# LIFE AND STRESS: A BIO-CULTURAL INVESTIGATION INTO THE LATER ANGLO-SAXON POPULATION OF THE BLACK GATE CEMETERY, NEWCASTLE-UPON-TYNE

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# CHAPTER 6

# BIO-CULTURAL ANALYSIS OF PALAEOPATHOLOGY AND BURIAL PRACTICES

This chapter will explore the bio-cultural relationships between health and the socio-economic status of individuals interred within the Black Gate cemetery. The intention is to identify if those interred in desirable burial locations, elaborate burials or in atypical body positions represent healthier members of the community buffered from stress and accorded preferential access to resources by cultural practices.

## 6.1 Background to Bio-Cultural Analysis: Status, Demographics and Health

The social structures within which an individual exists can affect their health in a number of ways. The physical development of that individual and their susceptibility to infectious and deficiency diseases can be greatly impacted by variations in physiological stress caused by selective distribution of resources imposed by social process (Goodman and Martin 2002: 12; Bennike *et al.* 2005; Zuckerman and Armelagos 2011). Differences in status can also be reflected in the biomechanical stresses imposed upon the skeleton from diverse day-to-day physical activities experienced by groups of individuals of different occupation or gender (Robb *et al.* 2001).

The relationships between health and activity and social status expressed via the location, orientation, construction and elaboration of the burial have been investigated for various archaeological periods (e.g. Robb *et al.* 2001; Pechenkina and Delgado 2006). In the present study, these relationships are explored by inferring social status from the location and labour investment in the form and variation of the grave. The disposition of the body within the grave will also be addressed. Such an approach is not without its failings and susceptible to bias and error (Robb *et al.* 2001; Jankauskas 2003). However, previous studies of the relationship between health and the type and variation of the grave have provided convincing evidence that the construction of robust stone cists or rubble-lined graves represents burial of individuals of a high social or economic status (Buckberry 2004; 2007; Craig 2009). Health differences between different burial locations, burial types and body disposition within this thesis are investigated using, where possible, true prevalence rates. Severity of lesions is not quantified due to concerns regarding the reliability of lesion severity as a true representation of the severity of the episode, as is identified in the previous chapter. The uncertainty regarding accuracy of severity as a health indicator, coupled with the small number of elaborate burials determined that analysis of the relationship between severity of health indicators and burial practice was not feasible in this research context.

Many studies of stress and health indicators compare sites of different periods, settlement type or subsistence strategies, disregarding differences in socio-economic status within the cemetery. Many projects look at the population as a whole with no consideration of differences in age and sex. This thesis looks at total health then undertakes a bio-cultural investigation into the impact of social identity (age, sex, and socio-economic status) upon the expression of health indicators.

Differences in burial types are typically accorded to differences in socio-economic status (Tainter 1978; Parker Pearson 1999: 31; Sullivan 2005: 258). This study principally investigates if the health and lifestyles of people interred in different burial types reflect differences in health and behaviour. It is likely that polarising burial practices into high and low social status is insufficient to identify nuances in the socio-economic relationships within this cemetery.

In consideration of the role of socio-economic status on mortality and morbidity, the two most common scenarios discussed in the literature were investigated.

In consideration of the role of socio-economic status on mortality and morbidity, two possible scenarios were investigated.

Hypothesis 1

Those interred in plain graves were lower status than those observed in elaborate graves and would have experienced higher levels of environmental, nutritional and physiological stress than those interred in elaborate graves. Consequently, they would experience a higher prevalence of stress indicators. This represents the 'traditional' approach to interpreting stress and health indicators (Bennike *et al.* 2005).

Hypothesis 2

Individuals interred in plain and elaborate graves experienced similar levels of physiological stress, but those interred in elaborate graves were better equipped due to improved nutritional status and care to survive episodes of attack and therefore would live long enough for stress to affect the skeleton. The lower status individuals buried in the plain graves would have died before stress could manifest on the skeleton and would therefore not exhibit health indicators, or would show them at a much lower level than those interred in elaborate graves. This represents the main principles of the 'Osteological Paradox' approach to interpreting health and stress indicators (Wood *et al.* 1992).

Within this chapter the terms *plain* and *elaborate burial type* are utilised. Plain earth-cut graves and earth-cut graves containing evidence for coffin wood are classified as *plain* burials, whereas earth-cut graves containing pillow stones, earmuffs and head cists and graves constructed with stone cists and rubble cists are referred to as *elaborate*. The two chest burials (BG619 and BG644) are also classified as *elaborate* due to the inclusion of locks and the association of such chests with higher-status burials.(Craig 2009: 330). A further distinction is made between the *grave type* and *grave variation* (as is described in Chapter 2). *Grave type* relates to the physical construction of the grave and additional structures, such as shrouds, coffins and chests, within which the body was contained. *Grave variation* refers to any features within the different grave types which are not grave goods nor constitute the physical construction of the grave. Examples of grave variations are grave markers and stone inclusions such as head support stones (Buckberry 2007: 117). The distinctions between *burial type*, *grave type* and *grave variation* are summarised in Figure 6.1. In total 41 elaborate graves were recovered, 22 of which were elaborate grave types and 19 were elaborate grave variations.

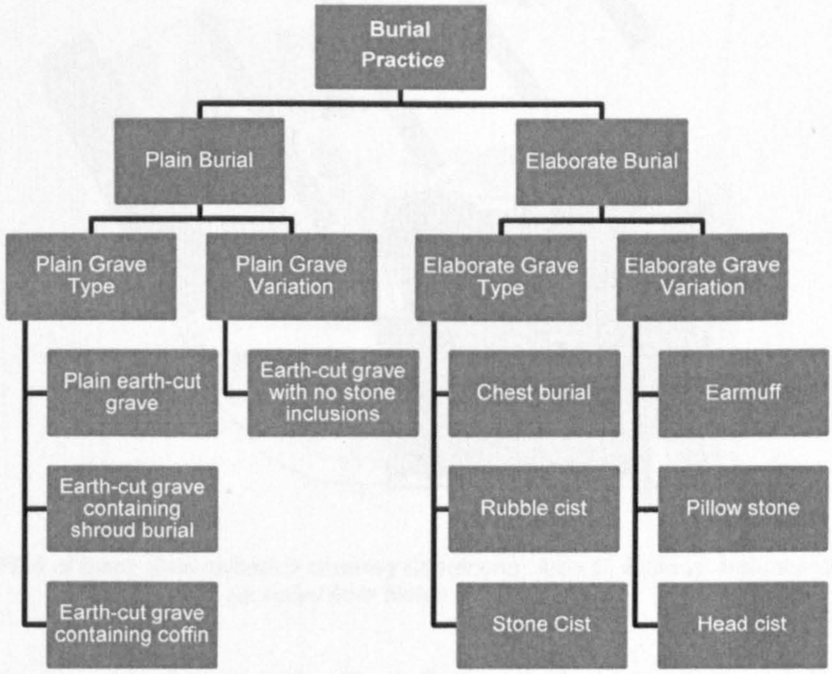


Figure 6.1 *Summary of terminology used to describe burial practices observed within the Black Gate cemetery*

## 6.2 Burial Location

Examination was made of the proportion of adults and immatures, individuals of each adult age and sex categories, the prevalence of health indicators and body disposition in each of the burial zones (the Compound, Area C, the Railway Arches and Area D) (Figure 6.2). Information on the location of 631 burials was attained from an AutoCAD file provided by John Nolan.

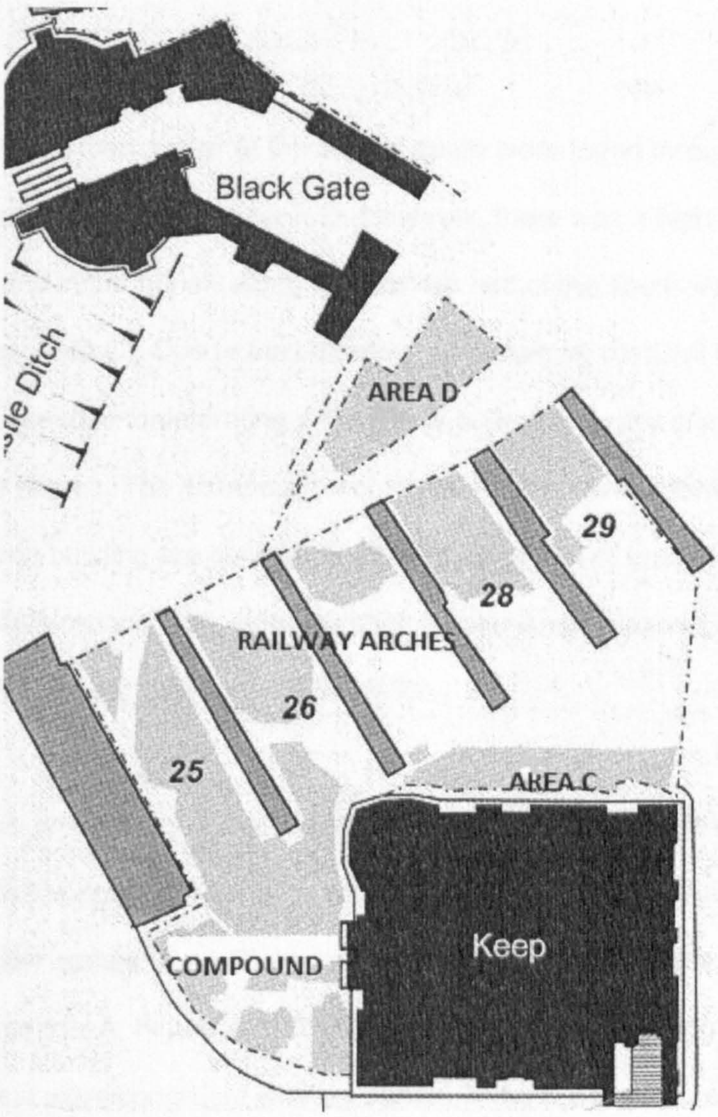


Figure 6.2 *Plan of Black Gate cemetery showing Compound, Area C, Railway Arches and Area D (adapted from Nolan 2011: 153)*

The highest density of burial within the Black Gate cemetery was in Area C to the south of the proposed church represented by Buildings A, B and 68 (Appendix A: Figure A.1). A second area of dense burial was also seen within a localised area approximately 16m to the north of the projected south side of the church, beneath the railway arches

(Appendix A: Figure A.1). The Civil War bastion ditch and some 17th- and 18th-century cellars have obscured and removed burials directly adjacent to the proposed northern edge of the church (Nolan 2010: 152). However, it can be inferred from the high density of burials beneath the railway arches to the north of the disturbed area, that the unobservable area originally contained a high density of burials. This suggests a focus for intensive burial against the north and south walls of the possible church (Nolan 2010: 223).

Immatures aged less than 1 year at the time of death were found throughout the excavated areas (Appendix A: Figure A.2). However, there was a high concentration of foetal, neonate and infant burials along the eastern half of the south wall of the focal or religious building (Area C). Due to the disruption of burials by the Civil War bastion ditch, it was not possible to determine if there was a similar cluster of infants on the north side of the church. The juxtaposition of foetal, neonate and infant burials and the walls of the church building are consistent with the interment of un-baptised infants in 'eaves-drip' burial locations alongside churches in later Anglo-Saxon England (Boddington 1996: xii, 45; Crawford 1999; 85-9).

There were equal proportions of male to female burials in the concentrated area of burial adjacent to the projected northern wall of the church (Railway Arches), further north of the railway arches (Area D) and the area to the west of the church (the Compound) (Appendix A: Figure A.3). This mixed sex distribution suggests the areas to the north and west were congruent with lay burials. If the building represented by structures A, B and 68 within the cemetery was in fact a church, one might expect a concentration of high-status male adult burials next to this building, a distribution that has been noted near to other later Anglo-Saxon churches (as discussed in Chapter 3). Indeed, the high concentration of cist and rubble cist burials along the south wall of the proposed church within the Black Gate cemetery were predominantly provided for males, save for three female burials. There were two potential explanations for this occurrence. Firstly, the distribution of burials may be consistent with a burial ground for monks and possibly nuns or important lay patrons to the south of the church and lay burials to the north and west, with the more elite members of the lay community being interred in the southern area of the cemetery. Alternatively, the male dominated stone cist and rubble cist burials to the south may represent particularly high-status members of the community, with males being more often ascribed with such status than females.

The distribution of elaborate grave types (stone and rubble cist burials and chest burials), and grave variations (pillow stones, earmuffs and head cists) within the Black Gate cemetery is shown in Appendix A: Figure A.4. It would be expected that burials adjacent to the church building would not only be densely packed, but also of a high quality if they represented high-status members of society. This was indeed the case, with stone cists only present in the area adjacent to the southern wall of the proposed church (Area C). Chest burials and the elaborate grave variations (head cists, pillow stones and earmuffs) were only found in the area north of the church (Railway Arches) within Railway Arches 28 and 29 and rubble cists were recovered from both Area C and the Railway Arches. In contrast, only plain burials were recovered from the western side of the building (the Compound), suggesting this to be a less affluent area of burial.

### *6.2.1 Burial Location and Demographics*

The summary statistics and statistical analysis of the relationship between burial location and the age and sex distribution within the Black Gate assemblage are recorded in Appendix C: Tables C.1 to C.3. Both age at death and burial location were known for 546 individuals. Age and sex were known for 333 of the adults of known burial location.

| Age Category | Compound | | Area C | | Railway Arches | | Area D | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| **Pre-Infant** | 7 | 4.38 | 14 | 10.94 | 4 | 1.65 | 0 | 0.00 |
| **Infant** | 13 | 8.12 | 27 | 21.09 | 8 | 3.31 | 0 | 0.00 |
| **Young Child** | 20 | 12.50 | 22 | 17.19 | 24 | 9.92 | 1 | 6.25 |
| **Older Child** | 10 | 6.25 | 9 | 7.03 | 9 | 3.72 | 3 | 18.75 |
| **Adolescent** | 6 | 3.75 | 4 | 3.13 | 16 | 6.61 | 2 | 12.50 |
| **Young Adult** | 11 | 6.87 | 8 | 6.25 | 16 | 6.61 | 0 | 0.00 |
| **Prime Adult** | 23 | 14.38 | 16 | 12.50 | 45 | 18.59 | 0 | 0.00 |
| **Mature Adult** | 26 | 16.25 | 9 | 7.03 | 56 | 23.14 | 6 | 37.50 |
| **Senior Adult** | 44 | 27.50 | 19 | 14.84 | 64 | 26.45 | 4 | 25.00 |
| **Total*** | 160 | 100 | 128 | 100 | 242 | 100 | 16 | 100 |

Table 6.1 *Percentage of individuals within each burial location from pre-infant to senior adult (546 recordable individuals)*

There was a statistically significant higher presence of adults compared to immatures in each of the burial locations (Appendix C: Tables C.1), save for Area C, where a significantly greater number of immature (59.4%; 76/128) to adult (40.6%; 52/128) burials were recovered ($\chi^2$ = 9.000; P = 0.003) (Table 6.1). There were no consistent trends in the age profiles within the four burial zones.

| Age Category | Sex | Compound | | Area C | | Railway Arches | | Area D | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % | N | % |
| **Young Adult** | Male | 5 | *4.95* | 4 | *7.84* | 10 | *5.81* | 0 | *0.00* |
| | Female | 5 | *4.95* | 3 | *5.88* | 4 | *2.33* | 0 | *0.00* |
| **Prime Adult** | Male | 8 | *7.92* | 13 | *25.49* | 18 | *10.47* | 0 | *0.00* |
| | Female | 14 | *13.86* | 3 | *5.88* | 24 | *13.95* | 0 | *0.00* |
| **Mature Adult** | Male | 17 | *16.83* | 5 | *9.80* | 19 | *11.05* | 3 | *33.33* |
| | Female | 8 | *7.92* | 4 | *7.84* | 34 | *19.77* | 3 | *33.33* |
| **Senior Adult** | Male | 14 | *13.86* | 14 | *27.45* | 36 | *20.93* | 3 | *33.33* |
| | Female | 30 | *29.70* | 5 | *9.80* | 27 | *15.70* | 0 | *0.00* |
| **Total** | | 101 | *100* | 51 | *100* | 172 | *100* | 9 | *100* |

Table 6.2 *Percentage of adult age and sex categories within each burial location (333 recordable individuals)*

Males constituted approximately two-thirds of the assemblage in both Area C (males = 70.6%; females = 29.4%) and Area D (males = 66.7%; females = 33.3%) (Table 6.2). The higher prevalence of males to females observed in Area C was statistically significant ($\chi^2$= 17.294; P = 0.000). There was no statistically significant difference in the presence of males and females in the Compound (males = 44% [44/101]; females = 56% [57/101]) and the Railway Arches (males = 48% [83/172]; females = 52% [89/172]), but there was a slightly higher percentage of females in both areas.

In the Compound, mature adult males were significantly greater in number than mature females ($\chi^2$= 11.636; P = 0.001). In contrast, senior adult females were more greatly represented than males ($\chi^2$= 17.294; P = 0.000).There was a significantly higher representation of males than females in Area C for both prime ($\chi^2$= 12.500; P = 0.001) and senior ($\chi^2$= 8.526; P = 0.009) adults. In the Railway Arches, young adult males ($\chi^2$= 5.143; P = 0.057) and mature adult females ($\chi^2$= 8.491; P = 0.004) were the predominant age and sex categories. In Area D, only the greater prevalence of males to females amongst the senior adults was statistically significant ($\chi^2$= 6.000; P = 0.014). Overall, there were no statistically significant trends between sex and burial location based on age. The only real relationship was the greater prevalence of males relative to females in all of the adult age categories in Area C.

### *6.2.2 Burial Location and Palaeopathology*

If the male interments within the stone and rubble cists did indeed represent burials of either monks or high-status lay individuals, it is possible that they would present differences in stature and the prevalence of health indicators (of non-specific stress, non-specific infection, dental health and biomechanical stress) than other burials throughout the cemetery. This possibility is discussed in the following section. Health indicators are also compared between individuals interred in the high-density areas of burial to the north and south of the proposed church building and the less concentrated, plain burials to the west of this building.

### *6.2.2.1 Indicators of Environmental Stress: Adult Stature*

The summary statistics and statistical analysis of the relationship between burial location and mean adult stature for males and females within the Black Gate assemblage are recorded in Appendix C: Tables C.4 to C.5. Adult stature and burial location was recordable for 75 males and 76 females.

| Burial Area | Sex | *N* | Minimum Stature (cm) | Maximum Stature (cm) | Mean Stature (cm) | Standard Deviation |
|---|---|---|---|---|---|---|
| Compound | Male | *22* | 158.04 | 174.46 | 167.60 | 4.48 |
| | Female | *31* | 152.33 | 170.89 | 161.29 | 4.55 |
| Area C | Male | *20* | 149.71 | 185.17 | 171.19 | 7.55 |
| | Female | *8* | 155.42 | 165.89 | 160.51 | 3.61 |
| Railway Arches | Male | *30* | 158.04 | 184.22 | 170.09 | 6.32 |
| | Female | *37* | 148.99 | 181.60 | 161.49 | 6.58 |
| Area D | Male | *3* | 173.51 | 179.46 | 176.68 | 2.99 |
| | Female | *0* | - | - | - | - |

Table 6.3 *Relationship between burial location and male and female stature within the Black Gate cemetery (n= 151 graves for which information is available)*

There was a significantly higher mean stature for the males interred in the Compound (174.46 cm) and Area D (176.68 cm) than in Area C (171.19 cm) and the Railway Arches (170.09 cm) ($t = 3.873$; $P = 0.030$) (Table 6.3). Females showed no statistically significant differences in stature in relation to burial location. The significantly higher mean stature for the males relative to the females observed for the Black Gate cemetery overall was also visible in each of the burial zones (excluding Area D, for which no information was available) (Appendix C: Table C.5).

### *6.2.2.2 Indicators of Environmental Stress: Non-Specific Stress*

The summary statistics and statistical analysis of the relationship between burial location and the true prevalence rate of non-specific stress (cribra orbitalia and dental enamel hypoplasia) within the Black Gate assemblage are recorded in Appendix C: Tables C.6 to C.17. Burial location and the presence of cribra orbitalia and DEH was recordable for 325 and 223 individuals respectively.

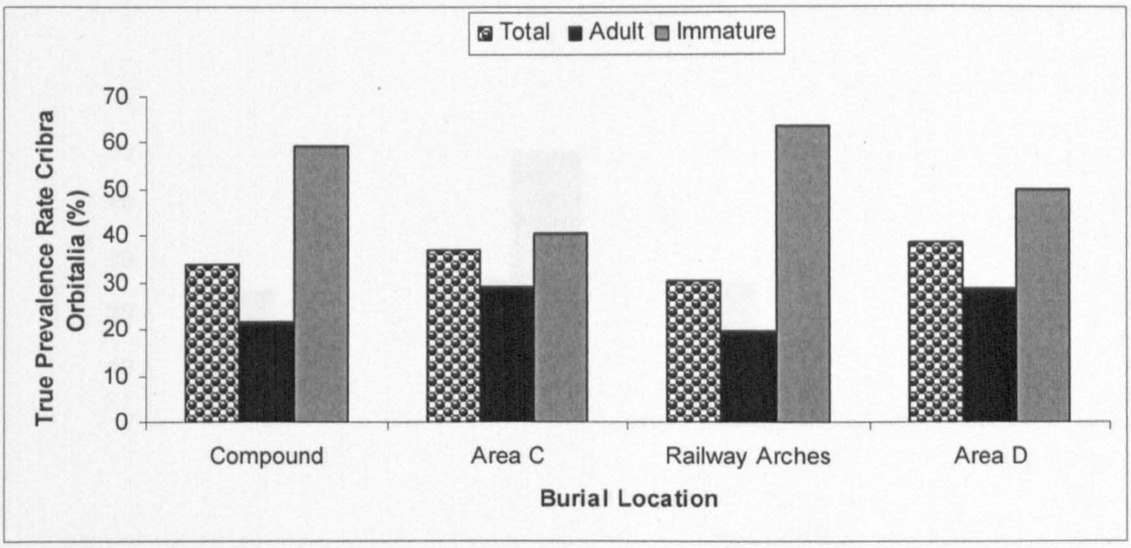


Figure 6.3 *True prevalence of cribra orbitalia for the total, adult and immature populations within each burial location within the Black Gate cemetery (n = 325 graves for which information is available; 101 Compound; 76 Area C; 135 Railway Arches; 13 Area D)*

The much greater percentage of cribra orbitalia in the immature burials of the Railway Arches (63.6%) relative to Area C (40.4%) (Figure 6.3) was statistically significant ($\chi^2$= 4.366; P = 0.037). There were no other statistically significant differences in the prevalence of cribra orbitalia between the total, adult or immature populations of the four burial zones.

Immatures exhibited higher frequencies of cribra orbitalia than the adults in all four burial zones. The higher prevalence of immature cribra orbitalia in the Compound ($\chi^2$= 13.867; P = 0.000) and Railway Arches ($\chi^2$= 22.856; P = 0.000) was statistically significant.

