	**n/a**	**n/a**	**121/158**	**76.6**	**n/a**	**n/a**
Males	33/38	86.9	**n/a**	**n/a**	20/27	74.1	**n/a**	**n/a**	49/67	73.1	**n/a**	**n/a**
Females	31/40	77.5	**n/a**	**n/a**	8/13	61.5	**n/a**	**n/a**	54/67	80.6	**n/a**	**n/a**
Trauma												
	Compound				**Area C**				**Railway Arches**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**16/179**	**8.9**	**n/a**	**n/a**	**6/49**	**12.2**	**n/a**	**n/a**	**17/282**	**6.0**	**n/a**	**n/a**
Males	8/45	17.8	**n/a**	**n/a**	1/36	2.8	**n/a**	**n/a**	5/83	6.0	**n/a**	**n/a**
Females	8/59	13.6	**n/a**	**n/a**	1/15	6.7	**n/a**	**n/a**	6/92	6.5	**n/a**	**n/a**
Adults	16/123	13.0	**n/a**	**n/a**	3/73	4.1	**n/a**	**n/a**	13/221	5.9	**n/a**	**n/a**
Non-adults	0/56	0.0	**n/a**	**n/a**	1/75	1.3	**n/a**	**n/a**	3/61	4.9	**n/a**	**n/a**

Table 3: Crude and true prevalence rates of skeletal stress indicators for each burial location

Burial Type												
Cribra Orbitalia												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**95/291**	**32.6**	**169/496**	**34.1**	**8/15**	**53.3**	**12/25**	**48.0**	**6/12**	**50.0**	**12/24**	**50.0**
Males	27/89	30.3	43/157	27.4	0/3	0.0	0/6	0.0	1/4	25.0	2/8	25.0
Females	15/86	17.4	25/150	16.7	1/5	20.0	4/8	50.0	1/3	33.3	2/6	33.3
Adults	45/181	24.9	72/316	22.8	3/8	37.5	4/14	28.6	2/7	28.6	4/14	28.6
Non-adults	55/110	50.0	88/180	48.9	5/7	71.4	8/11	72.7	4/5	80.0	8/10	80.0
Linear Enamel Hypoplasias (LEH)												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**112/204**	**54.9**	n/a	n/a	**6/9**	**66.7**	n/a	n/a	**2/8**	**25.0**	n/a	n/a
Males	51/89	57.3	n/a	n/a	3/3	100.0	n/a	n/a	2/5	40.0	n/a	n/a
Females	38/77	49.4	n/a	n/a	2/4	50.0	n/a	n/a	0/1	0.0	n/a	n/a
Adults	91/170	53.5	n/a	n/a	5/7	71.4	n/a	n/a	2/6	33.3	n/a	n/a
Non-adults	21/34	61.8	n/a	n/a	1/2	50.0	n/a	n/a	0/2	0.0	n/a	n/a
Tibial Periosteal Reactions												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**96/332**	**28.9**	**162/655**	**24.7**	**3/10**	**30.0**	**6/19**	**31.6**	**7/16**	**43.7**	**11/30**	**36.7**
Males	36/95	37.9	62/182	34.1	0/2	0.0	0/4	0.0	1/5	20.0	2/9	22.2
Females	21/91	23.1	36/180	20.0	0/4	0.0	0/8	0.0	2/4	50.0	3/7	42.9
Adults	75/230	32.6	131/454	28.8	0/6	0.0	0/12	0.0	1/5	20.0	5/18	27.8
Non-adults	21/102	20.6	31/201	15.4	3/4	75.0	6/7	85.7	2/4	50.0	6/12	50.0
Maxillary Sinusitis												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**67/195**	**34.4**	n/a	n/a	**6/10**	**60.0**	n/a	n/a	**1/9**	**11.1**	n/a	n/a
Males	26/83	31.3	n/a	n/a	1/1	100.0	n/a	n/a	0/5	0.0	n/a	n/a
Females	26/61	42.6	n/a	n/a	2/5	40.0	n/a	n/a	0/1	0.0	n/a	n/a
Adults	53/146	36.3	n/a	n/a	3/6	50.0	n/a	n/a	0/6	0.0	n/a	n/a
Non-adults	14/49	28.6	n/a	n/a	3/4	75.0	n/a	n/a	1/3	33.3	n/a	n/a
Calculus												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**228/254**	**89.8**	n/a	n/a	**12/12**	**100.0**	n/a	n/a	**10/12**	**83.3**	n/a	n/a