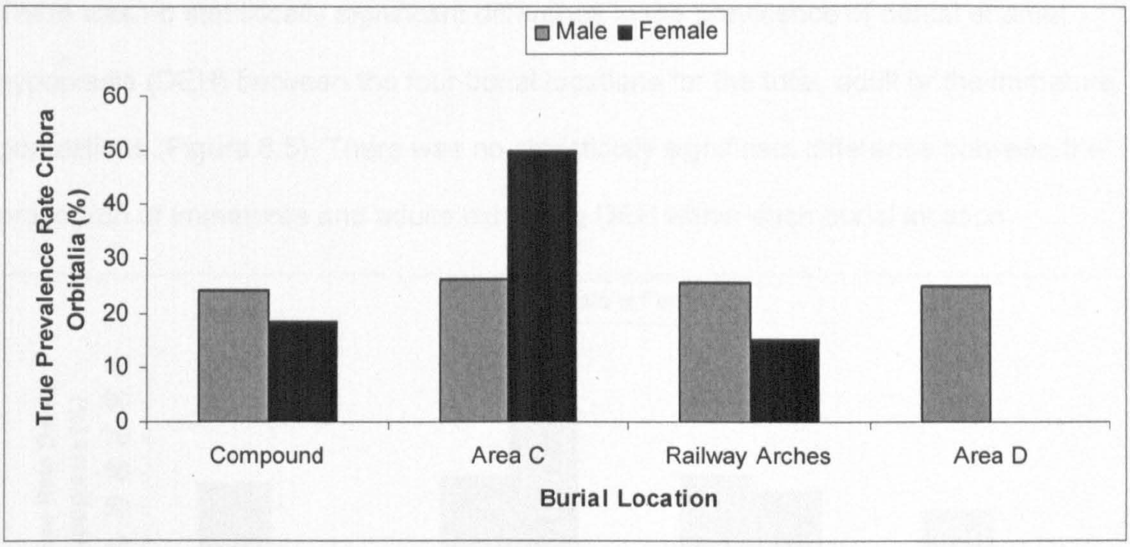


Figure 6.4 *True prevalence of cribra orbitalia for the males and females within each burial location within the Black Gate cemetery (n = 195 adults of known sex and burial location)*

There were no significant differences in the frequency of males and females exhibiting cribra orbitalia within the four burial locations. This appears to contradict the much higher percentage of cases recorded for females than males in Area C and absence of female cases in Area D (Figure 6.4). This discrepancy is probably an artefact of sample size, because although the percentage differences were quite substantial i.e. in Area C 50% of females exhibit cribra orbitalia in contrast to only 13.5% of males, the real numbers involved (2/4 and 5/19) were very small.

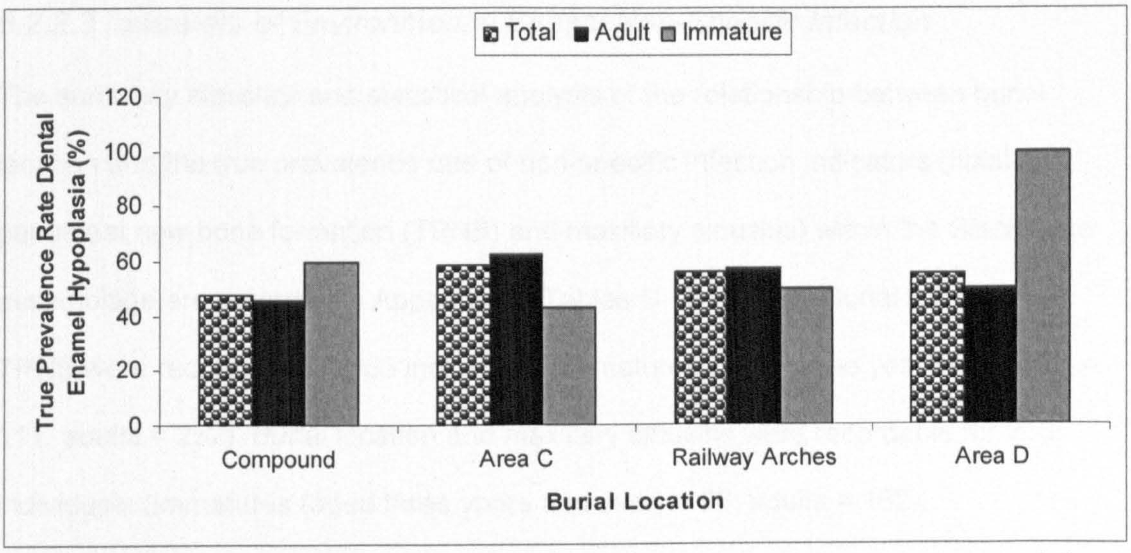


Figure 6.5 *True prevalence of dental enamel hypoplasia for the total, adult and immature populations within each burial location within the Black Gate cemetery (n= 223 graves for which information is available; 69 Compound; 34 Area C; 111 Railway Arches; 9 Area D)*

There was no statistically significant difference in the prevalence of dental enamel hypoplasia (DEH) between the four burial locations for the total, adult or the immature populations (Figure 6.5). There was no statistically significant difference between the proportion of immatures and adults exhibiting DEH within each burial location.

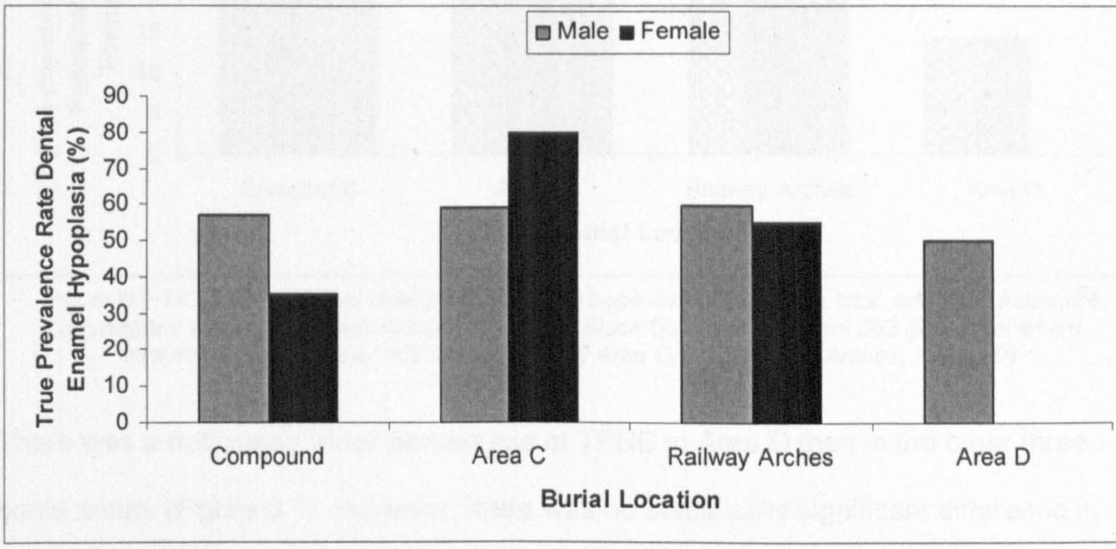


Figure 6.6 *True prevalence of dental enamel hypoplasia for the males and females within each burial location within the Black Gate cemetery (n = 181 adults of known sex and burial location)*

There was no significant difference in the prevalence of DEH expressed between the sexes between or within the different burial locations (Figure 6.6).

### *6.2.2.3 Indicators of Environmental Stress: Non-Specific Infection*

The summary statistics and statistical analysis of the relationship between burial location and the true prevalence rate of non-specific infection indicators (tibial periosteal new bone formation (TPNB) and maxillary sinusitis) within the Black Gate assemblage are recorded in Appendix C: Tables C.18 to C.29. Burial location and TPNB were recordable for 363 individuals (immatures (aged three years and over) = 111; adults = 252). Burial location and maxillary sinusitis were recordable for 218 individuals (immatures (aged three years and over) = 56; adults = 162).

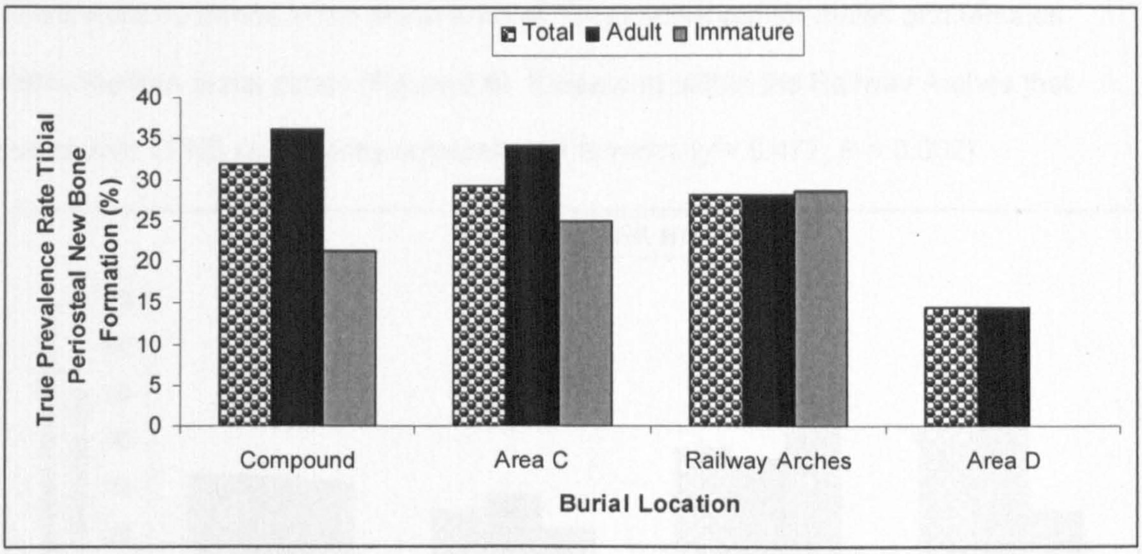


Figure 6.7 *True prevalence of tibial periosteal new bone formation for the total, adult and immature populations within each burial location within the Black Gate cemetery (n= 363 graves for which information is available; 100 Compound; 89 Area C; 167 Railway Arches; 7 Area D)*

There was a noticeably lower percentage of TPNB in Area D than in the other three burial zones (Figure 6.7). However, there was no statistically significant difference in the prevalence of TPNB between the four burial zones for the total, adult or the immature populations. This may be because the similarity of the prevalence of this pathology within the Compound (32/100; 32%), Area C (10/40; 25%) and the Railway Arches (47/167; 28.1%) outweighs the difference of Area D (1/7; 14.3%), which comes from a total population of only seven individuals. There was no significant difference in the prevalence of TPNB between adults and immatures within the Compound, Area C and Railway Arches. The lack of immatures in Area D prevented statistical analysis.

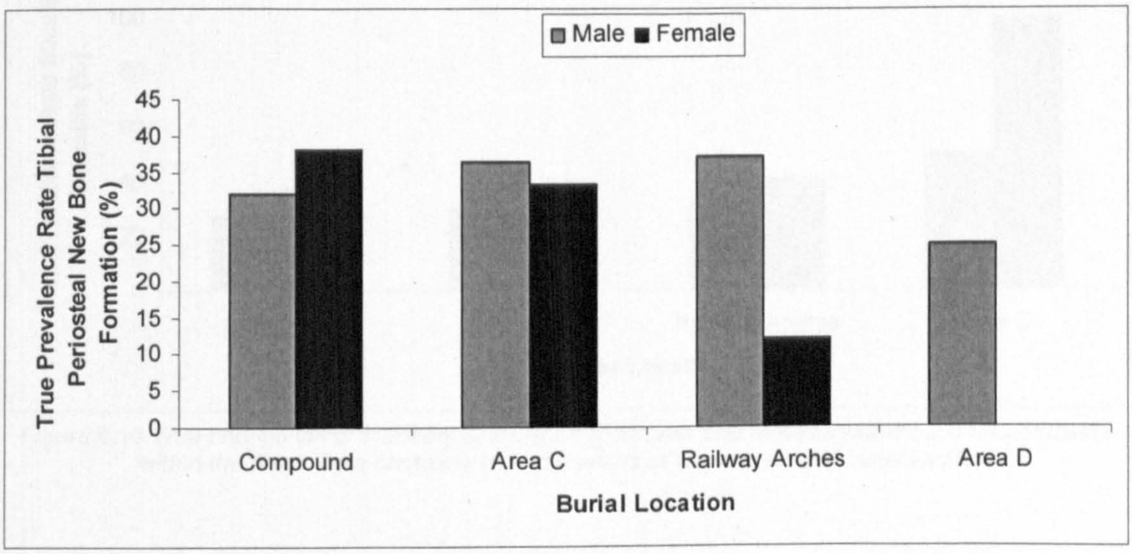


Figure 6.8 *True prevalence of tibial periosteal new bone formation for the males and females within each burial location within the Black Gate cemetery (n = 205 adults of known sex and burial location)*

There were no trends in the prevalence of TPNB observed for males and females within the four burial zones (Figure 6.8). It was only within the Railway Arches that males with TPNB significantly outnumbered females ($\chi^2 = 9.477$; $P = 0.002$).

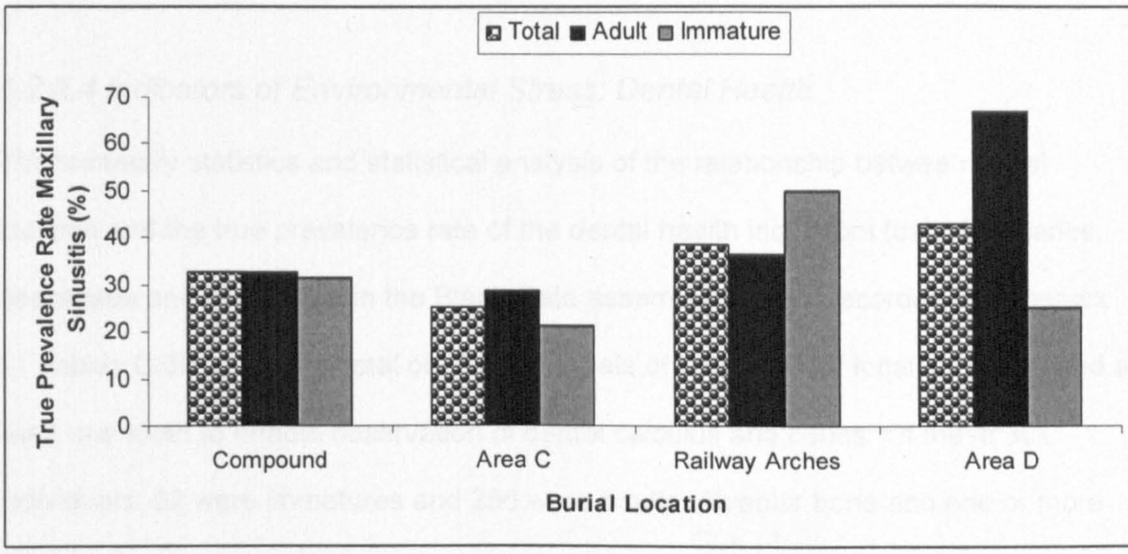


Figure 6.9 *True prevalence of maxillary sinusitis for the total, adult and immature populations within each burial location within the Black Gate cemetery (n= 218 graves for which information is available; 83 Compound; 40 Area C; 88 Railway Arches; 7 Area D)*

The difference in prevalence of maxillary sinusitis observed between the four burial areas was not statistically significant for the total, adult or the immature populations (Figure 6.9). There was no statistically significant difference in the adult and immature prevalence of maxillary sinusitis in any of the burial zones.

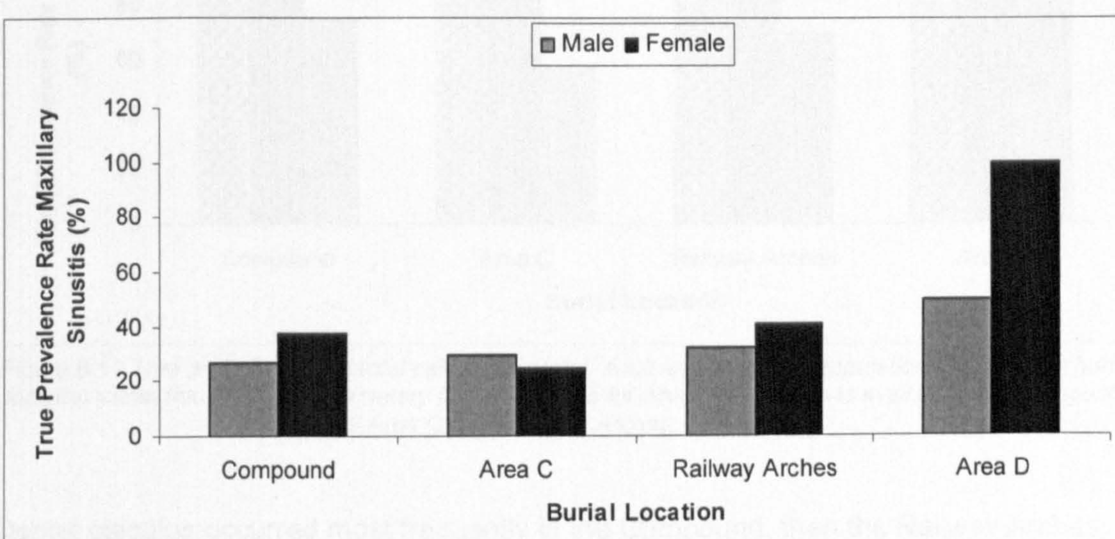


Figure 6.10 *True prevalence of maxillary sinusitis for the males and females within each burial location within the Black Gate cemetery (n = 160 adults of known sex and burial location)*

The prevalence of maxillary sinusitis was higher for females in all burial locations except for Area C, where males were more commonly affected (Figure 6.10). However, none of these differences was great enough to be statistically significant.

### 6.2.2.4 Indicators of Environmental Stress: Dental Health

The summary statistics and statistical analysis of the relationship between burial location and the true prevalence rate of the dental health indicators (calculus, caries, abscesses and AMTL) within the Black Gate assemblage were recorded in Appendix C: Tables C.30 to C.53. A total of 301 individuals of known burial location possessed at least one tooth to enable observation of dental calculus and caries. Of these 301 individuals, 52 were immatures and 256 were adults. Alveolar bone and one or more surviving permanent tooth sockets were recordable in 301 individuals of known burial location (51 immatures and 256 adults) enabling the presence of dental abscesses and AMTL to be quantified.

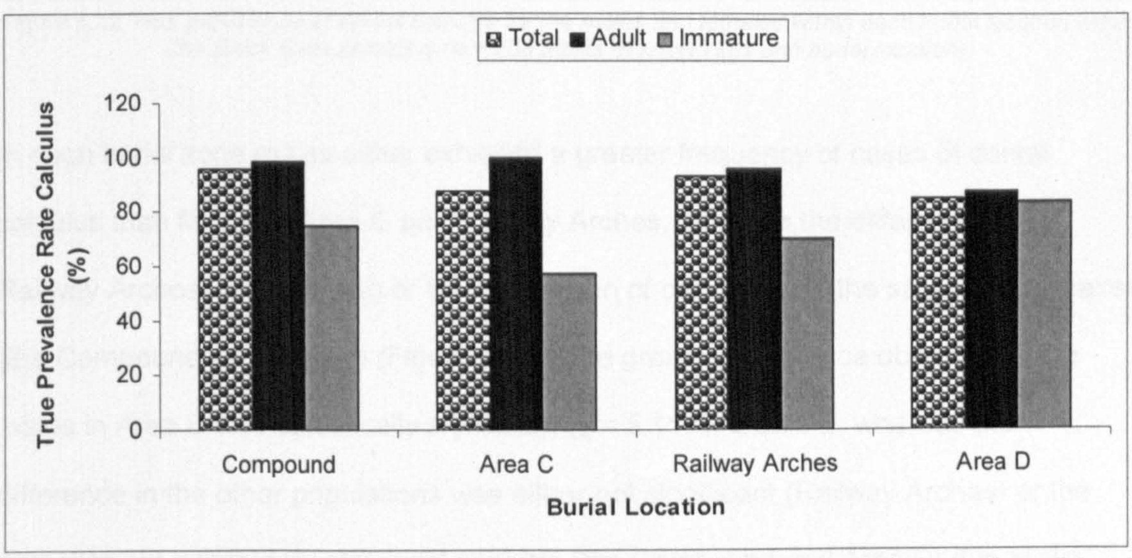


Figure 6.11 *True prevalence of dental calculus for total, adult and immature populations within each burial location within the Black Gate cemetery (n= 309 graves for which information is available; 90 Compound; 49 Area C; 157 Railway Arches; 13 Area D)*

Dental calculus occurred most frequently in the Compound, then the Railway Arches, followed by Area C. The lowest frequency was observed in Area D. There was no statistically significant difference in the prevalence of dental calculus between the four burial zones for the total or immature populations (Figure 6.11).

Amongst the adults there was a statistically significant greater prevalence of calculus within Area C (100.0%) compared to Area D (87.5%) ($\chi^2$= 4.354; P = 0.037). This was probably an artefact of the small sample size available for the analysis. The adult prevalence of dental calculus was significantly greater than the immatures in the Compound ($\chi^2$= 13.210; P = 0.000), Area C ($\chi^2$= 16.653; P = 0.000) and the Railway Arches ($\chi^2$= 16.078; P = 0.000).

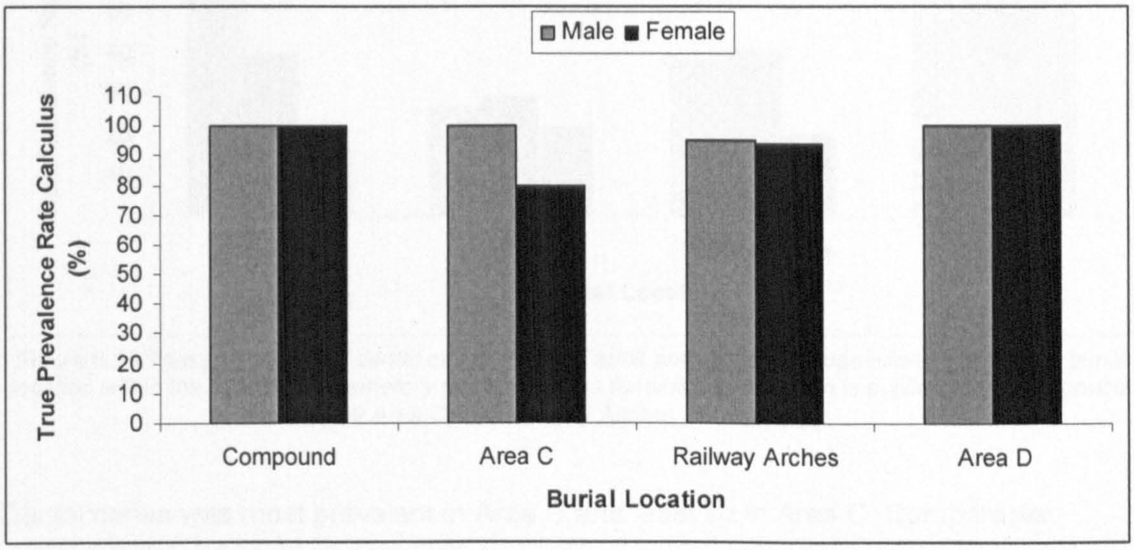


Figure 6.12 *True prevalence of dental calculus for the males and females within each burial location within the Black Gate cemetery (n = 238 adults of known sex and burial location)*

In each burial zone males either exhibited a greater frequency of cases of dental calculus than females (Area C and Railway Arches, although the difference in the Railway Arches was nominal) or the expression of calculus was the same in both sexes (the Compound and Area D) (Figure 6.12). The greater prevalence observed in the males in Area C was statistically significant ($\chi^2$= 5.11; P = 0.024), whereas the difference in the other populations was either not significant (Railway Arches) or the data was not suitable for statistical analysis (the Compound and Area D) due to too many cells containing zero counts. In both the Compound and Area D all the males and females exhibited calculus and in the Railway Arches 95.0% of males and 93.7% of females exhibited calculus deposits. This highlights the ubiquity of calculus within the Black Gate population as a whole. The significant difference observed between males (100.0%) and females (80.0%) in Area C probably results from the small number of female skeletons (n = 10) recovered from this area compared to the males (n = 24). There was no significant difference observed between males and females in any of the adult age categories for any of the burial zones.