Males	109/112	97.3	n/a	n/a	3/3	100.0	n/a	n/a	5/5	100.0	n/a	n/a
Females	94/99	94.9	n/a	n/a	6/6	100.0	n/a	n/a	4/5	80.0	n/a	n/a
Adults	210/218	96.3	n/a	n/a	9/9	100.0	n/a	n/a	9/10	90.0	n/a	n/a
Non-adults	18/36	50.0	n/a	n/a	3/3	100.0	n/a	n/a	1/2	50.0	n/a	n/a
Caries												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**115/316**	**36.4**	**274/5148**	**5.3**	**7/15**	**46.7**	**30/296**	**10.0**	**6/15**	**40.0**	**12/301**	**4.0**
Males	46/116	39.6	100/2265	4.4	2/3	66.7	9/58	15.5	2/5	40.0	5/134	3.7
Females	40/101	39.6	106/1721	6.2	6/7	85.7	21/132	15.9	2/5	40.0	3/82	3.7
Adults	87/229	38.0	207/4102	5.0	7/9	77.8	30/216	13.9	4/10	40.0	8/216	3.7
Non-adults	12/37	32.2	67/1046	6.4	0/8	0.0	0/80	0.0	2/5	40.0	4/85	4.7
Abscesses												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	**58/268**	**21.6**	**99/5893**	**1.7**	**2/12**	**16.7**	**5/279**	**1.8**	**0/14**	**0.0**	**0/281**	**0.0**
Males	29/113	25.7	47/2850	1.6	1/3	33.3	3/87	3.4	0/5	0.0	0/153	**0.0**
Females	27/101	26.7	48/2314	2.1	1/6	16.7	2/158	1.3	0/5	0.0	0/98	**0.0**
Adults	56/222	25.2	95/5307	1.8	2/12	16.7	5/245	2.0	0/10	0.0	**0/251**	**0.0**
Non-adults	2/44	4.5	4/586	0.7	0/3	0.0	0/34	0.0	0/4	0.0	0/30	**0.0**
Ante-Mortem Tooth Loss (AMTL)												
	Plain				Elaborate Grave Variation				Elaborate Grave Type			
	CPR		TPR		CPR		TPR		CPR		TPR	

	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**72/266**	**27.1**	**228/5893**	**3.9**	**3/12**	**25.0**	**16/279**	**5.7**	**2/14**	**14.3**	**4/281**	**1.4**
Males	31/113	27.4	123/2850	4.3	0/3	0.0	0/87	0.0	0/5	0.0	0/153	0.0
Females	37/100	37.0	99/2314	4.3	3/6	50.0	16/158	10.1	2/5	40.0	4/98	4.1
Adults	70/222	31.5	225/5307	4.2	3/9	33.3	16/245	6.5	2/10	20.0	4/251	1.6
Non-adults	2/44	4.5	3/586	0.5	0/3	0.0	0/34	0.0	0/4	0.0	0/30	0.0
Appendicular Degenerative Joint Disease (ADJD)												
	Plain				**Elaborate Grave Variation**				**Elaborate Grave Type**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**220/354**	**62.1**	**684/2074**	**33.0**	**7/9**	**77.8**	**36/75**	**48.0**	**7/12**	**58.3**	**31/86**	**36.0**
Males	100/147	68.0	**355/1047**	**33.9**	3/3	100.0	13/28	46.4	4/6	66.7	15/49	30.6
Females	93/135	68.9	**329/1027**	32.0	4/6	66.7	23/47	48.9	3/5	60.0	16/36	44.4
Spinal Degenerative Joint Disease (SDJD)												
	Plain				**Elaborate Grave Variation**				**Elaborate Grave Type**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**225/287**	**78.4**	**n/a**	**n/a**	**7/8**	**87.5**	**n/a**	**n/a**	**7/16**	**43.7**	**n/a**	**n/a**
Males	95/125	76.0	**n/a**	**n/a**	2/2	100.0	**n/a**	**n/a**	5/5	100.0	**n/a**	**n/a**
Females	84/106	79.2	**n/a**	**n/a**	5/5	100.0	**n/a**	**n/a**	3/5	60.0	**n/a**	**n/a**
Trauma												
	Plain				**Elaborate Grave Variation**				**Elaborate Grave Type**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**33/579**	**5.7**	**n/a**	**n/a**	**2/17**	**11.8**	**n/a**	**n/a**	**3/19**	**15.8**	**n/a**	**n/a**
Males	14/158	8.9	**n/a**	**n/a**	0/3	0.0	**n/a**	**n/a**	1/6	16.7	**n/a**	**n/a**
Females	13/148	8.8	**n/a**	**n/a**	1/7	14.3	**n/a**	**n/a**	1/5	20.0	**n/a**	**n/a**
Adults	30/395	7.6	**n/a**	**n/a**	1/11	9.1	**n/a**	**n/a**	2/12	16.7	**n/a**	**n/a**
Non-adults	2/182	1.1	**n/a**	**n/a**	1/10	10.0	**n/a**	**n/a**	1/7	14.3	**n/a**	**n/a**

Table 4: Crude and true prevalence rates of skeletal stress indicators for each burial type

Body Position																				
Cribra orbitalia																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**69/207**	**33.3**	**117/363**	**32.2**	**5/10**	**50.0**	**9/17**	**52.9**	**5/13**	**38.5**	**7/20**	**35.0**	**29/83**	**34.9**	**46/137**	**33.6**	**1/5**	**20.0**	**2/9**	**22.2**
Males	18/68	32.5	35/124	28.2	2/6	33.3	3/10	30.0	1/4	25.0	2/5	40.0	4/20	20.0	5/33	15.1	0/1	0.0	0/2	0.0
Females	11/60	18.3	18/108	16.7	0/1	0.0	0/1	0.0	2/8	25.0	3/12	25.0	4/22	18.2	7/40	17.5	1/2	50.0	2/4	50.0
Adults	30/131	22.9	55/236	23.3	2/7	28.6	3/11	27.3	3/12	25.0	5/17	29.4	9/45	20.0	14/78	17.9	1/3	33.3	2/6	33.3
Non-adults	39/76	51.3	62/127	48.8	3/3	100.0	6/6	100.0	1/2	50.0	2/3	66.7	20/38	52.6	32/59	54.2	0/2	0.0	0/3	0.0
Linear Enamel Hypoplasias (LEH)																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**79/145**	**54.5**	n/a	n/a	**5/7**	**71.4**	n/a	n/a	**5/8**	**62.5**	n/a	n/a	**28/58**	**48.3**	n/a	n/a	**2/2**	**100.0**	n/a	n/a
Males	36/66	54.5	n/a	n/a	5/6	83.3	n/a	n/a	2/3	66.7	n/a	n/a	13/22	59.1	n/a	n/a	0/0	0.0	n/a	n/a
Females	29/55	52.7	n/a	n/a	0/1	0.0	n/a	n/a	2/4	50.0	n/a	n/a	7/20	35.0	n/a	n/a	1/1	100.0	n/a	n/a
Adults	67/123	54.5	n/a	n/a	2/2	100.0	n/a	n/a	4/7	57.1	n/a	n/a	20/44	45.4	n/a	n/a	1/1	100.0	n/a	n/a
Non-adults	12/22	54.5	n/a	n/a	1/1	100.0	n/a	n/a	1/1	100.0	n/a	n/a	8/14	57.1	n/a	n/a	1/1	100.0	n/a	n/a
Tibial Periosteal Reactions																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**83/250**	**33.2**	**140/485**	**28.9**	**2/10**	**20.0**	**2/19**	**10.5**	**6/14**	**42.9**	**10/27**	**37.0**	**14/78**	**17.9**	**26/165**	**15.8**	**0/4**	**0.0**	**0/8**	**0.0**
Males	28/72	38.9	48/139	34.5	1/4	25.0	1/8	12.5	3/7	42.9	5/12	41.7	5/19	26.3	10/36	27.8	0/1	0.0	0/1	0.0
Females	14/67	20.9	24/128	18.7	1/4	25.0	1/7	14.3	2/4	50.0	4/10	40.0	4/23	17.4	8/54	14.8	0/1	0.0	0/2	0.0
Adults	57/177	32.2	99/345	28.7	2/8	25.0	2/15	13.3	5/12	41.7	10/24	41.7	12/49	24.5	24/106	22.6	0/2	0.0	0/3	0.0
Non-adults	26/73	35.6	41/140	29.3	0/2	0.0	0/4	0.0	0/2	0.0	0/3	0.0	2/31	6.4	2/59	3.4	0/2	0.0	0/5	0.0