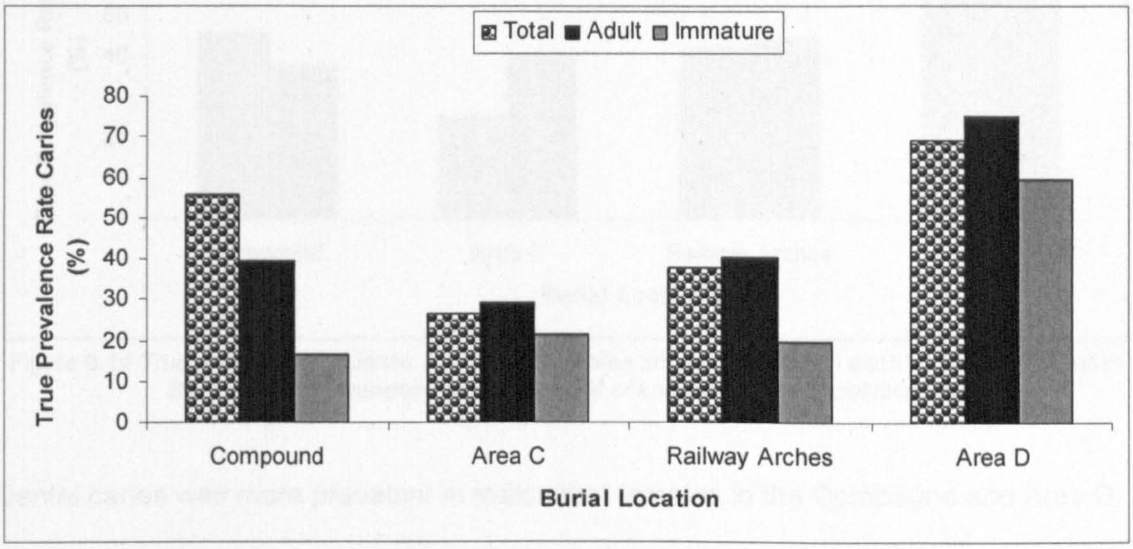


Figure 6.13 *True prevalence of dental caries for total, adult and immature populations within each burial location within the Black Gate cemetery (n= 309 graves for which information is available; 90 Compound; 49 Area C; 157 Railway Arches; 13 Area D)*

Dental caries was most prevalent in Area D and least so in Area C. Comparable prevalences were observed for the Compound and the Railway Arches (Figure 6.13). The high percentage of dental caries within Area D made it significantly different from the lower percentages observed in the Compound ($\chi^2$= 4.988; P = 0.026), Area C ($\chi^2$= 8.183; P = 0.004) and the Railway Arches ($\chi^2$= 5.011; P = 0.025). Comparisons of the adult populations revealed significant differences in the prevalence of dental caries between Area D and the Compound ($\chi^2$= 3.679; P = 0.055), Area C ($\chi^2$= 5.707; P = 0.017) and the Railway Arches ($\chi^2$= 3.696; P = 0.055). There was no significant difference in the prevalence of dental caries recorded for the immature populations between the four burial zones. In all of the burial zones, adults exhibited greater frequencies of dental caries than the immatures. However, none of these differences was statistically significant.

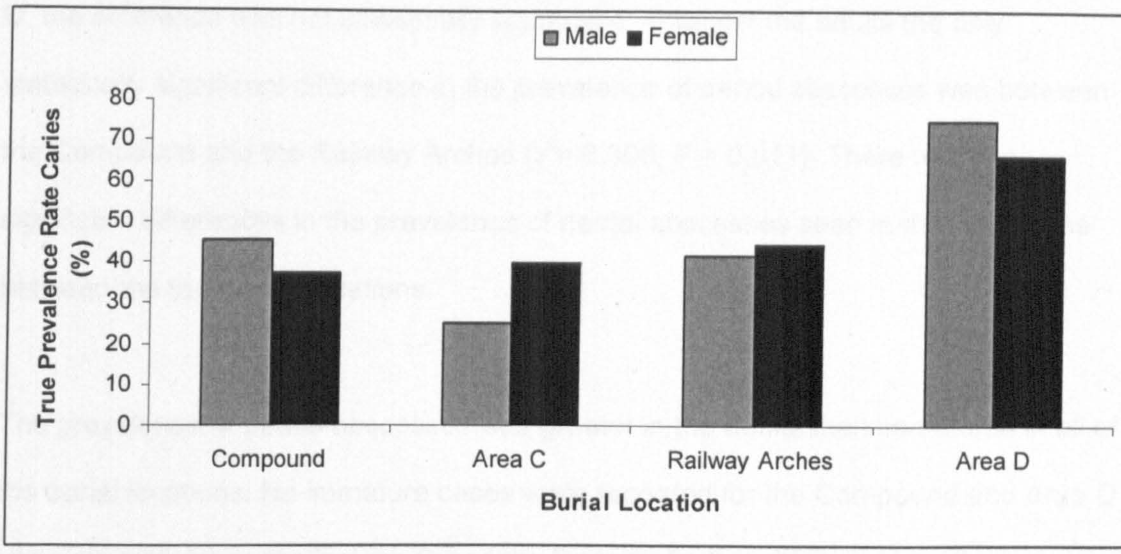


Figure 6.14 *True prevalence of dental caries for the males and females within each burial location within the Black Gate cemetery (n = 241 adults of known sex and burial location)*

Dental caries was more prevalent in males that females in the Compound and Area D, whereas females were more affected in Area C and the Railway Arches. There were no significant differences in the proportion of males to females exhibiting dental caries between or within the different burial locations (Figure 6.14).

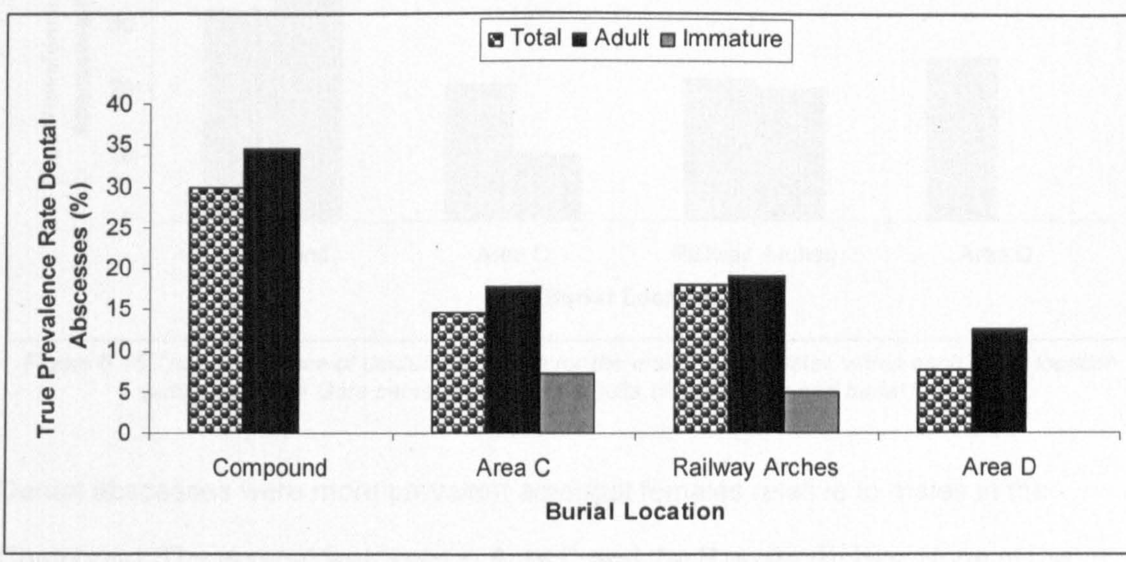


Figure 6.15 *True prevalence of dental abscesses for total, adult and immature populations within each burial location within the Black Gate cemetery (n= 301 graves for which information is available; 90 Compound; 48 Area C; 150 Railway Arches; 13 Area D)*

The percentage of dental abscesses for the total population in the Compound was significantly higher than observed in Area C ($\chi^2$= 4.007; P = 0.045) and the Railway Arches ($\chi^2$= 4.645; P = 0.031) (Figure 6.15). Area D showed the lowest percentage of individuals with dental abscesses, possibly due to the small assemblage size of Area

D, the difference was not statistically significant. Amongst the adults the only statistically significant difference in the prevalence of dental abscesses was between the Compound and the Railway Arches ($\chi^2$= 6.390; P = 0.011). There were no significant differences in the prevalence of dental abscesses seen in the immatures between the four burial locations.

The prevalence of dental abscesses was greater in the adults than immatures in all of the burial locations. No immature cases were recorded for the Compound and Area D and only singular cases in Area C and the Railway Arches. It was only in the Compound that the greater percentage of cases observed in the adults was significantly higher than that seen in the immatures ($\chi^2$= 5.934; P = 0.015).

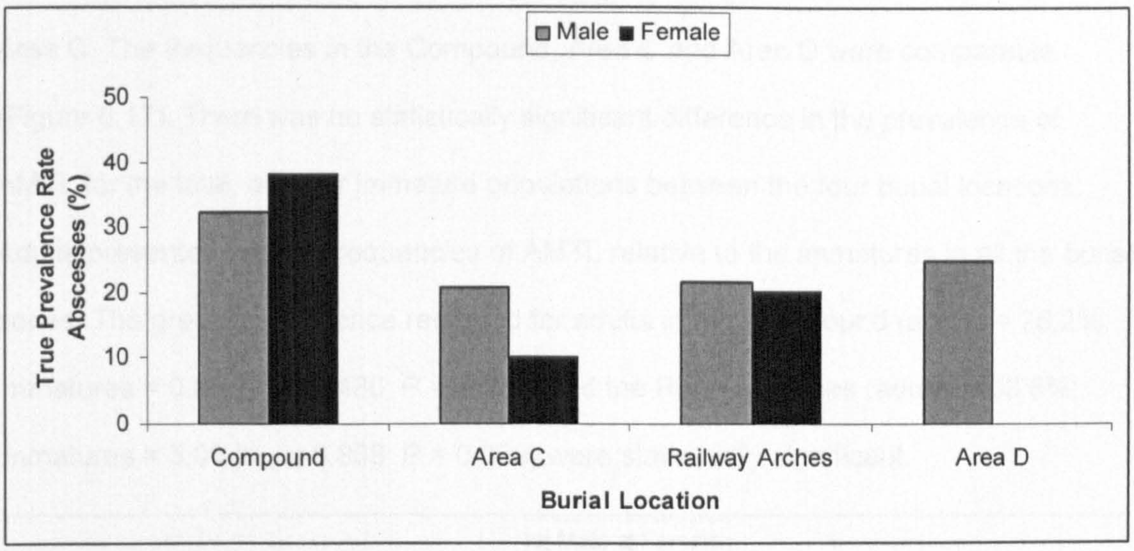


Figure 6.16 *True prevalence of dental abscesses for the males and females within each burial location within the Black Gate cemetery (n = 160 adults of known sex and burial location)*

Dental abscesses were more prevalent amongst females relative to males in the Compound. The reverse was seen in Area C and the Railway Arches. None of the females in Area D exhibited dental abscesses (Figure 6.16).There were no significant differences in the proportion of males to females exhibiting dental abscesses between or within the different burial locations.

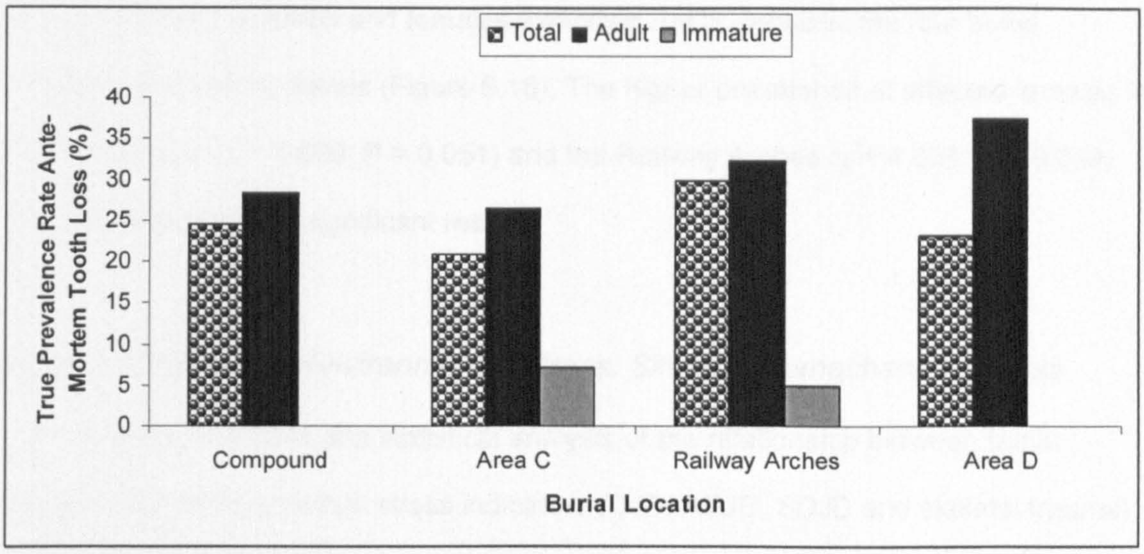


Figure 6.17 *True prevalence of ante-mortem tooth loss for total, adult and immature populations within each burial location within the Black Gate cemetery (n= 301 graves for which information is available; 90 Compound; 48 Area C; 150 Railway Arches; 13 Area D)*

The greatest frequency of AMTL was observed in the Railway Arches and the lowest in Area C. The frequencies in the Compound, Area C and Area D were comparable (Figure 6.17). There was no statistically significant difference in the prevalence of AMTL for the total, adult or immature populations between the four burial locations. Adults presented greater frequencies of AMTL relative to the immatures in all the burial zones. The greater prevalence recorded for adults in the Compound (adults = 28.2%; immatures = 0.0%) ($\chi^2$= 4.480; P = 0.034) and the Railway arches (adults = 33.8%; immatures = 5.0%) ($\chi^2$= 6.868; P = 0.009) were statistically significant.

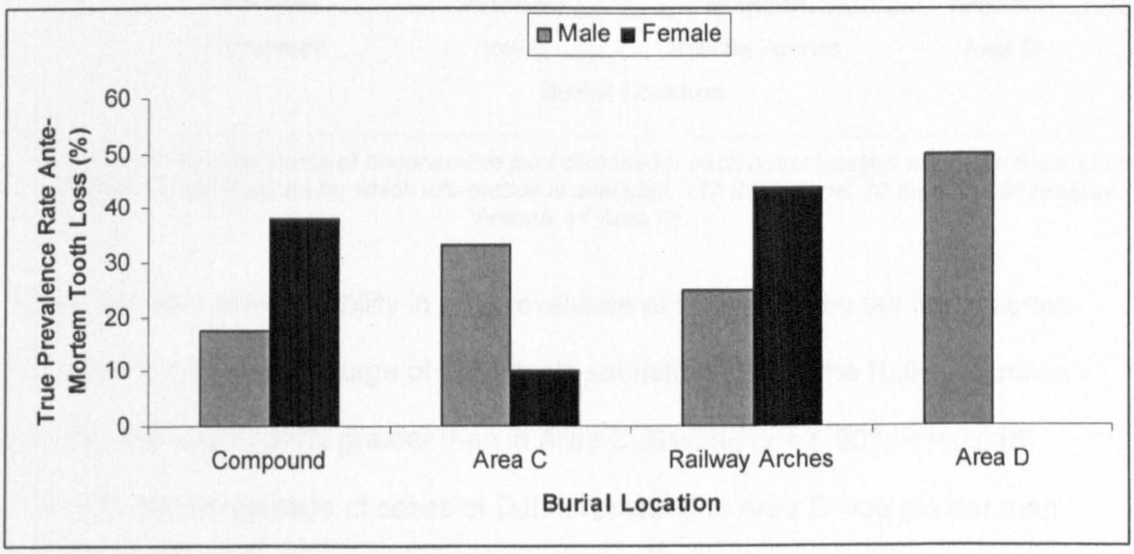


Figure 6.18 *True prevalence of ante-mortem tooth loss for the males and females within each burial location within the Black Gate cemetery (n = 241 adults of known sex and burial location)*

The proportions of males and females exhibiting AMTL between the four burial locations showed no trends (Figure 6.18). The higher prevalence of affected females in the Compound ($\chi^2$= 3.820; P = 0.051) and the Railway Arches ($\chi^2$= 4.806; P = 0.028) generated statistically significant results.

### *6.2.2.5 Indicators of Environmental Stress: Skeletal Biomechanical Stress*

The summary statistics and statistical analysis of the relationship between burial location and biomechanical stress indicators (DJD, ADJD, SDJD and skeletal trauma) within the Black Gate assemblage are recorded in Appendix C: Tables C.54 to C.68. A total of 397 individuals of known burial location possessed at least one recordable joint surface. At least one appendicular joint was recordable for 387 individuals of known burial location and 310 individuals possessed one or more recordable spinal articular surface. Skeletal trauma was recordable for 628 individuals of known burial location.

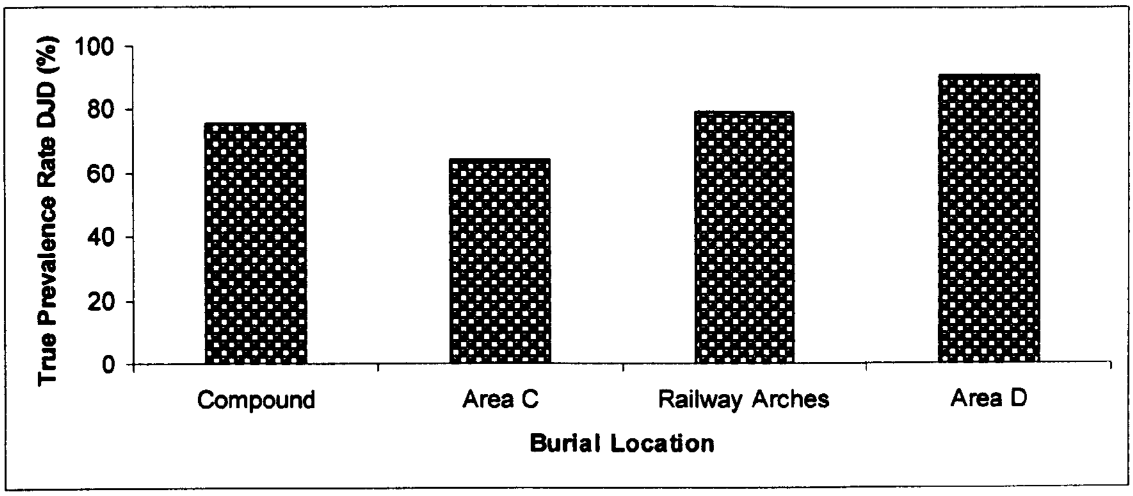


Figure 6.19 *True prevalence of degenerative joint disease for each burial location within the Black Gate cemetery (n= 397 graves for which information is available; 117 Compound; 70 Area C; 199 Railway Arches; 11 Area D)*

There was very little variability in the prevalence of DJD between the burial zones (Figure 6.19). The percentage of individuals exhibiting DJD in the Railway Arches (78.9%) was significantly greater than in Area C (64.3%) ($\chi^2$= 5.909; P = 0.015). However, the percentage of cases of DJD expressed in Area D was greater than observed in the Railway Arches, creating a larger disparity between Area D and Area C than observed between the Railway Arches and Area C. The difference between Area

D and Area C was not statistically significant, possibly an artefact of the small number of observable individuals recorded for Area D, but also calling into question the reliability of the statistical significance observed between Area C and the Railway Arches.

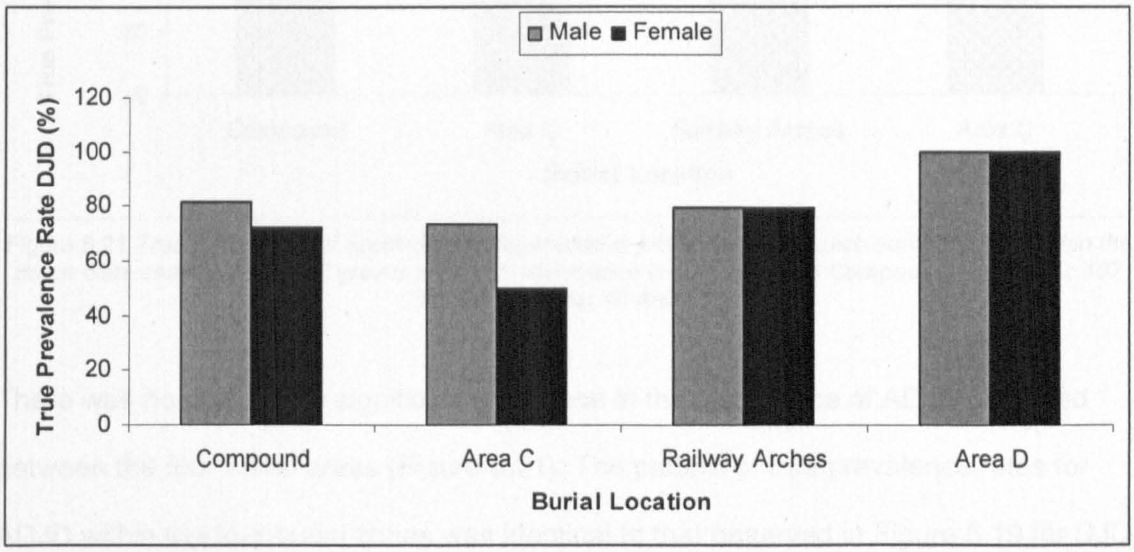


Figure 6.20 *True prevalence of degenerative joint disease for the males and females within each burial location within the Black Gate cemetery (n = 320 adults of known sex and burial location)*

The prevalence of DJD was either higher in the males (the Compound and Area C) or comparable between the sexes (Railway Arches and Area D) (Figure 6.20). The percentage of cases within each burial zone did not differ significantly between the sexes. When the prevalence between males and females were compared for each adult age category, the only statistically significant difference was the higher prevalence of prime adult females relative to prime adult males with DJD observed in the Railway Arches ($\chi^2 = 5.284$; P = 0.044).

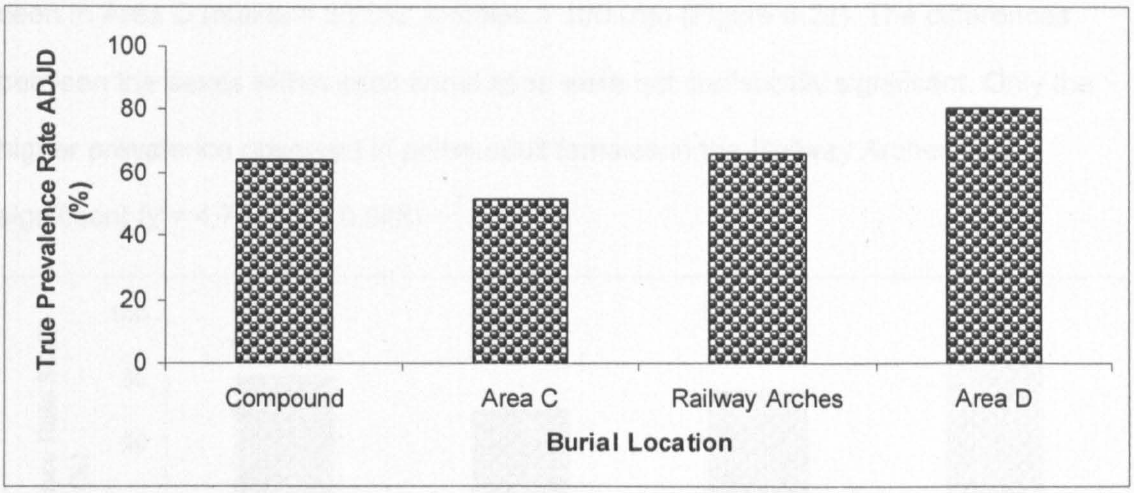


Figure 6.21 *True prevalence of appendicular degenerative joint disease for each burial location within the Black Gate cemetery (n= 387 graves for which information is available; 114 Compound; 66 Area C; 197 Railway Arches; 10 Area D)*

There was no statistically significant difference in the prevalence of ADJD observed between the four burial areas (Figure 6.21). The pattern of true prevalence rates for ADJD within the four burial zones was identical to that observed in Figure 6.19 for DJD, with a statistical difference between Area C and the Railway Arches ($\chi^2$= 4.413; P = 0.036), but not between Area C and Area D, which actually exhibited a greater difference in the percentage of cases of ADJD.

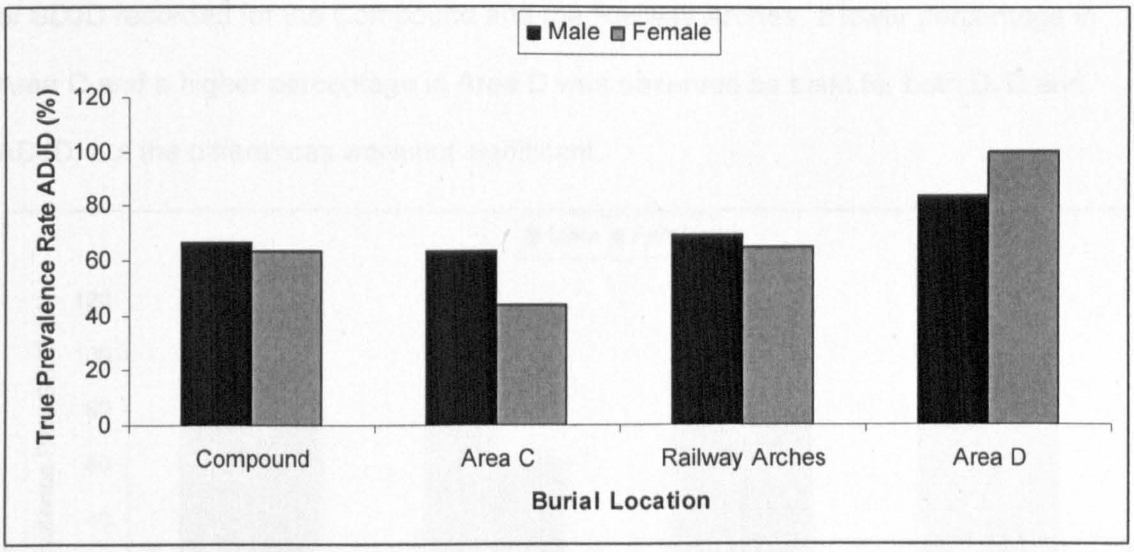


Figure 6.22 *True prevalence of appendicular degenerative joint disease for the males and females within each burial location within the Black Gate cemetery (n = 311 adults of known sex and burial location)*

A greater percentage of males relative to females expressed ADJD in the Compound (males = 66.7%; females = 63.5%), Area C (males = 63.6%; females = 43.8%) and the Railway Arches (males = 69.2%; females = 64.6%) (Figure 6.21). The reverse was seen in Area D (males = 83.3%; females = 100.0%) (Figure 6.22). The differences between the sexes within each burial zone were not statistically significant. Only the higher prevalence observed in prime adult females in the Railway Arches was significant ($\chi^2$= 4.744; P = 0.048).

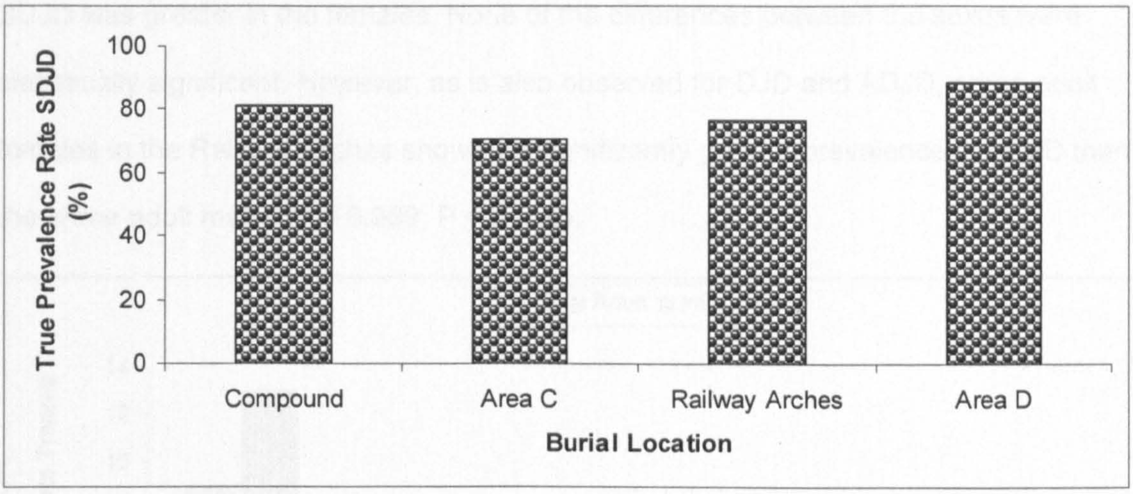


Figure 6.23 *True prevalence of spinal degenerative joint disease for each burial location within the Black Gate cemetery (n= 310 graves for which information is available; 92 Compound; 51 Area C; 158 Railway Arches; 9 Area D)*

There was no statistically significant difference in the prevalence of SDJD observed between the four burial zones (Figure 6.23). The same overall pattern of similar levels of SDJD recorded for the Compound and the Railway Arches, a lower percentage in Area C and a higher percentage in Area D was observed as seen for both DJD and ADJD, but the differences were not significant.

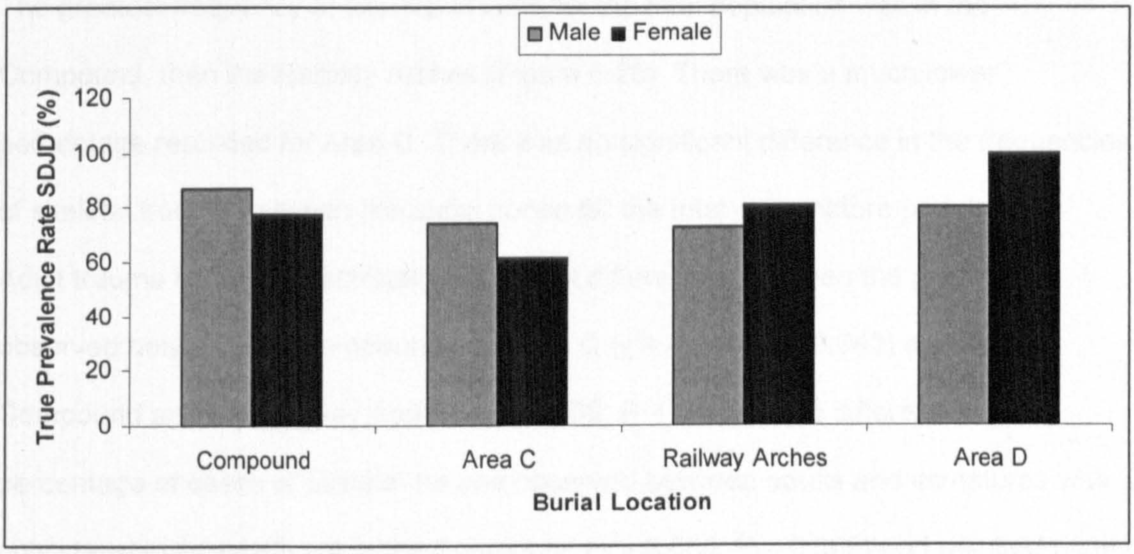


Figure 6.24 *True prevalence of spinal degenerative joint disease for the males and females within each burial location within the Black Gate cemetery (n = 260 adults of known sex and burial location)*

As with appendicular degeneration, there was a greater prevalence of SDJD in the males interred in the Compound (males = 86.8%; females = 77.5%) and Area C (males = 74.1%; females = 61.5%) (Figure 6.24). In the Railway Arches (males = 73.1%; females = 80.6%) and Area D (males = 80.0%; females = 100.0%) the presence of SDJD was greater in the females. None of the differences between the sexes were statistically significant. However, as is also observed for DJD and ADJD, prime adult females in the Railway Arches showed a significantly greater prevalence of SDJD than the prime adult males ($\chi^2$= 6.969; P = 0.010).

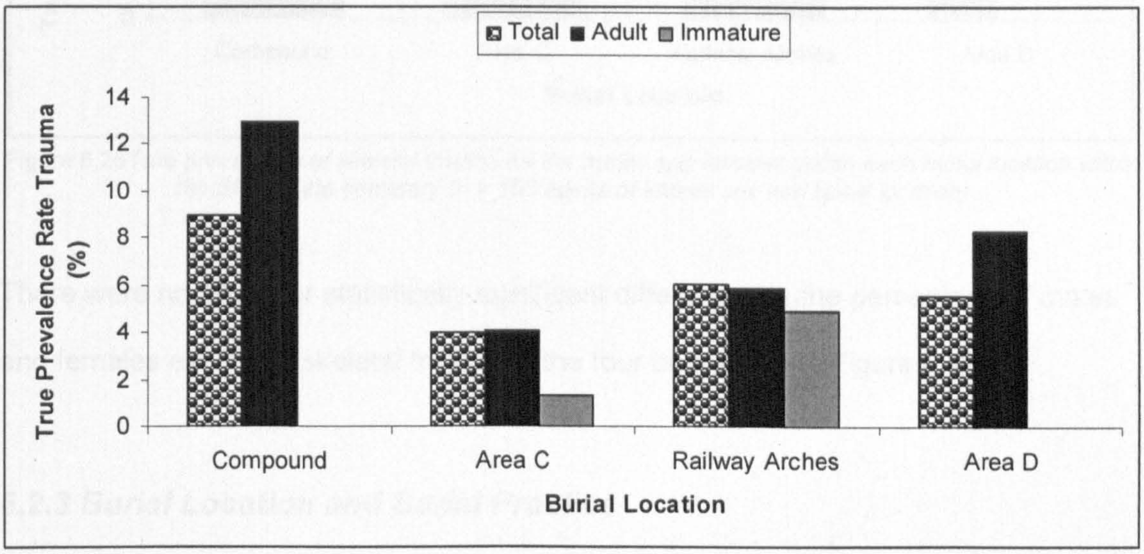


Figure 6.25 *True prevalence of trauma for total, adult and immature populations within each burial location within the Black Gate cemetery (n= 628 graves for which information is available; 179 Compound; 149 Area C; 282 Railway Arches; 18 Area D)*

The greatest frequency of skeletal trauma for the total population was in the Compound, then the Railway Arches (Figure 6.25). There was a much lower percentage recorded for Area C. There was no significant difference in the frequencies of skeletal trauma between the burial zones for the total or immature populations. Adult trauma revealed statistically significant differences between the prevalence observed between the Compound and Area C ($\chi^2$= 4.144; P = 0.042) and the Compound and the Railway Arches ($\chi^2$= 5.198; P = 0.023). The difference in the percentage of cases of skeletal trauma observed between adults and immatures was only statistically significant in the Compound ($\chi^2$= 8.000; P = 0.005) and resulted purely from the high percentage of adult cases (13.0%) in contrast to the total absence of immature trauma.

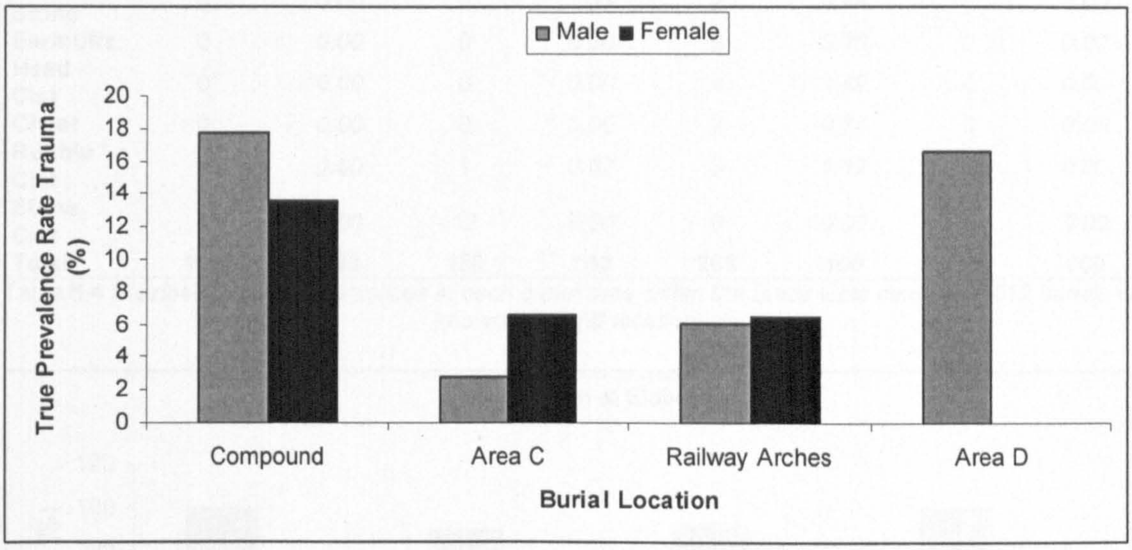


Figure 6.26 *True prevalence of skeletal trauma for the males and females within each burial location within the Black Gate cemetery (n = 160 adults of known sex and burial location)*

There were no trends or statistically significant differences in the percentage of males and females exhibiting skeletal trauma in the four burial zones (Figure 6.26).

### *6.2.3 Burial Location and Burial Practice*

The summary statistics and statistical analysis of the relationship between burial location and burial practice within the Black Gate assemblage are recorded in Appendix C: Tables C.69 to C.71. Burial location and burial practice were recordable for 612 individuals. Table 6.4 shows the frequency and percentage of each burial type within each burial area. Burial location and grave type (chest, rubble cist, and stone cist) were recordable for 26 burials. Burial location and grave variation (pillow stone, earmuffs, and head cist) were recordable for 17 burials.

| | Compound | | Area C | | Railway Arch | | Area D | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| **Plain** | 125 | *71.43* | 120 | *80.00* | 234 | *86.99* | 17 | *94.44* |
| **Coffin** | 50 | *28.57* | 15 | *10.00* | 15 | *5.58* | 1 | *5.56* |
| **Pillow Stone** | 0 | *0.00* | 2 | *1.33* | 2 | *0.74* | 0 | *0.00* |
| **Earmuffs** | 0 | *0.00* | 0 | *0.00* | 9 | *3.35* | 0 | *0.00* |
| **Head Cist** | 0 | *0.00* | 0 | *0.00* | 4 | *1.49* | 0 | *0.00* |
| **Chest** | 0 | *0.00* | 0 | *0.00* | 2 | *0.74* | 0 | *0.00* |
| **Rubble Cist** | 0 | *0.00* | 1 | *0.67* | 3 | *1.12* | 0 | *0.00* |
| **Stone Cist** | 0 | *0.00* | 12 | *8.00* | 0 | *0.00* | 0 | *0.00* |
| **Total** | **175** | ***100*** | **150** | ***100*** | **269** | ***100*** | **18** | ***100*** |

Table 6.4 *Distribution of burial practices in each burial area within the Black Gate cemetery (612 burials of known type and location)*

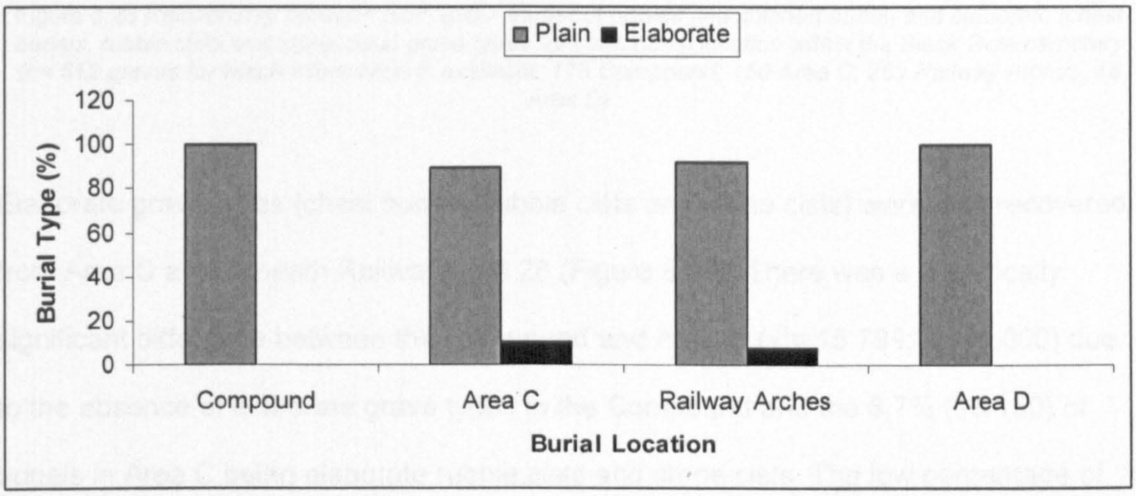


Figure 6.27 *Relationship between plain (plain earth-cut graves and coffined burial) and elaborate (pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists) burial types for each burial location within the Black Gate cemetery (n= 612 graves for which information is available; 175 Compound; 150 Area C; 269 Railway Arches; 18 Area D)*

Elaborate burial types (pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists) were only recovered from Area C and beneath Railway Arches 28 and 29 (Figure 6.27). There was a statistically significant lower frequency of elaborate burial types in the Compound relative to Area C ($\chi^2$= 18.347; P = 0.000) and the Railway Arches ($\chi^2$= 13.625; P = 0.000).

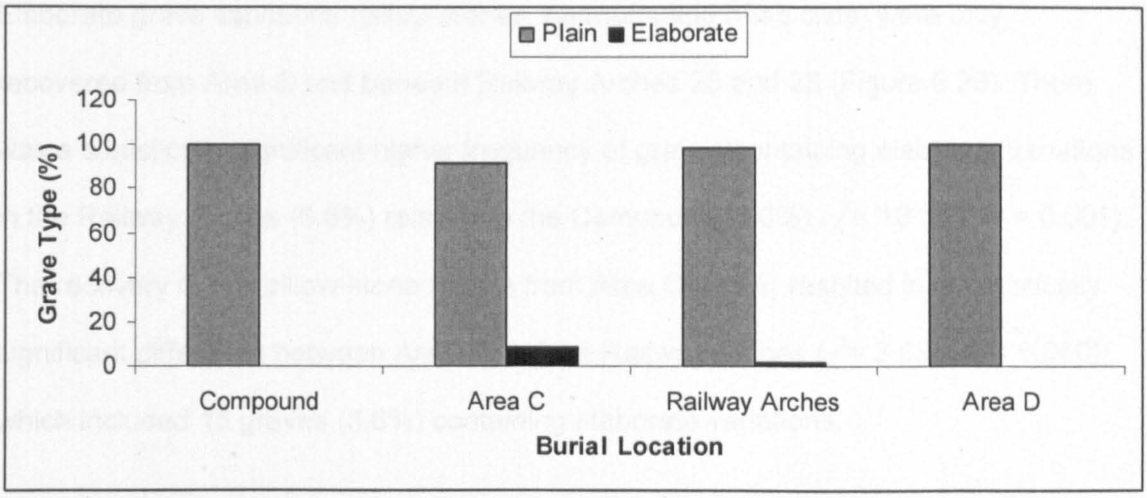


Figure 6.28 *Relationship between plain (plain earth-cut graves and coffined burial) and elaborate (chest burials, rubble cists and stone cists) grave types for each burial location within the Black Gate cemetery (n= 612 graves for which information is available; 175 Compound; 150 Area C; 269 Railway Arches; 18 Area D)*

Elaborate grave types (chest burials, rubble cists and stone cists) were only recovered from Area C and beneath Railway Arch 28 (Figure 6.28). There was a statistically significant difference between the Compound and Area C ($\chi^2$= 15.799; P = 0.000) due to the absence of elaborate grave types in the Compound and the 8.7% (13/150) of burials in Area C being elaborate rubble cists and stone cists. The low percentage of elaborate burials observed in the Railway Arches (1.9%; 5/269) resulted in a statistically significant difference between Area C and the Railway Arches ($\chi^2$= 10.856; P = 0.001).

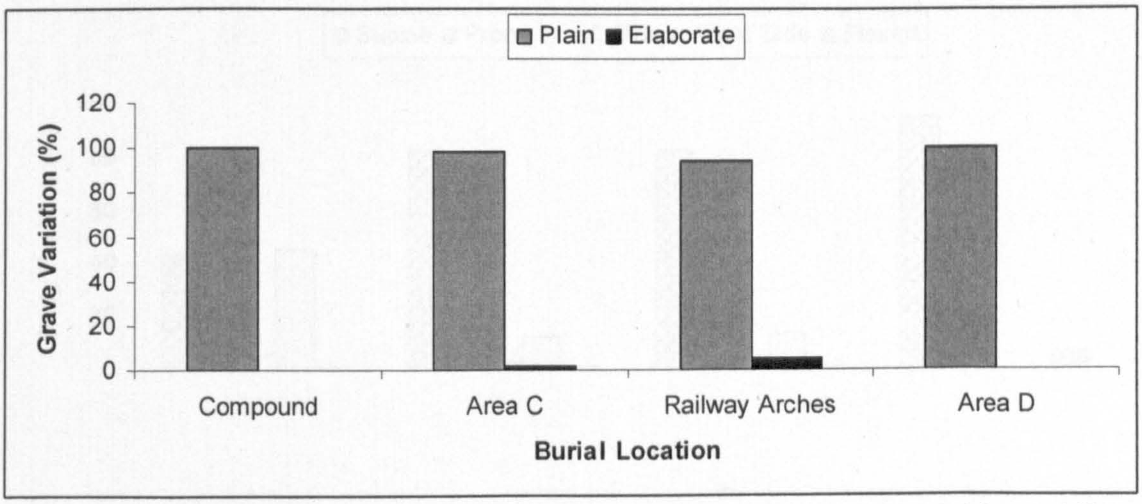


Figure 6.29 *Relationship between plain (plain earth-cut graves and coffined burial) and elaborate (pillow stones, earmuffs, head cists) grave variations for each burial area within the Black Gate cemetery (n= 599 graves for which information is available; 175 Compound; 137 Area C; 269 Railway Arches; 18 Area D)*

Elaborate grave variations (pillow stones, earmuffs and head cists) were only recovered from Area C and beneath Railway Arches 28 and 29 (Figure 6.29). There was a statistically significant higher frequency of graves containing elaborate variations in the Railway Arches (5.6%) relative to the Compound (0.0%) ($\chi^2$= 10.100; P = 0.001). The recovery of two pillow-stone burials from Area C (1.5%) resulted in a statistically significant difference between Area C and the Railway Arches ($\chi^2$= 3.834; P = 0.050), which included 15 graves (5.6%) containing elaborate variations.