Maxillary Sinusitis																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**46/133**	**34.6**	n/a	n/a	**3/7**	**42.9**	n/a	n/a	**4/10**	**40.0**	n/a	n/a	**21/64**	**32.8**	n/a	n/a	**0/2**	**0.0**	n/a	n/a
Males	19/59	32.2	n/a	n/a	3/6	50.0	n/a	n/a	1/3	33.3	n/a	n/a	4/22	18.2	n/a	n/a	0/0	0.0	n/a	n/a
Females	17/43	39.5	n/a	n/a	0/1	0.0	n/a	n/a	2/6	33.3	n/a	n/a	9/18	50.0	n/a	n/a	0/1	0.0	n/a	n/a
Adults	36/102	35.3	n/a	n/a	3/7	42.9	n/a	n/a	3/9	33.3	n/a	n/a	14/42	33.3	n/a	n/a	0/1	0.0	n/a	n/a
Non-adults	10/31	32.3	n/a	n/a	0/0	0.0	n/a	n/a	1/1	100.0	n/a	n/a	7/22	31.8	n/a	n/a	0/1	0.0	n/a	n/a
Calculus																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**173/192**	**90.1**	**n/a**	**n/a**	**8/8**	**100.0**	**n/a**	**n/a**	**11/12**	**91.7**	**n/a**	**n/a**	**61/69**	**88.4**	**n/a**	**n/a**	**2/2**	**100.0**	**n/a**	**n/a**
Males	82/85	96.5	**n/a**	**n/a**	6/6	100.0	**n/a**	**n/a**	3/3	60.0	**n/a**	**n/a**	27/28	96.4	**n/a**	**n/a**	1/1	100.0	**n/a**	**n/a**
Females	70/76	92.1	**n/a**	**n/a**	1/1	100.0	**n/a**	**n/a**	8/8	100.0	**n/a**	**n/a**	26/28	96.4	**n/a**	**n/a**	1/2	50.0	**n/a**	**n/a**
Adults	165/168	98.2	**n/a**	**n/a**	7/7	100.0	**n/a**	**n/a**	11/11	100.0	**n/a**	**n/a**	53/57	93.0	**n/a**	**n/a**	2/3	66.7	**n/a**	**n/a**

Non-adults	17/27	63.0	**n/a**	**n/a**	1/1	100.0	**n/a**	**n/a**	0/1	0.0	**n/a**	**n/a**	13/17	76.5	**n/a**	**n/a**	0/1	0.0	**n/a**	**n/a**
Caries																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**88/232**	**37.9**	**211/3820**	**5.5**	**3/8**	**37.5**	**11/153**	**7.2**	**3/15**	**20.0**	**4/189**	**2.1**	**30/80**	**37.5**	**90/1564**	**5.7**	**2/3**	**66.7**	**7/35**	**20.0**
Males	38/86	44.2	85/1715	5.0	2/6	33.3	3/116	2.6	0/5	0.0	0/53	0.0	11/28	39.3	28/594	4.7	0/1	0.0	0/12	0.0
Females	32/75	42.7	90/1283	7.0	1/1	100.0	8/9	88.9	2/8	25.0	2/98	2.0	12/28	42.9	33/536	6.2	1/1	100.0	1/11	9.1
Adults	71/167	42.5	176/3036	5.8	3/7	42.9	11/125	8.8	2/14	14.3	2/154	1.3	23/60	38.3	61/1203	5.1	1/2	50.0	1/23	4.3
Non-adults	16/65	24.6	35/784	4.5	0/1	0.0	0/28	0.0	1/3	33.3	2/35	5.7	10/31	32.3	29/361	8.0	1/1	100.0	5/12	41.7
Abscesses																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**39/195**	**20.0**	**62/4207**	**1.5**	**4/8**	**50.0**	**8/212**	**3.8**	**2/14**	**14.3**	**5/289**	**1.7**	**15/75**	**20.0**	**31/1718**	**1.8**	**1/4**	**25.0**	**1/72**	**1.4**
Males	16/83	21.7	21/2079	1.0	3/6	50.0	6/179	3.3	2/5	40.0	5/92	5.4	9/28	32.1	18/733	2.5	0/1	0.0	0/23	0.0
Females	21/75	28.0	37/1659	2.2	1/1	100.0	2/28	7.1	0/8	0.0	0/183	0.0	6/28	21.4	13/677	1.9	1/2	50.0	1/41	2.4
Adults	37/162	22.8	58/3812	1.5	4/7	57.1	8/207	3.8	2/13	15.4	5/275	1.8	15/60	25.0	31/1479	2.1	1/3	33.3	1/64	1.6
Non-adults	2/33	6.1	4/395	1.01	0/1	0.0	0/5	0.0	0/1	0.0	0/14	0.0	0/15	0.0	0/239	0.0	0/1	0.0	0/8	0.0