The low number of elaborate grave types recovered from Area C and low assemblage size for Area D resulted in no statistically significant difference between the percentage of elaborate burial types recovered from the Compound and Area C, or Area D and any of the other burial areas.

### 6.2.4 Burial Location and Body Position

The summary statistics and statistical analysis of the relationship between burial location and body position within the Black Gate assemblage are recorded in Appendix C: Tables C.72 to C.74. Burial location and body position were recordable for 609 individuals.

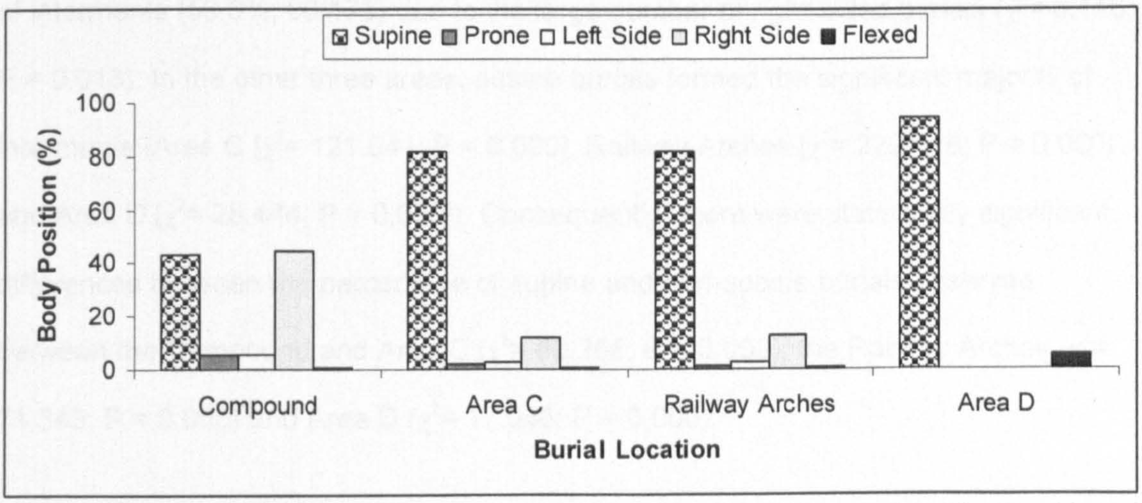


Figure 6.30 Relationship between burial location and burial position (supine, prone, left side, right side and flexed) within the Black Gate cemetery (n= 609 graves for which information is available).

The majority of burials in Area C, the Railway Arches and Area D were supine interments (Figure 6.30), as would be expected for a later Anglo-Saxon cemetery. However, in the Compound there was a slight majority of right-sided interments (44.5%; 77/173) over the supine burials (43.4%; 75/173).The Compound, Area C and the Railway Arches exhibited all five body positions. Only very small numbers of prone, left-side and flexed burials were recovered from these burial locations. Area D only contained supine and flexed burials.

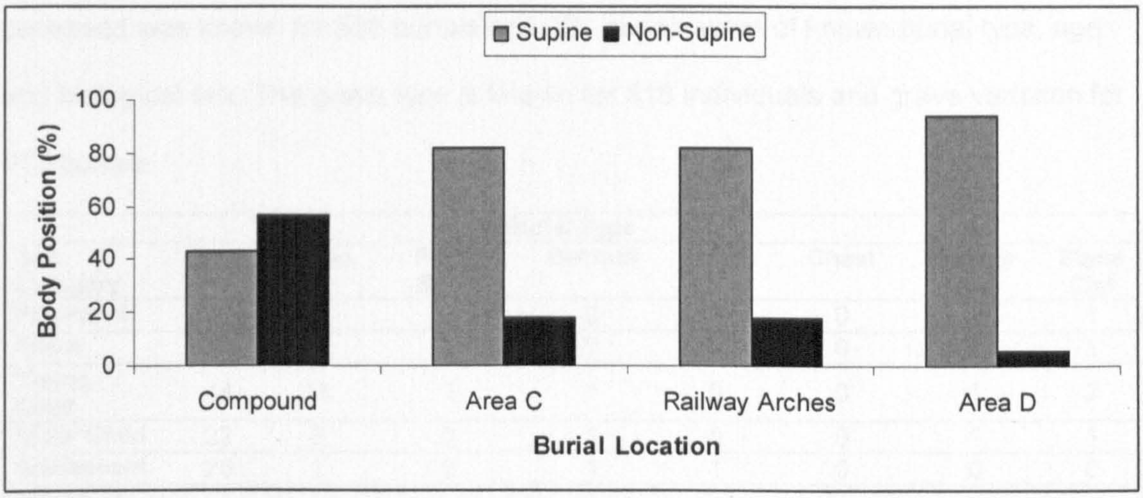


Figure 6.31 *Relationship between burial location and burial position (supine vs. non-supine) within the Black Gate cemetery (n= 609 graves for which information is available)*

Figure 6.31 shows the relationships between supine and non-supine burials recovered from each of the burial areas. In the Compound, non-supine burials formed the majority of interments (56.6%; 98/173) due to the large number of right-sided burials ($\chi^2$= 6.116; P = 0.013). In the other three areas, supine burials formed the significant majority of interments (Area C [$\chi^2$= 121.041; P = 0.000], Railway Arches [$\chi^2$= 222.618; P = 0.000] and Area D [$\chi^2$= 28.444; P = 0.000]). Consequently, there were statistically significant differences between the percentage of supine and non-supine burials observed between the Compound and Area C ($\chi^2$= 50.266; P = 0.000), the Railway Arches ($\chi^2$= 71.343; P = 0.000) and Area D ($\chi^2$= 17.046; P = 0.000).

## 6.3 Burial Practice

### *6.3.1 Burial Practice and Demography*

The summary statistics and statistical analysis of the relationship between burial practice and the age and sex of the individual to which that practice is accorded within the Black Gate assemblage are recorded in Appendix C: Tables C.75 to C.92. The frequency of each burial type observed within each of the age categories is shown in Table 6.5. Burial type was recorded for 616 graves. The burial type and age of the deceased was known for 535 burials and 321 burials were of known burial type, age and biological sex. The grave type is known for 518 individuals and grave variation for 517 burials.

| | Burial Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Age Category** | **Plain** | **Coffin** | **Pillow Stone** | **Earmuff** | **Head Cist** | **Chest** | **Rubble Cist** | **Stone Cist** |
| **Pre-Infant** | 17 | 7 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Infant** | 38 | 7 | 1 | 2 | 0 | 0 | 0 | 1 |
| **Young Child** | 44 | 18 | 1 | 1 | 0 | 0 | 1 | 2 |
| **Older Child** | 22 | 5 | 0 | 1 | 0 | 0 | 1 | 1 |
| **Adolescent** | 25 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| **Young Adult** | 29 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Prime Adult** | 71 | 8 | 0 | 2 | 0 | 0 | 1 | 2 |
| **Mature Adult** | 77 | 8 | 0 | 0 | 1 | 0 | 0 | 3 |
| **Senior Adult** | 100 | 19 | 2 | 2 | 2 | 2 | 1 | 1 |
| **Total** | **423** | **77** | **4** | **9** | **4** | **2** | **4** | **12** |

Table 6.5 *Frequency of each burial practice within each age category within the Black Gate Cemetery (535 individuals of known burial practice and age category)*

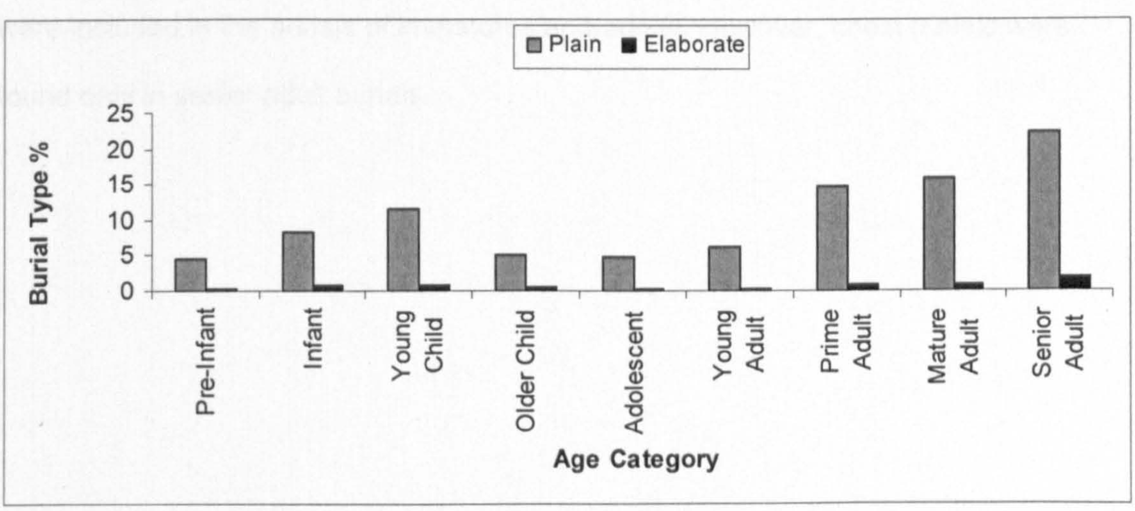


Figure 6.32 Relationship between plain (plain earth-cut graves and coffined burial) and elaborate *(pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists)* burial types for each age category within the Black Gate cemetery (n= 535 graves for which information is available)

There was no statistically significant difference in the provision of elaborate burial types (pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists) for the immatures and adults (Figure 6.32). There was a non-significant increase in the frequency of interments in elaborate burials with advancing age, culminating in the highest percentage of elaborate burials present in the senior adult age category (1.87%; 10/535).

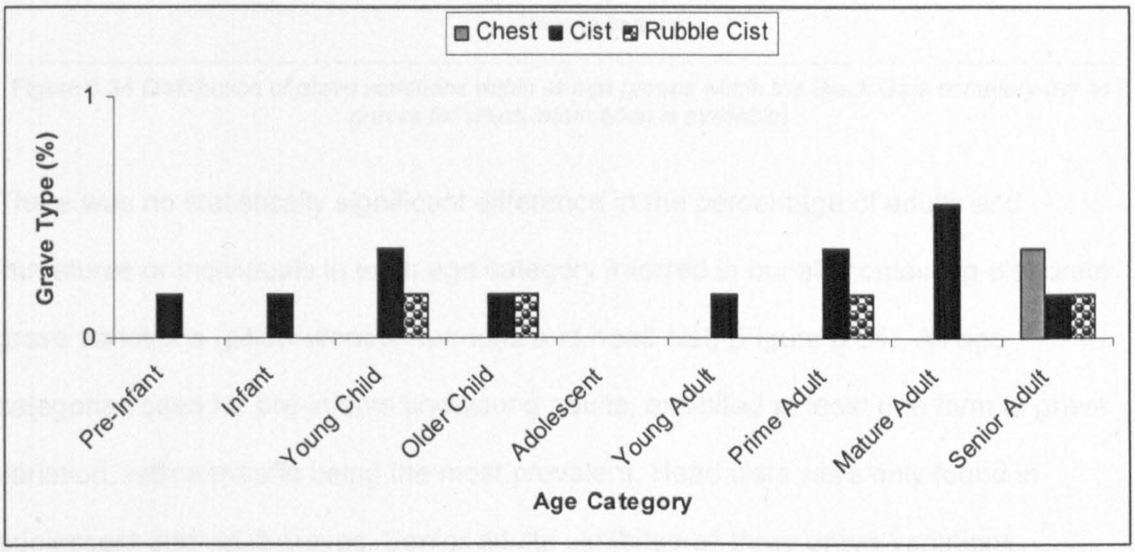


Figure 6.33 *Distribution of grave types within all age groups within the Black Gate cemetery (n= 518 graves for which information is available)*

There was no statistically significant difference in the percentage of immatures or adults interred in elaborate grave types (chest, rubble cist and stone cist) or between individuals from each age category (Figure 6.33). Both stone cists and rubble cists were included in the burials of immatures and adults. However, chest burials were found only in senior adult burials.

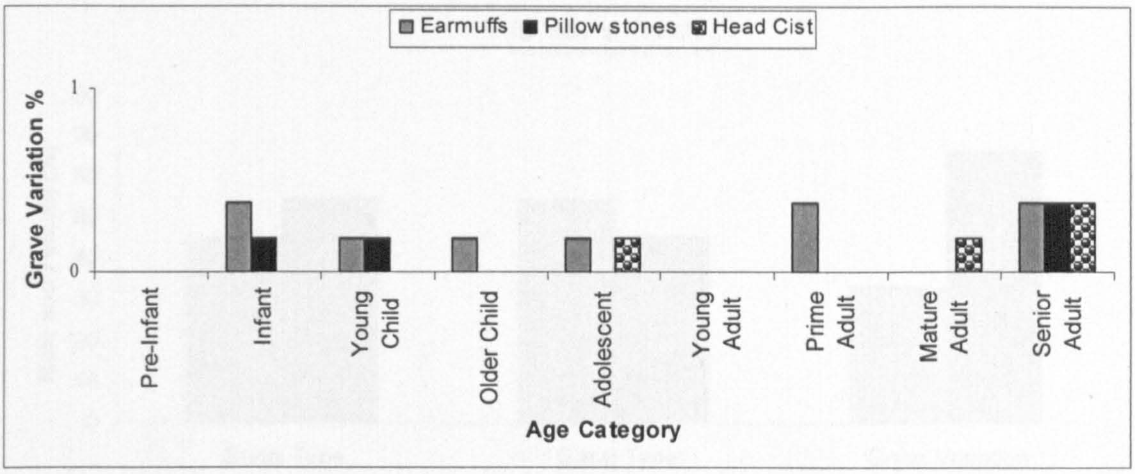


Figure 6.34 *Distribution of grave variations within all age groups within the Black Gate cemetery (n= 517 graves for which information is available)*

There was no statistically significant difference in the percentage of adults and immatures or individuals in each age category interred in burials containing elaborate grave variations (pillow stones, earmuffs and head cist) (Figure 6.34). All age categories save for pre-infants and young adults, exhibited at least one form of grave variation, with earmuffs being the most prevalent. Head cists were only found in adolescent and adult graves. Senior adults exhibited all three grave variations. Senior adults exhibited the greatest variety of grave types and variations, and displayed a greater percentage of elaborate grave types. All the elaborate grave types (chest, rubble cist and stone cist) and variations (pillow stones, earmuffs and head cists) were present in senior adult graves. Furthermore, only senior adult females were interred in chest burials. Pre-infants and young adults showed the smallest amount of variability in their burial type and formation. The only elaborate burial type provided for both pre-infants and young adults was stone cists. Interestingly, both the pre-infants and young adults only exhibited a single stone cist burial. All the other burials in these two age categories were either plain or contained evidence of a wooden coffin.

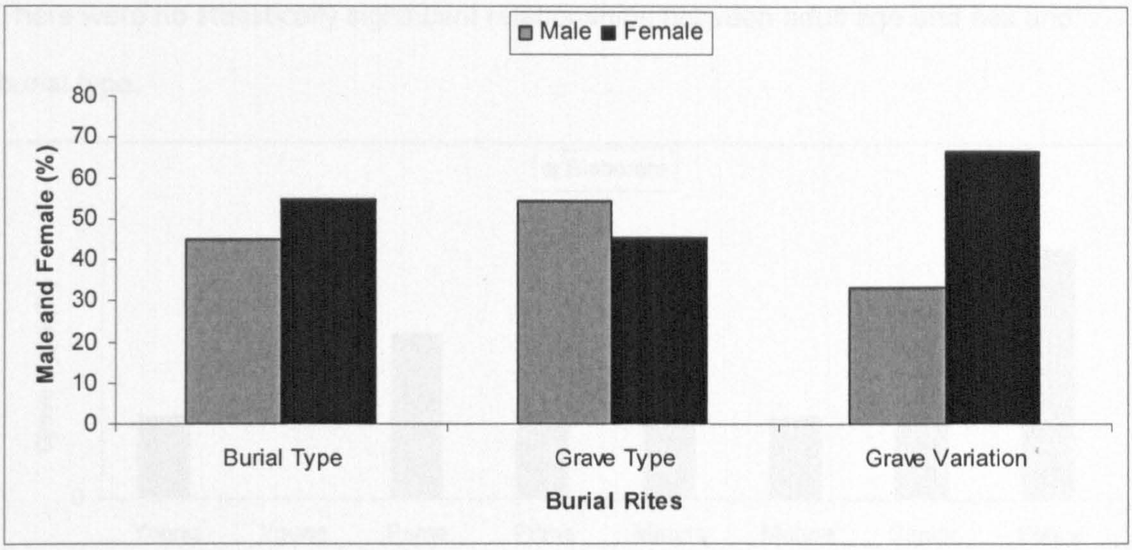


Figure 6.35 The frequency of *burial practices (burial type, grave type and grave variation) accorded to male and female interments (n = 20 interments of adult individuals of known sex exhibiting elaborate burial practices)*

There were no statistically significant differences in the frequency of elaborate burial types, grave types of grave variations between males and females (Figure 6.35).

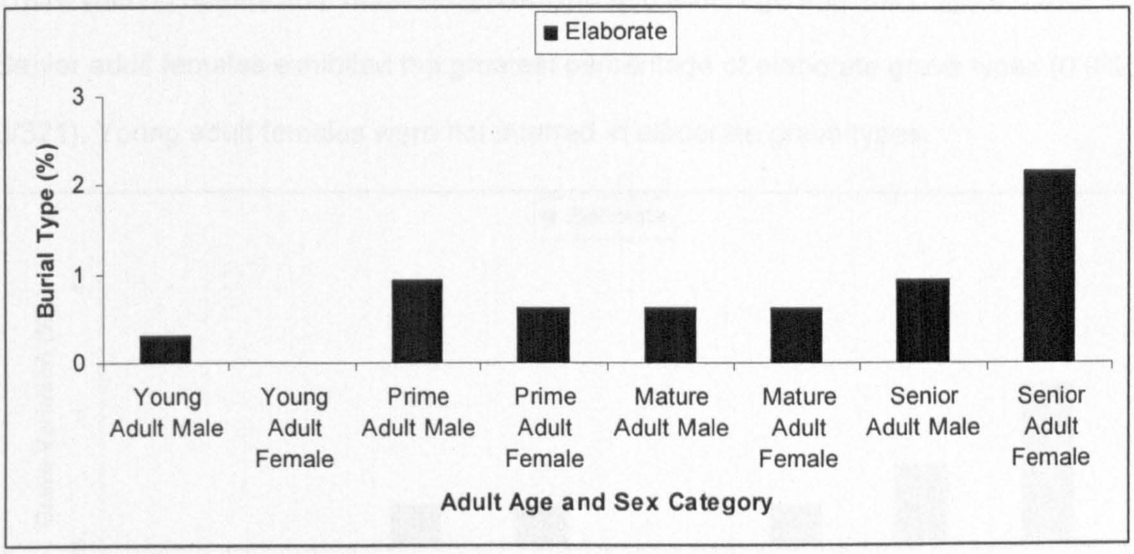


Figure 6.36 *Elaborate burial type (pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists) and adult age and sex categories within the Black Gate cemetery assemblage (n = 321 individuals of known burial type, age and sex)*

Elaborate burial practices were observable in 20 graves of adults of known age and sex. Elaborate grave types were recorded for 11 individuals, while 9 individuals were interred in graves containing elaborate variations (Figure 6.36). The greatest proportion of elaborate burial types (pillow stones, earmuffs, head cists, chest burials, rubble cists and stone cists) was seen amongst senior adult females (2.2%; 7/321). All adult age categories, save for young adult females, exhibited some form of elaborate burial type.

There were no statistically significant relationships between adult age and sex and burial type.

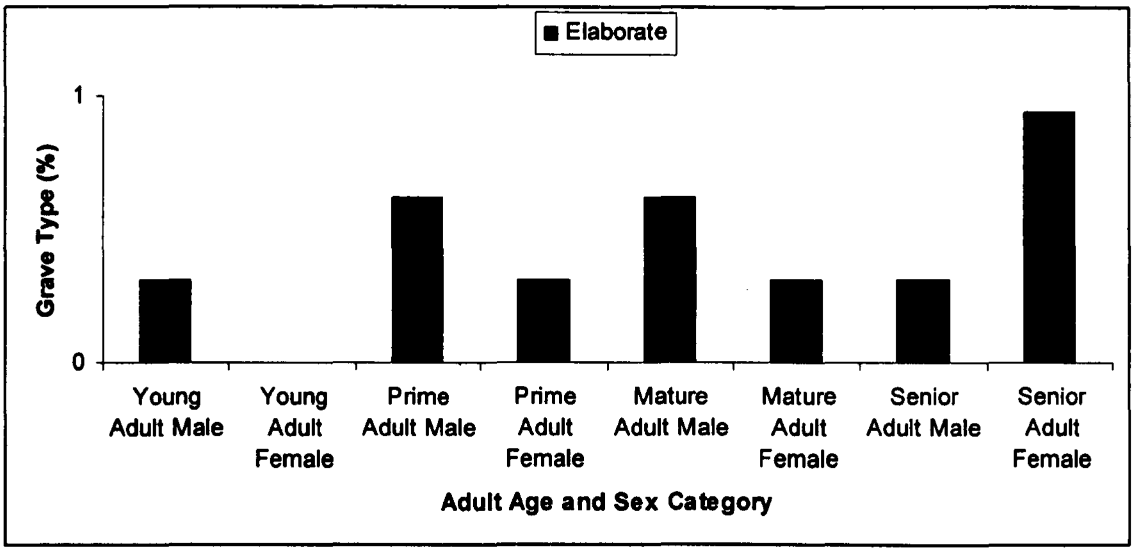


Figure 6.37 *Elaborate grave type (chest burials, rubble cists and stone cists) and adult age and sex categories within the Black Gate cemetery assemblage (n = 321 individuals of known burial type, age and sex)*

There was no relationship between grave type and adult age and sex (Figure 6.37). Senior adult females exhibited the greatest percentage of elaborate grave types (0.9%; 3/321). Young adult females were not interred in elaborate grave types.

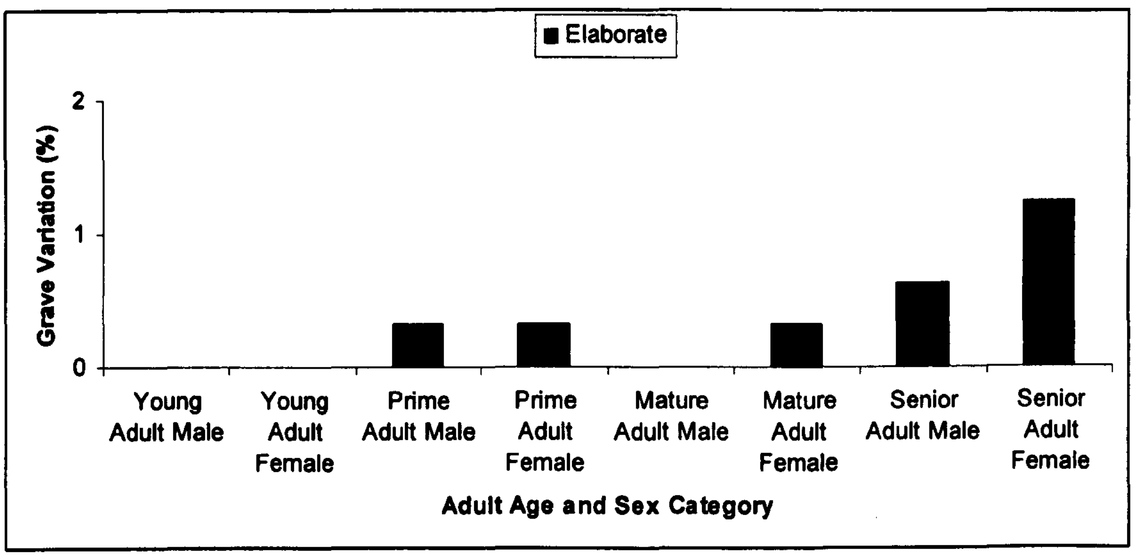


Figure 6.38 *Elaborate grave variation (pillow stones, earmuffs and head cists) and adult age and sex categories within the Black Gate cemetery assemblage (n = 321 individuals of known burial type, age and sex)*

There were no relationships between grave variation and adult age and sex (Figure 6.38). Senior adult females exhibited the greatest frequencies of elaborate grave variations (1.2%; 4/321). No elaborate grave variations were recovered from the graves of young adult females and males, or mature adult males.

### *6.3.2 Burial Practice and Palaeopathology*

#### *6.3.2.1 Indicators of Environmental Stress: Adult Stature*

The summary statistics and statistical analysis of the relationship between burial practice and mean adult stature for males and females within the Black Gate assemblage are recorded in Appendix C: Tables C.93 to C.96. Table 6.6 shows the male and female mean adult stature for plain burials and elaborate burial types, grave types and grave variations. Adult stature and burial type was recordable for 76 males and 73 females.

| Burial Practice | | Sex | *N* | Minimum Stature (cm) | Maximum Stature (cm) | Mean Stature (cm) | Standard Deviation |
|---|---|---|---|---|---|---|---|
| Burial Type | Plain | Male | *70* | 149.71 | 185.17 | 169.58 | 5.98 |
| | | Female | *66* | 148.99 | 181.60 | 161.12 | 5.50 |
| | Elaborate | Male | *6* | 158.04 | 184.22 | 174.14 | 8.82 |
| | | Female | *7* | 156.61 | 178.03 | 163.24 | 6.90 |
| Burial Type (Stone) | Elaborate | Male | *6* | 158.04 | 184.22 | 174.14 | 8.82 |
| | | Female | *6* | 159.47 | 178.03 | 164.35 | 6.84 |
| Grave Type | Elaborate | Male | *4* | 172.08 | 184.22 | 177.20 | 5.08 |
| | | Female | *3* | 156.61 | 162.08 | 159.39 | 2.74 |
| Grave Variation | Elaborate | Male | *2* | 158.04 | 178.03 | 168.03 | 14.14 |
| | | Female | *4* | 161.37 | 178.03 | 166.13 | 8.01 |

Table 6.6 *Male and female stature data for plain and elaborate burial practices (n = 149 individuals of known burial practice and adult stature) (Plain = all plain and coffined burials; Burial Type: Elaborate = pillow stones, earmuffs, head cist, chest, rubble cist and stone cist; Burial Type (Stone): Elaborate = pillow stones, earmuffs, head cist, rubble cist and stone cist); Grave Type: Elaborate = chest, rubble cist and stone cist; Grave Variation: Elaborate = pillow stones, earmuffs and head cist)*

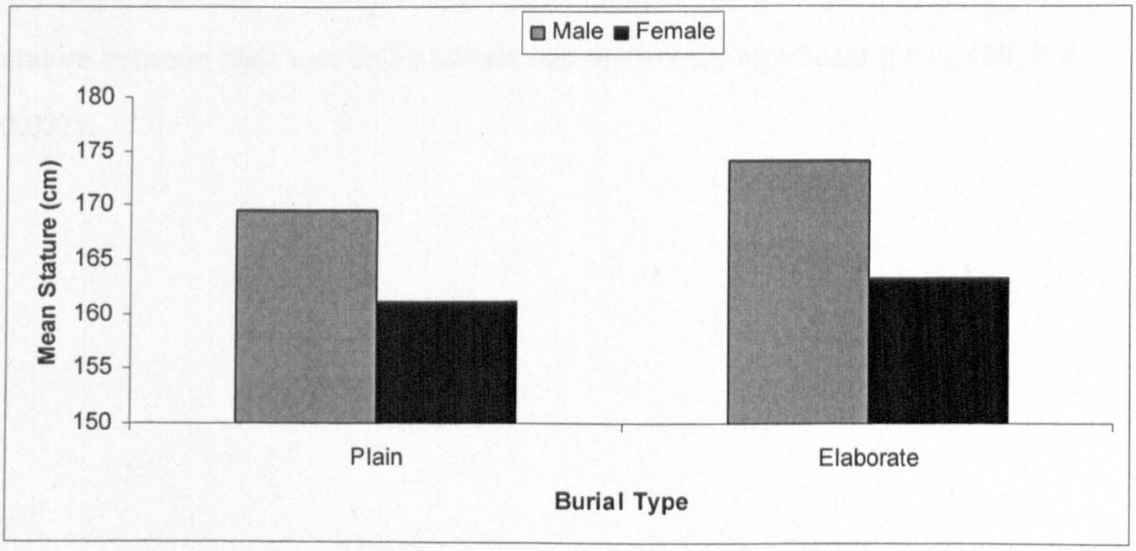


Figure 6.39 *Burial type and mean adult stature for males and females within the Black Gate cemetery assemblage (n = 143 recordable individuals)*

Males interred in elaborate burial types (174.1 cm) were 4.5 cm taller than males interred in plain burials (169.6 cm). Females interred in elaborate burial types (163.2 cm) were 2.1 cm taller than those interred in plain burials (161.1 cm) (Figure 6.39). Even though this shows an interesting trend, the higher mean statures for males and females in elaborate burial types were not statistically significant.

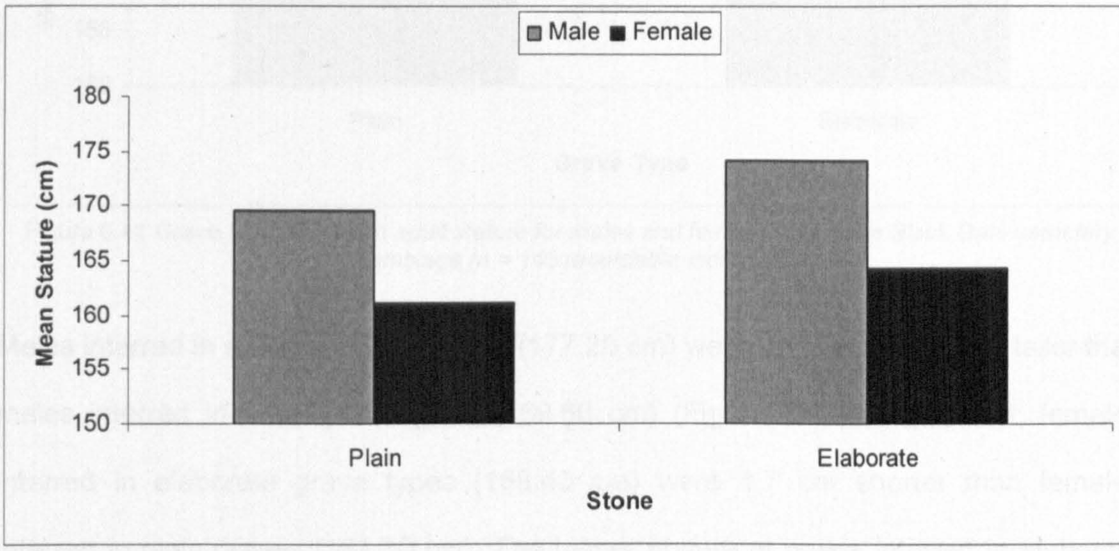


Figure 6.40 *Burial type (plain vs. stone) and mean adult stature for males and females within the Black Gate cemetery assemblage (n = 148 recordable individuals)*

Males interred in elaborate graves, constructed from or containing stone inclusions – but excluding chest burials – were on average 4.5 cm taller than males interred in graves without stone components (169.59 cm) (Figure 6.40). Females interred in graves constructed from, or containing, stone (164.40 cm) were taller than females interred in plain graves (161.10 cm) by an average of 3.3 cm. The difference in female stature between plain and stone burials was statistically significant ($t = -2.489$; $P = 0.037$).

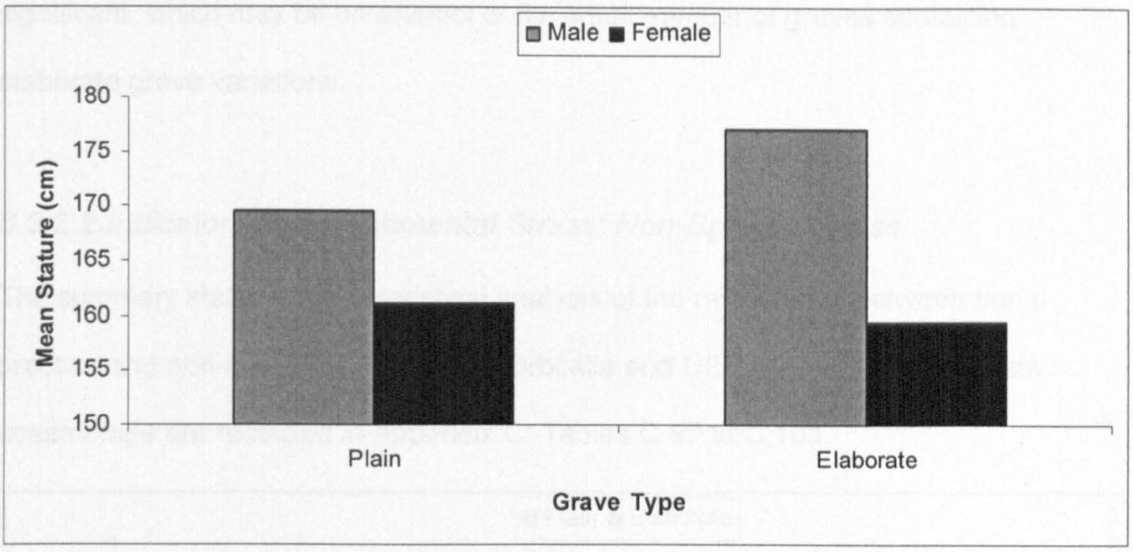


Figure 6.41 *Grave type and mean adult stature for males and females within the Black Gate cemetery assemblage (n = 143 recordable individuals)*

Males interred in elaborate grave types (177.20 cm) were on average 7.6 cm taller than males interred in plain grave types (169.60 cm) (Figure 6.41). In contrast, females interred in elaborate grave types (159.40 cm) were 1.7 cm shorter than females interred in plain graves (161.10 cm). The higher stature of males interred in elaborate grave types was statistically significant ($t = -2.489$; $P = 0.015$).

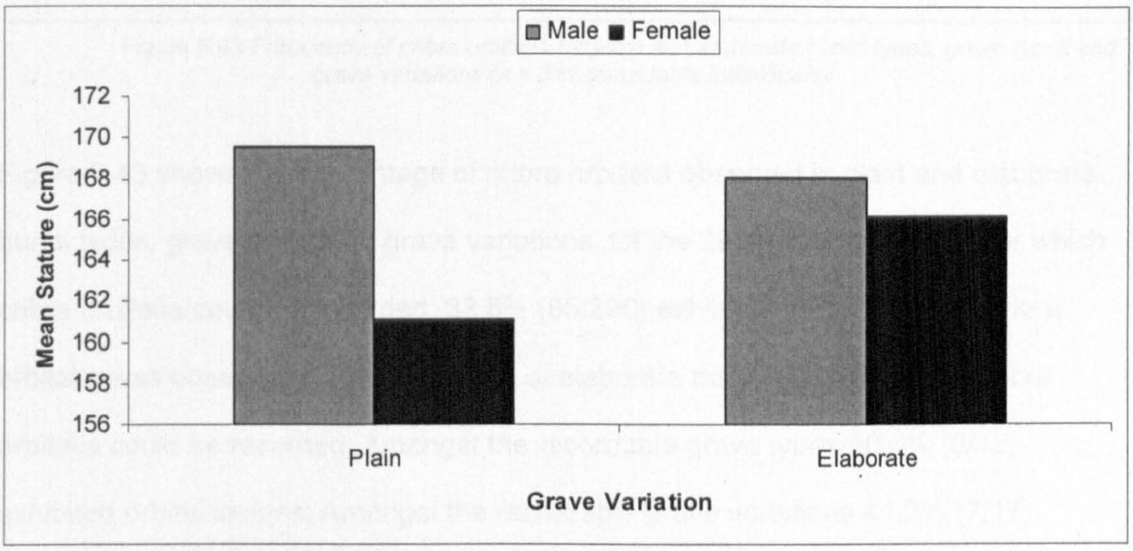


Figure 6.42 *Grave variation and mean adult stature for males and females within the Black Gate cemetery assemblage (n= 142 recordable individuals)*

Males interred with elaborate grave variations (168.0 cm) were on average 1.6 cm shorter than those interred in plain graves (169.60 cm). In contrast, females interred with elaborate grave variations (166.1 cm) were 5.0 cm taller than females interred in plain graves (161.1 cm) (Figure 6.42). These differences were not statistically significant, which may be an artefact of the small number of graves containing elaborate grave variations.

### *6.3.2.2 Indicators of Environmental Stress: Non-Specific Stress*

The summary statistics and statistical analysis of the relationship between burial practice and non-specific stress (cribra orbitalia and DEH) within the Black Gate assemblage are recorded in Appendix C: Tables C.97 to C.103.

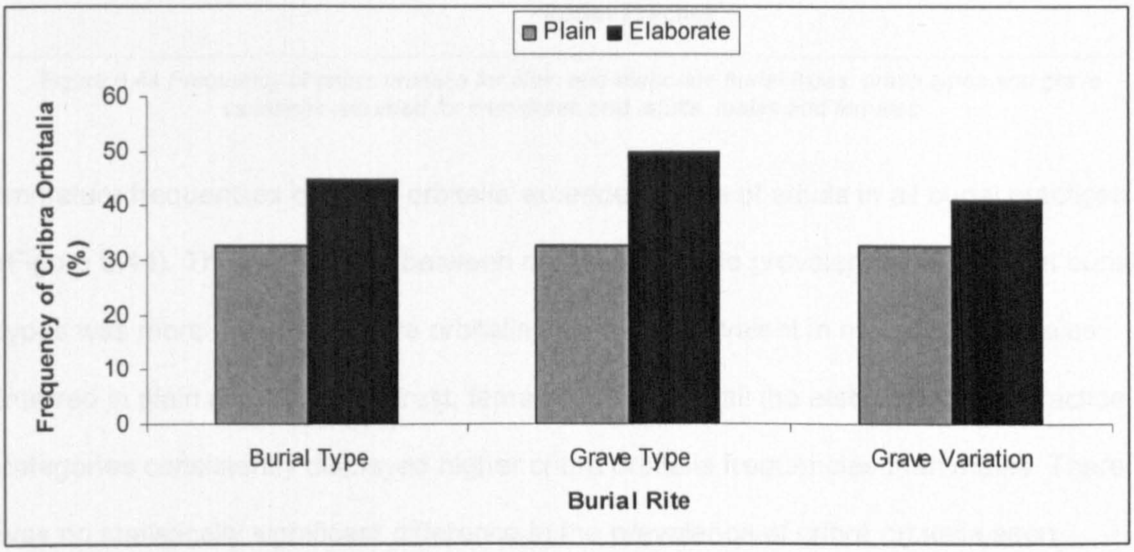


Figure 6.43 *Frequency of cribra orbitalia for plain and elaborate burial types, grave types and grave variations (n = 319 recordable individuals)*

Figure 6.43 shows the percentage of cribra orbitalia observed in plain and elaborate burial types, grave types and grave variations. Of the 290 plain burial types for which cribra orbitalia could be recorded, 32.8% (95/290) exhibited orbital lesions. Cribra orbitalia was observed in 44.8% (13/29) of elaborate burial types for which cribra orbitalia could be recorded. Amongst the recordable grave types 50.0% (6/12) exhibited orbital lesions. Amongst the recordable grave variations 41.2% (7/17) exhibited orbital lesions.

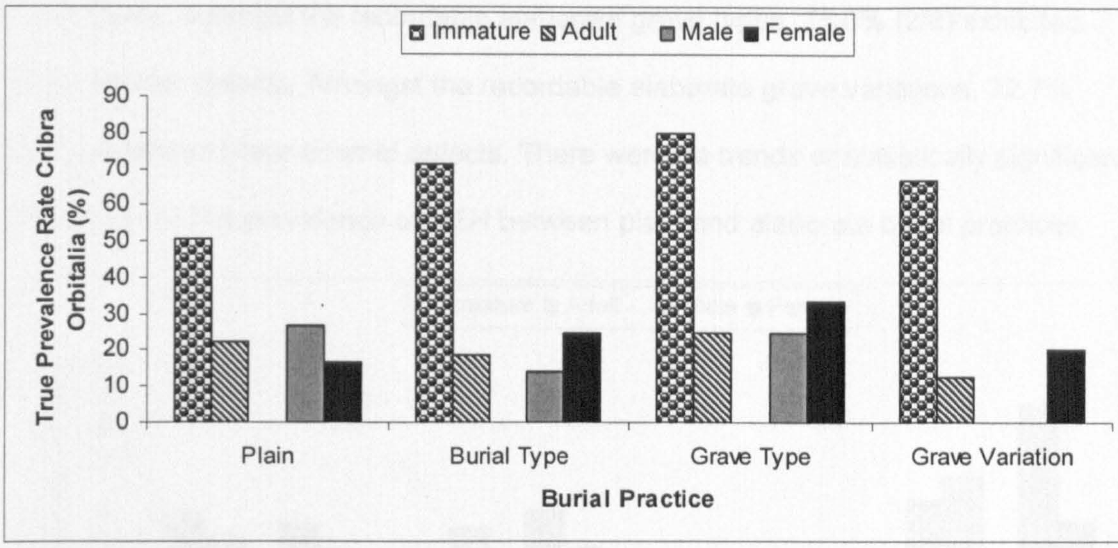


Figure 6.44 *Frequency of cribra orbitalia for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Immature frequencies of cribra orbitalia exceeded those of adults in all burial practices (Figure 6.44). The relationship between male and female prevalences in different burial types was more complex. Cribra orbitalia was more prevalent in males than females interred in plain graves. In contrast, females interred in all the elaborate burial practice categories consistently displayed higher cribra orbitalia frequencies than males. There was no statistically significant difference in the prevalence of cribra orbitalia seen between immatures and adults or males and females in any of the burial practices.

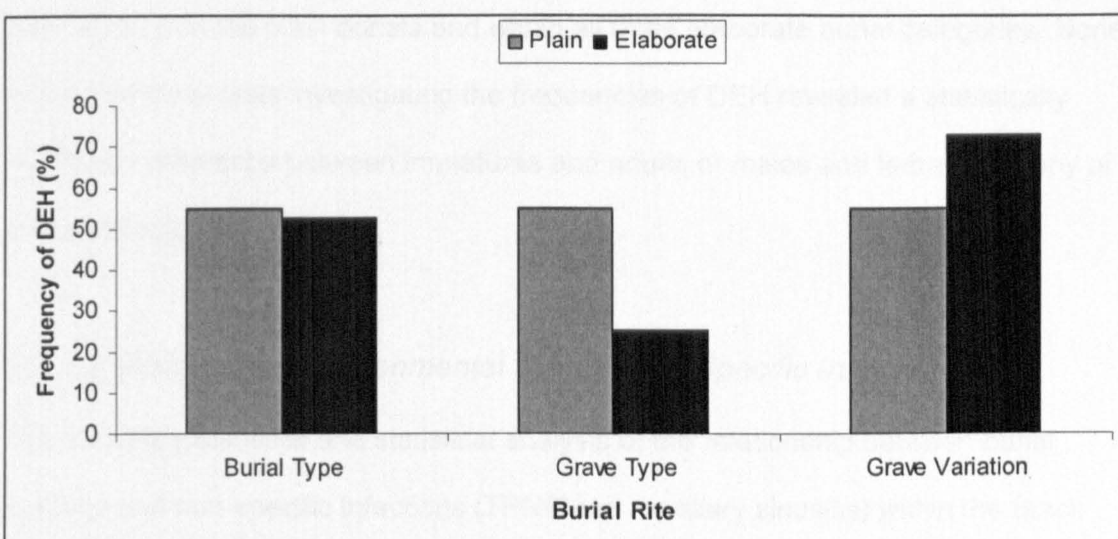


Figure 6.45 *Frequency of dental enamel hypoplasia for plain and elaborate burial types, grave types and grave variations (n = 223 recordable individuals)*

DEH was present in 54.9% (112/204) of the plain burials for which it could be recorded (Figure 6.45). A similar percentage of DEH (52.6%; 10/19) was observed for elaborate burial types. Amongst the recordable elaborate grave types, 25.0% (2/8) exhibited linear enamel defects. Amongst the recordable elaborate grave variations, 72.7% (8/11) exhibited linear enamel defects. There were no trends or statistically significant differences in the prevalence of DEH between plain and elaborate burial practices.

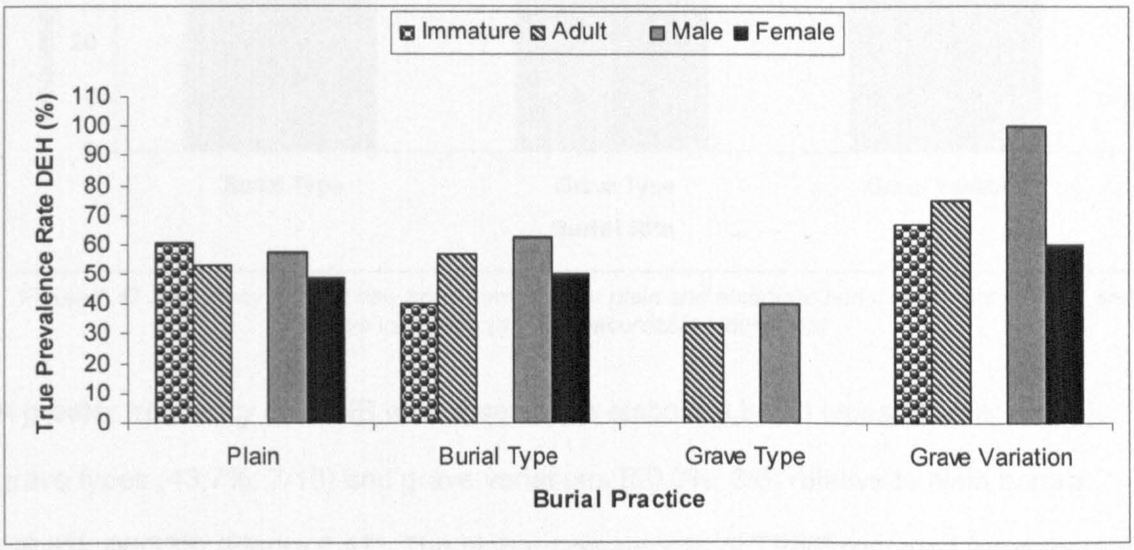


Figure 6.46 *Frequency of dental enamel hypoplasia for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Immature frequencies of DEH were higher than recorded for adults in the plain burials (Figure 6.46). In contrast, adult DEH frequencies exceed those of immatures for all three elaborate burial practice categories. Males exhibited greater frequencies of DEH than females in the plain burials and within all three elaborate burial categories. None of the statistical tests investigating the frequencies of DEH revealed a statistically significant difference between immatures and adults or males and females for any of the burial practices.