Ante-Mortem Tooth Loss (AMTL)																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**51/195**	**26.1**	**169/4207**	**4.0**	**5/8**	**62.5**	**11/212**	**5.2**	**6/14**	**42.9**	**32/289**	**11.1**	**14/69**	**20.3**	**27/1718**	**1.6**	**3/4**	**75.0**	**16/72**	**22.2**
Males	21/83	25.3	95/2079	4.6	4/6	66.7	9/179	5.0	1/5	20.0	6/92	6.5	4/28	14.3	6/733	0.8	1/1	100.0	7/23	30.4
Females	26/75	34.7	68/1659	4.1	1/1	100.0	2/28	7.1	5/8	62.5	26/183	14.2	10/28	35.7	21/677	3.1	2/2	100.0	9/41	21.9
Adults	49/162	30.2	166/3812	4.4	5/7	7134	11/207	5.3	6/13	46.1	32/275	11.6	14/60	23.3	27/1479	1.8	3/3	100.0	16/64	25.0
Non-adults	2/33	6.1	3/395	0.8	0/1	0.0	0/5	0.0	0/1	0.0	0/14	0.0	0/15	0.0	0/239	0.0	0/1	0.0	0/8	0.0
Appendicular Degenerative Joint Disease (ADJD)																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**166/265**	**62.6**	**551/1667**	**33.1**	**11/12**	**91.7**	**30/72**	**41.7**	**13/17**	**76.5**	**59/121**	**48.8**	**47/84**	**56.0**	**163/553**	**29.5**	**3/3**	**100.0**	**14/26**	**53.8**
Males	76/111	68.5	258/805	32.0	5/7	71.4	9/33	27.3	5/7	71.4	32/61	52.5	20/32	62.5	77/224	34.4	1/1	100.0	8/8	100.0
Females	67/95	70.5	248/720	34.4	3/4	75.0	17/33	51.5	7/9	77.8	23/56	41.1	24/40	60.0	83/305	27.2	2/2	100.0	6/18	33.3
Spinal Degenerative Joint Disease (SDJD)																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**166/208**	**79.8**	**n/a**	**n/a**	**8/11**	**72.7**	**n/a**	**n/a**	**12/13**	**92.3**	**n/a**	**n/a**	**48/67**	**71.6**	**n/a**	**n/a**	**3/3**	**100.0**	**n/a**	**n/a**
Males	75/94	79.8	**n/a**	**n/a**	6/7	85.7	**n/a**	**n/a**	3/4	75.0	**n/a**	**n/a**	19/28	67.9	**n/a**	**n/a**	1/1	100.0	**n/a**	**n/a**
Females	60/77	77.9	**n/a**	**n/a**	3/4	75.0	**n/a**	**n/a**	7/8	87.5	**n/a**	**n/a**	22/28	78.6	**n/a**	**n/a**	2/2	100.0	**n/a**	**n/a**
Trauma																				
	Supine				**Prone**				**Left**				**Right**				**Flexed**			
	CPR		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**		**CPR**		**TPR**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**25/427**	**5.8**	**n/a**	**n/a**	**1/16**	**6.25**	**n/a**	**n/a**	**3/19**	**15.8**	**n/a**	**n/a**	**8/128**	**6.2**	**n/a**	**n/a**	**0/6**	**0.0**	**n/a**	**n/a**

Males	9/122	7.4	**n/a**	**n/a**	1/7	14.3	**n/a**	**n/a**	1/7	14.3	**n/a**	**n/a**	4/32	12.5	**n/a**	**n/a**	0/1	0.0	**n/a**	**n/a**
Females	9/106	8.5	**n/a**	**n/a**	0/4	0.0	**n/a**	**n/a**	2/9	22.2	**n/a**	**n/a**	4/41	9.8	**n/a**	**n/a**	0/2	0.0	**n/a**	**n/a**
Adults	21/301	7.0	**n/a**	**n/a**	1/12	8.3	**n/a**	**n/a**	3/18	16.7	**n/a**	**n/a**	8/86	9.3	**n/a**	**n/a**	0/3	0.0	**n/a**	**n/a**
Non-adults	4/132	3.0	**n/a**	**n/a**	0/4	0.0	**n/a**	**n/a**	0/5	0.0	**n/a**	**n/a**	0/46	0.0	**n/a**	**n/a**	0/3	0.0	**n/a**	**n/a**

Table 5: Crude and true prevalence rates of skeletal stress indicators for each body position