### 6.3.2.3 *Indicators of Environmental Stress: Non-Specific Infection*

The summary statistics and statistical analysis of the relationship between burial practice and non-specific infections (TPNB and maxillary sinusitis) within the Black Gate assemblage are recorded in Appendix C: Tables C.104 to C.110.

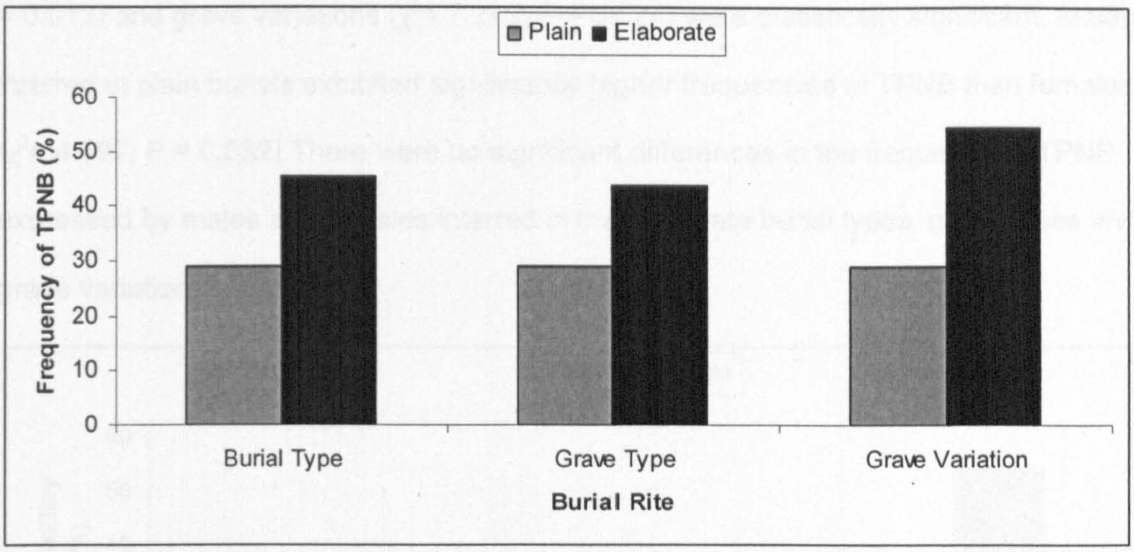


Figure 6.47 *Frequency of tibial new bone formation for plain and elaborate burial types, grave types and grave variations (n = 355 recordable individuals)*

A greater frequency of TPNB was observed in elaborate burial types (45.5%; 10/22), grave types (43.7%; 7/16) and grave variations (50.0%; 3/6) relative to plain burials (28.8%; 96/333) (Figure 6.47). The higher prevalences of TPNB recorded for elaborate burial types, grave types and grave variations were not statistically different from the frequencies observed in the plain burials.

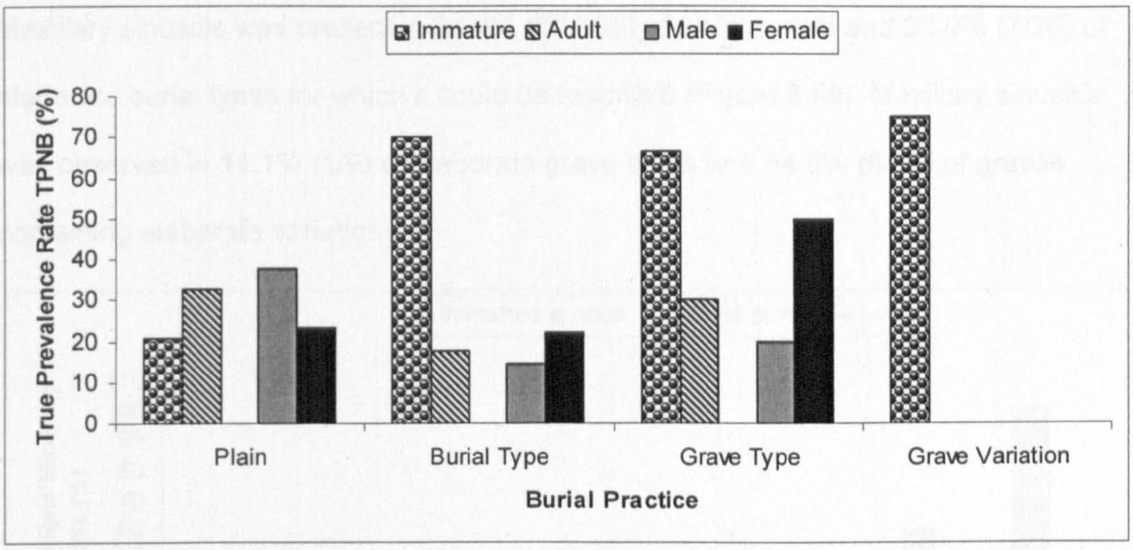


Figure 6.48 *Frequency of tibial periosteal new bone formation for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Immatures exhibited a statistically significant lower frequency of TPNB than adults in plain burials ($\chi^2$= 5.070; P = 0.024) (Figure 6.48). In contrast, immature TPNB exceeded adult frequencies in all of the elaborate burial practice categories. Only the higher prevalence of immatures exhibiting TPNB in elaborate burial types ($\chi^2$= 7.400; P

= 0.013) and grave variations ($\chi^2$= 7.219; P = 0.024) were statistically significant. Males interred in plain burials exhibited significantly higher frequencies of TPNB than females ($\chi^2$= 4.597; P = 0.032).There were no significant differences in the frequency of TPNB expressed by males and females interred in the elaborate burial types, grave types and grave variations.

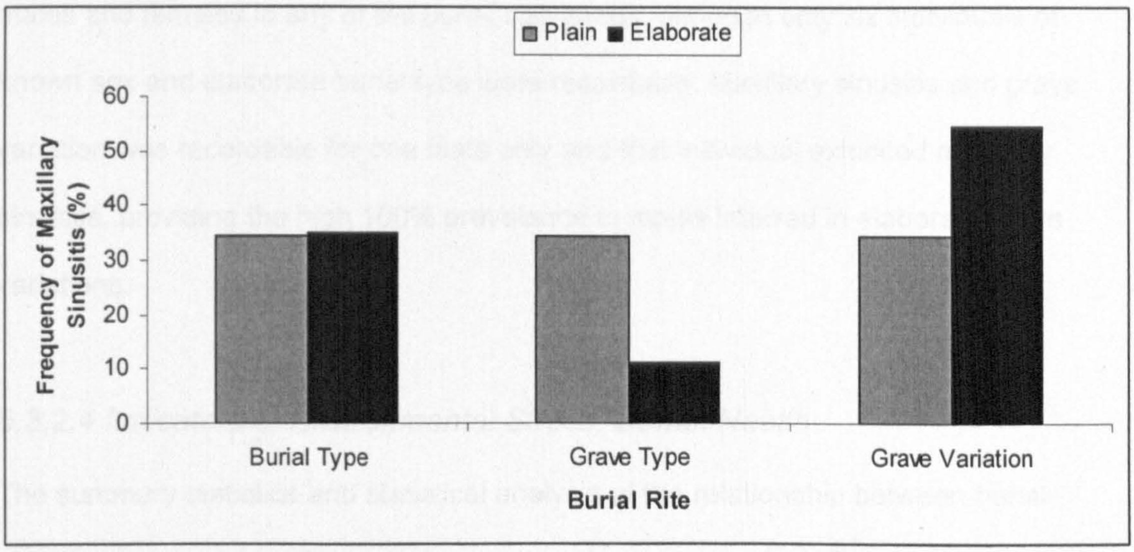


Figure 6.49 *Frequency of maxillary sinusitis for plain and elaborate burial types, grave types and grave variations (n = 235 recordable individuals)*

Maxillary sinusitis was present in 34.4% (67/195) of plain burials and 35.0% (7/20) of elaborate burial types for which it could be recorded (Figure 6.49). Maxillary sinusitis was observed in 11.1% (1/9) of elaborate grave types and 54.5% (6/11) of graves containing elaborate variations.

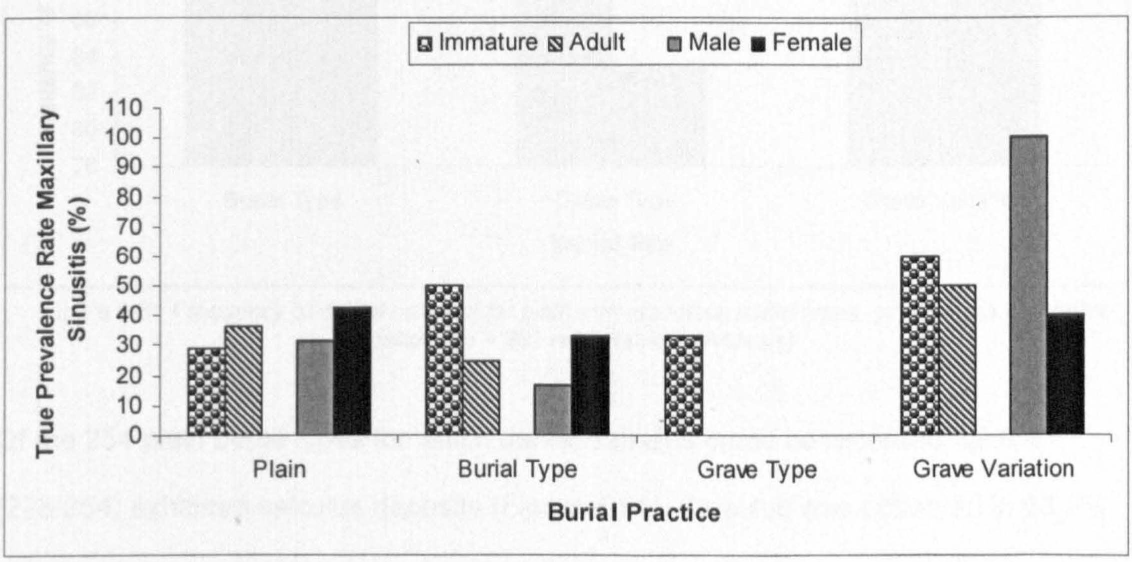


Figure 6.50 *Frequency of maxillary sinusitis for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Immatures displayed lower prevalences of maxillary sinusitis than adults in plain burials (Figure 6.50). The inverse relationship is seen for all the elaborate burial practices. There was no statistically significant difference between the adult and immature prevalences for maxillary sinusitis in either plain or elaborate burials. There were no statistically significant differences in the prevalence of maxillary sinusitis exhibited by males and females in any of the burial categories, although only six individuals of known sex and elaborate burial type were recordable. Maxillary sinusitis and grave variation was recordable for one male only and that individual exhibited maxillary sinusitis, providing the high 100% prevalence in males interred in elaborate grave variations.

### *6.3.2.4 Indicators of Environmental Stress: Dental Health*

The summary statistics and statistical analysis of the relationship between burial practice and dental health (calculus, caries, abscesses and AMTL) within the Black Gate assemblage are recorded in Appendix C: Tables C.111 to C.121.

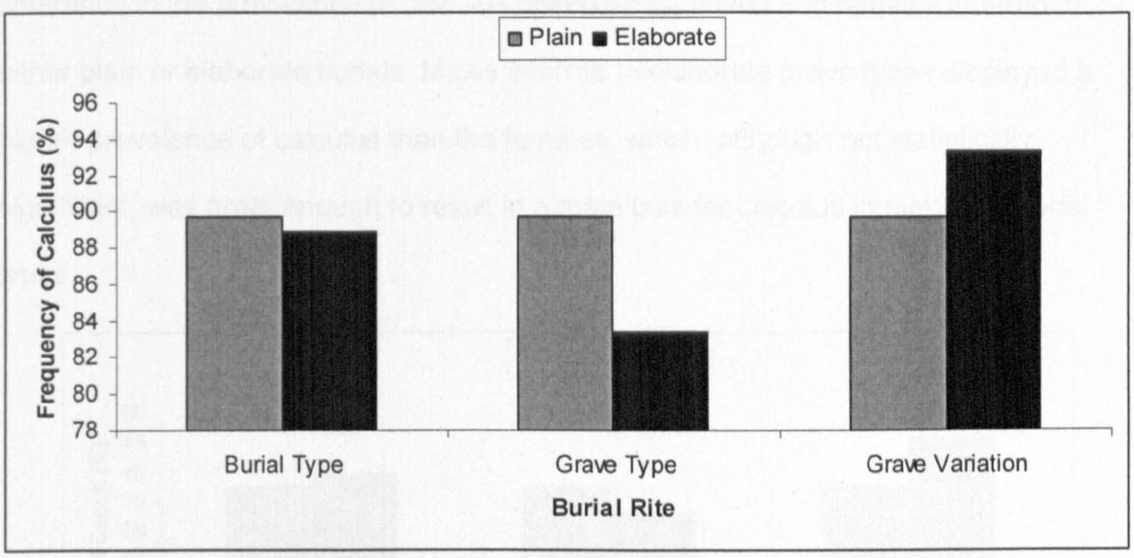


Figure 6.51 *Frequency of dental calculus for plain and elaborate burial types, grave types and grave variations (n = 281 recordable individuals)*

Of the 254 plain burial types for which dental calculus could be recorded, 89.8% (228/254) exhibited calculus deposits (Figure 6.51). Calculus was observed in 88.9% (24/27) of elaborate burial types for which at least one tooth was recordable. Dental calculus was observed in 83.3% (10/12) of recordable elaborate grave types and 93.3% (14/15) of recordable graves containing elaborate variation.

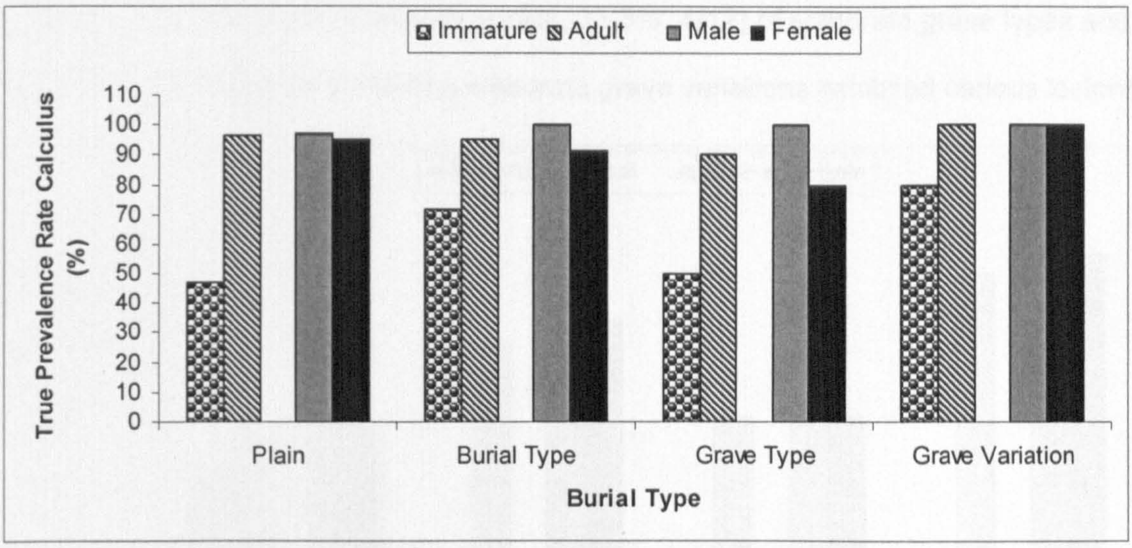


Figure 6.52 *Frequency of dental calculus for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Dental calculus was more prevalent amongst adults than immatures for all burial practices (Figure 6.52). Only the higher adult prevalence observed in the plain burials was statistically significant ($\chi^2$= 76.798; P = 0.000). There was no statistically significant difference in the prevalence of calculus observed for males and females interred in either plain or elaborate burials. Males interred in elaborate grave types displayed a higher prevalence of calculus than the females, which, although not statistically significant, was great enough to result in a male bias for calculus in elaborate burial types.

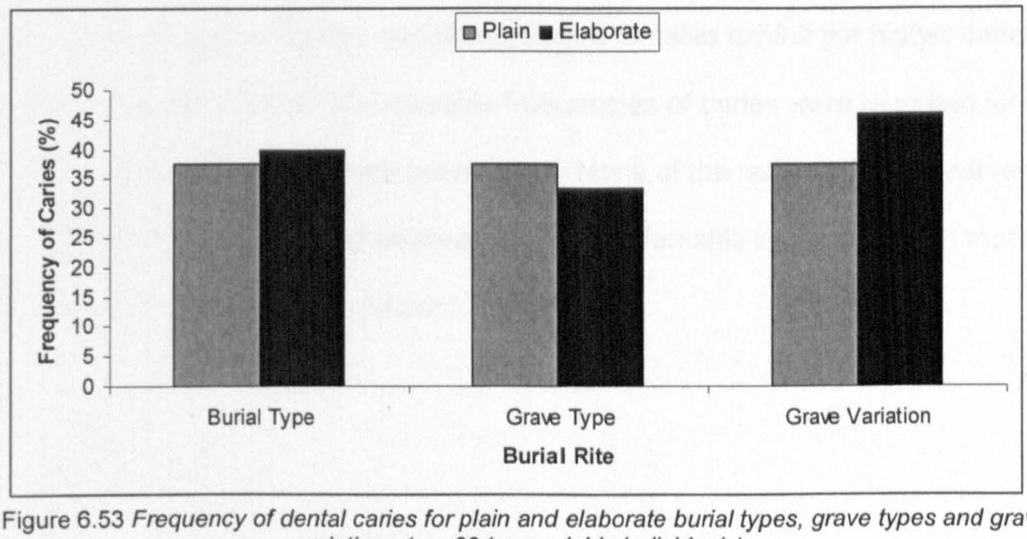


Figure 6.53 *Frequency of dental caries for plain and elaborate burial types, grave types and grave variations (n = 294 recordable individuals)*

Dental caries was present in 37.5% (101/269) of individuals interred in plain burials and 40.0% (10/25) of elaborate burial types within which at least one tooth was recordable (Figure 6.53). Within the elaborate burials, 33.3% (4/12) of elaborate grave types and 46.1% (6/13) of graves containing elaborate grave variations exhibited carious lesions.

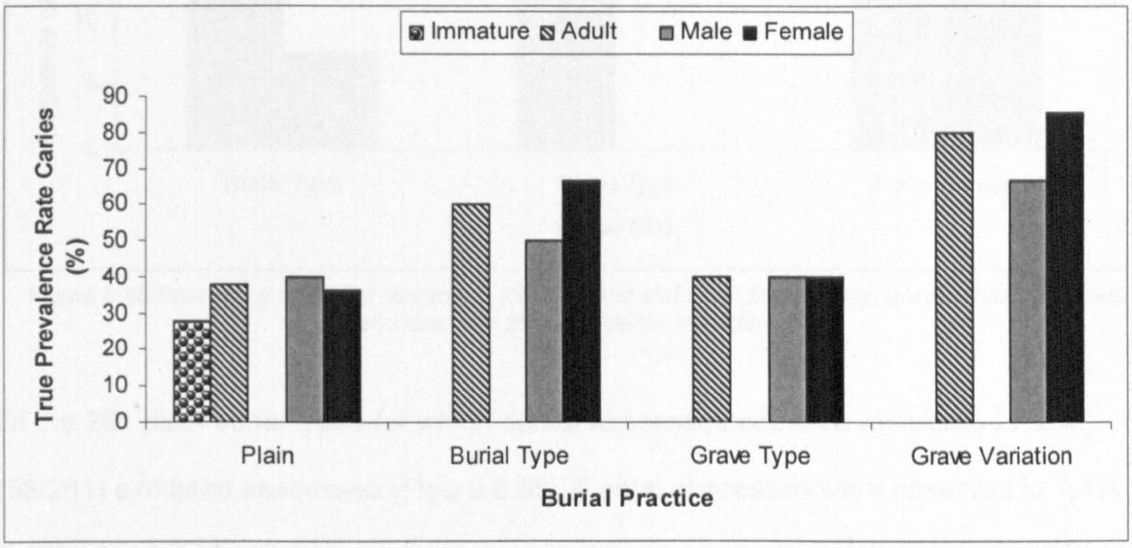


Figure 6.54 *Frequency of dental caries for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Only immatures interred in plain burials exhibited dental caries (Figure 6.54). The absence of dental caries in immatures associated with elaborate burial practices resulted in a statistically significant difference in prevalence between the immatures and adults interred in elaborate burial types ($\chi^2$= 10.000; P = 0.002) and grave variations ($\chi^2$= 8.571; P = 0.003). Males interred in plain burials displayed a higher frequency of dental caries than females. The reverse relationship is seen in all the elaborate burial type and grave variations, where females exhibit the higher caries frequency relative to males. Comparable frequencies of caries were recorded for males and females interred in elaborate grave types. None of the relationships observed for the prevalence of dental caries between males and females associated with mortuary behaviour were statistically significant.

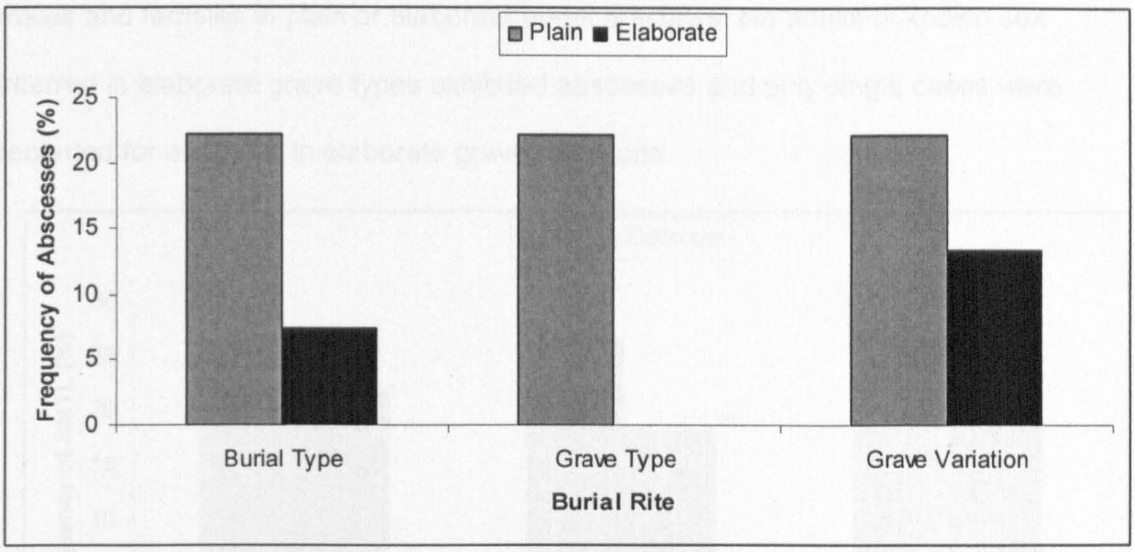


Figure 6.55 *Frequency of dental abscesses for plain and elaborate burial types, grave types and grave variations (n = 288 recordable individuals)*

Of the 261 plain burial types for which dental abscesses could be recorded, 22.2% (58/261) exhibited abscesses (Figure 6.55). Dental abscesses were observed in 7.4% (2/27) of elaborate burial types within which at least one tooth socket was recordable. None of the elaborate grave type burials were affected. Amongst the recordable elaborate grave variations 13.3% (2/15) exhibited abscess lesions.

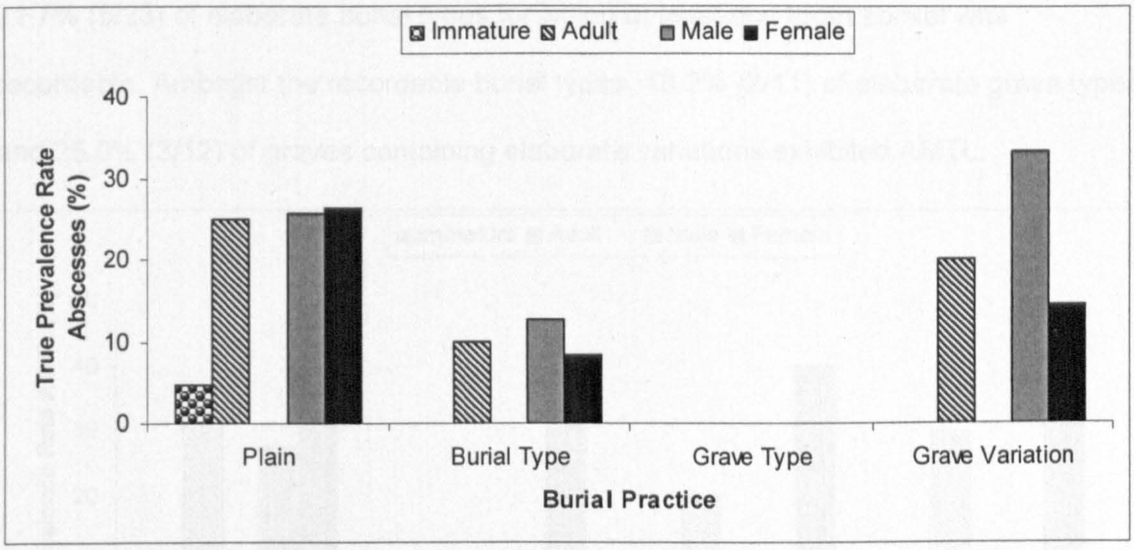


Figure 6.56 *Frequency of dental abscesses for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Only immatures interred in plain burials exhibited dental abscesses (Figure 6.56). Only two immatures (4.8%) exhibited abscesses in the plain burials, which was significantly lower than observed in the adults (24.8%) ($\chi^2$= 8.420; P = 0.004). There were no statistically significant differences in the prevalence of dental abscesses recorded for males and females in plain or elaborate burial practices. No adults of known sex interred in elaborate grave types exhibited abscesses and only single cases were recorded for each sex in elaborate grave variations.

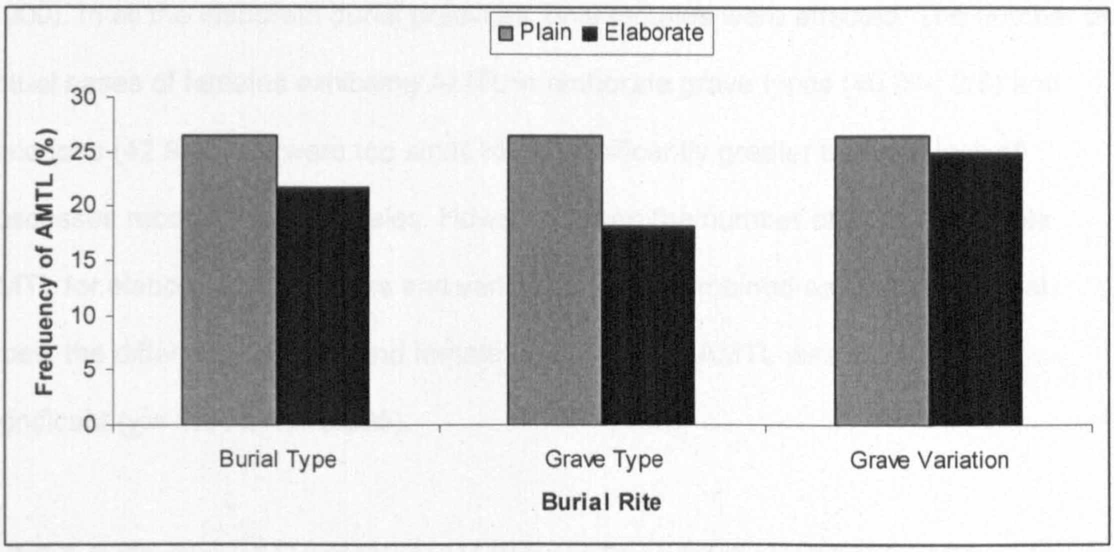


Figure 6.57 *Frequency of ante-mortem tooth loss for plain and elaborate burial types, grave types and grave variations (n = 295 recordable individuals)*

Of the 272 plain burial types for which AMTL could be recorded, 26.5% (72/272) exhibited partially or totally remodelled sockets (Figure 6.57). AMTL was observed in 21.7% (5/23) of elaborate burial types for which at least one tooth socket was recordable. Amongst the recordable burial types, 18.2% (2/11) of elaborate grave types and 25.0% (3/12) of graves containing elaborate variations exhibited AMTL.

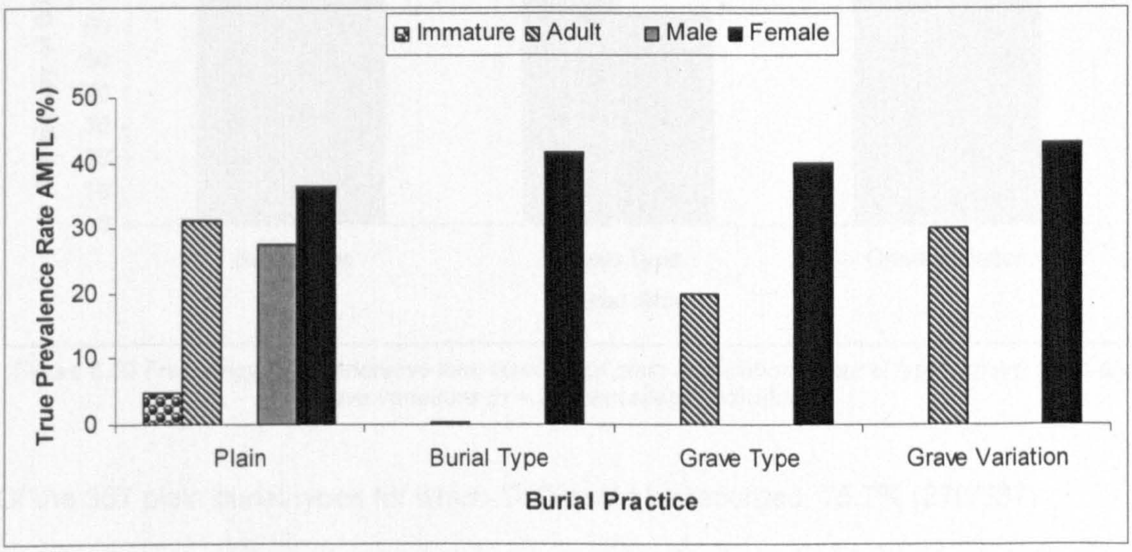


Figure 6.58 *Frequency of ante-mortem tooth loss for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Figure 6.58 shows that only immatures and males interred in plain graves exhibited AMTL. The prevalence of AMTL in the immatures (4.7%) interred in plain graves was so low compared to the adults (31.2%) to be statistically significant ($\chi^2$= 12.926 P = 0.000). In all the elaborate burial practices, only females were affected. The number of actual cases of females exhibiting AMTL in elaborate grave types (40.0%; 2/5) and variations (42.9%; 3/7) were too small to be significantly greater than the lack of abscesses recorded for the males. However, when the number of cases of female AMTL for elaborate grave types and variations were combined as elaborate burial types, the difference in male and female prevalence of AMTL was statistically significant ($\chi^2$= 4.444; P = 0.035).

### *6.3.2.5 Indicators of Environmental Stress: Skeletal Biomechanical Stress*

The summary statistics and statistical analysis of the relationship between burial practice and skeletal biomechanical stress (DJD; ADJD, SDJD and skeletal trauma) within the Black Gate assemblage are recorded in Appendix C: Tables C.122 to C.129.

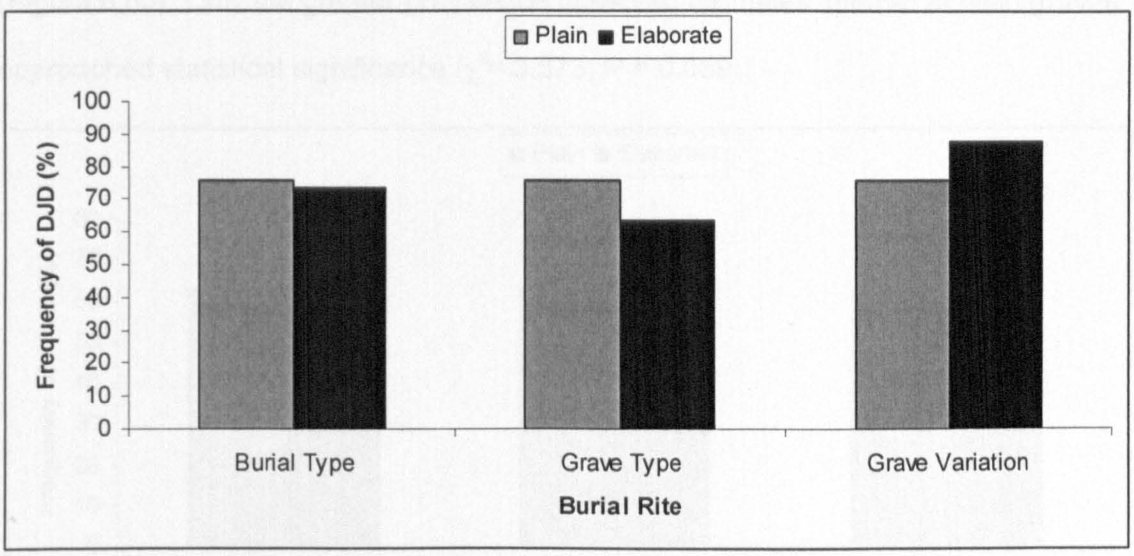


Figure 6.59 *Frequency of degenerative joint disease for plain and elaborate burial types, grave types and grave variations (n = 386 recordable individuals)*

Of the 367 plain burial types for which DJD could be recorded, 75.7% (278/367) exhibited degenerative changes to either appendicular or spinal joint surfaces (Figure 6.59). DJD was observed in 73.7% (14/19) of elaborate burial types possessing at least one recordable joint surface. Amongst the recordable elaborate burial types, 63.6% (7/11) of elaborate grave types and 87.5% (7/8) of graves with elaborate variations exhibited DJD. There was no statistically significant difference in the prevalence of DJD observed between plain burials and any of the elaborate burial practices.

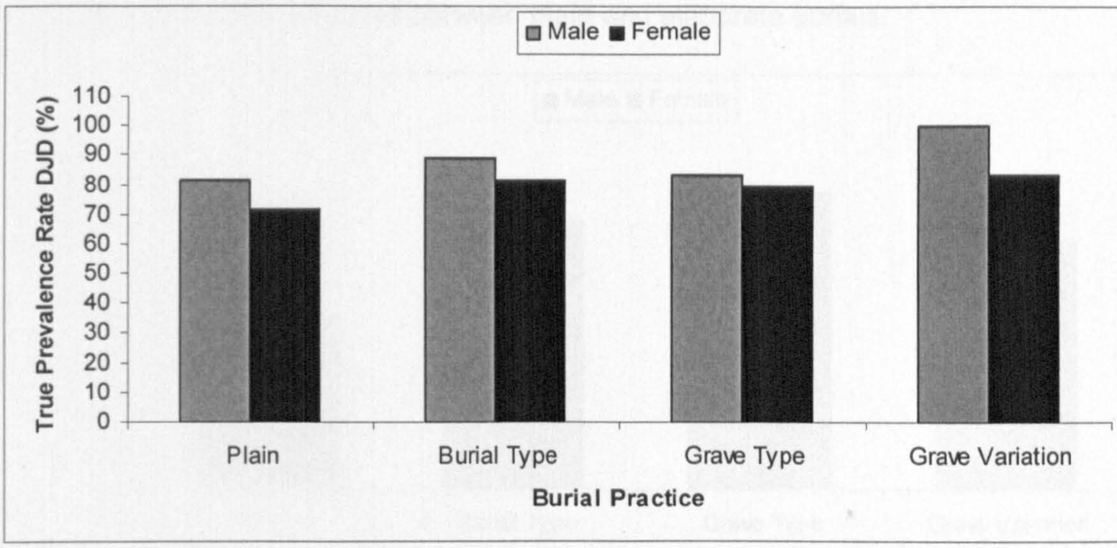


Figure 6.60 *Frequency of degenerative joint disease for plain and elaborate burial types, grave types and grave variations recorded for males and females*

Males consistently show a higher frequency of DJD than females for all burial practices (Figure 6.60). Only the greater prevalence observed for males interred in plain graves approached statistical significance ($\chi^2$= 3.573; P = 0.059).

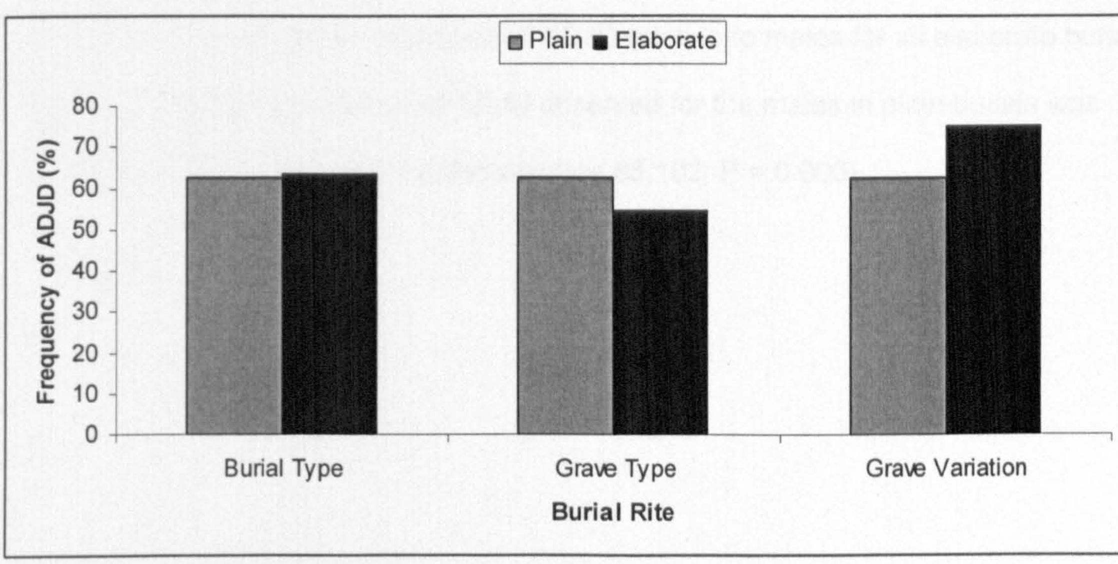


Figure 6.61 *Frequency of appendicular degenerative joint disease for plain and elaborate burial types, grave types and grave variations (n = 376 recordable individuals)*

Of the 357 plain burial types for which ADJD could be recorded, 62.5% (223/357) exhibited degenerative changes to appendicular joint surfaces (Figure 6.61). ADJD was observed in 63.2% (12/19) of elaborate burial types possessing at least one recordable appendicular joint surface. Amongst the recordable elaborate burial types, 54.5% (6/11) of elaborate grave types and 75.0% (6/8) of burials containing elaborate grave variations exhibited ADJD. There was no statistically significant difference in the prevalence of ADJD exhibited between plain and elaborate burials.

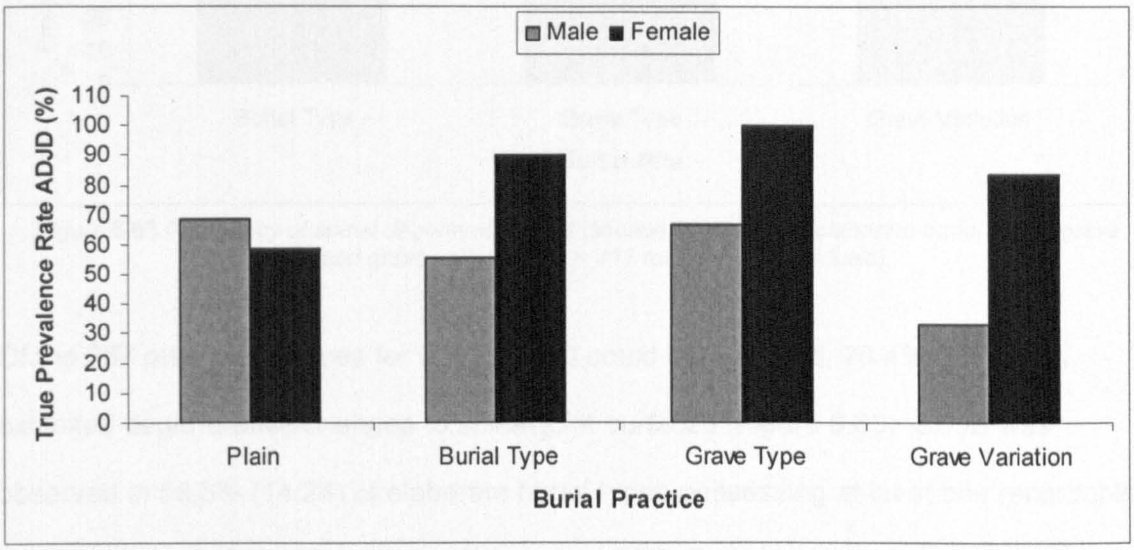


Figure 6.62 *Frequency of appendicular degenerative joint disease for plain and elaborate burial types, grave types and grave variations recorded for males and females*

Males interred in plain burials exhibited a higher frequency of ADJD than females (Figure 6.62). The reverse pattern is observed in elaborate burials, whereby females consistently show a higher frequency of ADJD relative to males for all elaborate burial practices. Only the prevalence of ADJD observed for the males in plain burials was statistically higher relative to the females ($\chi^2 = 88.102$; P = 0.000).

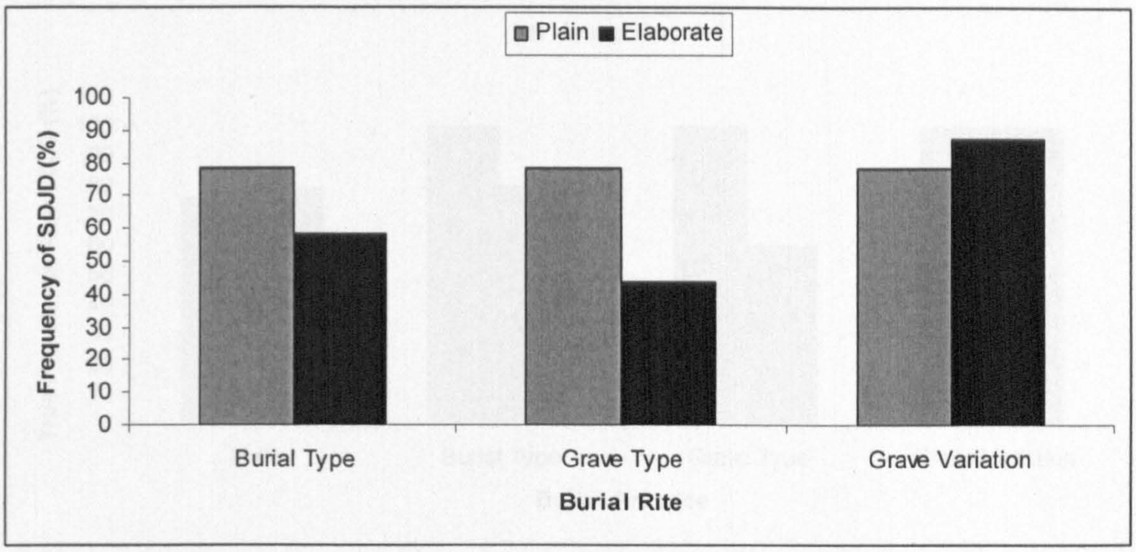


Figure 6.63 *Frequency of spinal degenerative joint disease for plain and elaborate burial types, grave types and grave variations (n = 311 recordable individuals)*

Of the 287 plain burial types for which SDJD could be recorded, 78.4% (225/287) exhibited degenerative changes to spinal joint surfaces (Figure 6.63). SDJD was observed in 58.3% (14/24) of elaborate burial types possessing at least one recordable vertebral joint surface. The greater frequency of SDJD observed in plain burial types in comparison to elaborate burial types was statistically significant ($\chi^2$= 5.011; P = 0.025). Amongst the recordable elaborate grave types 43.7% (7/16) exhibited SDJD. The lower frequencies of SDJD observed in elaborate grave types in comparison to plain burials was statistically significant ($\chi^2$= 10.140; P = 0.001). Amongst the recordable elaborate grave variations 87.5% (7/8) exhibited SDJD. The greater frequency of SDJD observed in graves containing elaborate variations relative to plain burials was not statistically significant.

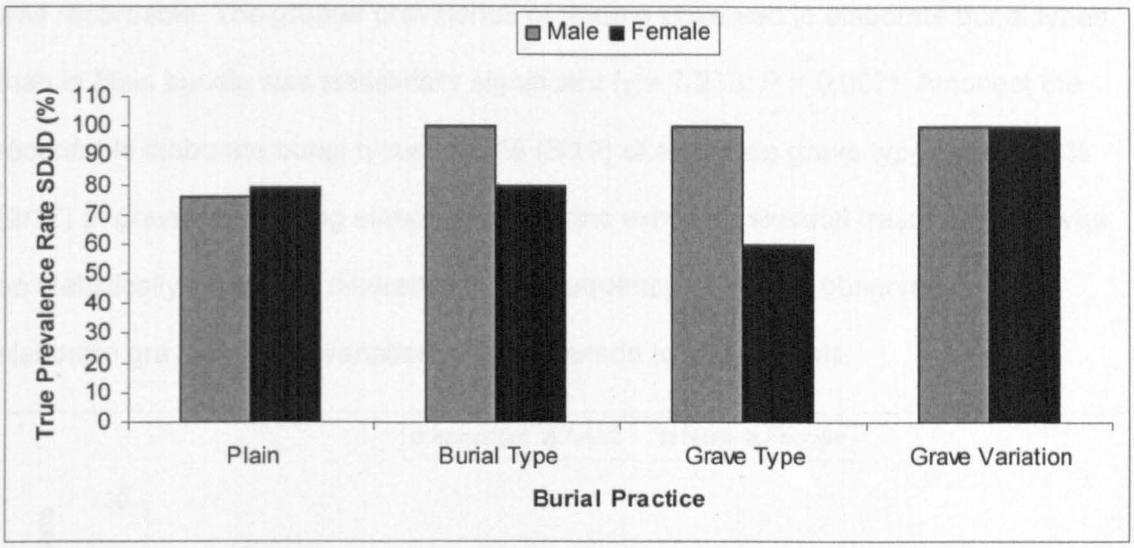


Figure 6.64 *Frequency of spinal degenerative joint disease for plain and elaborate burial types, grave types and grave variations recorded for males and females*

Figure 6.64 shows that males and females exhibited equivocal frequencies of SDJD in plain graves and those interred with elaborate grave variations. Males show a notably higher frequency of SDJD than females in elaborate grave types, which subsequently results in a higher prevalence of SDJD in males recorded for elaborate burial types overall. There were no significant differences in the male and female prevalences of SDJD within plain or elaborate burials.

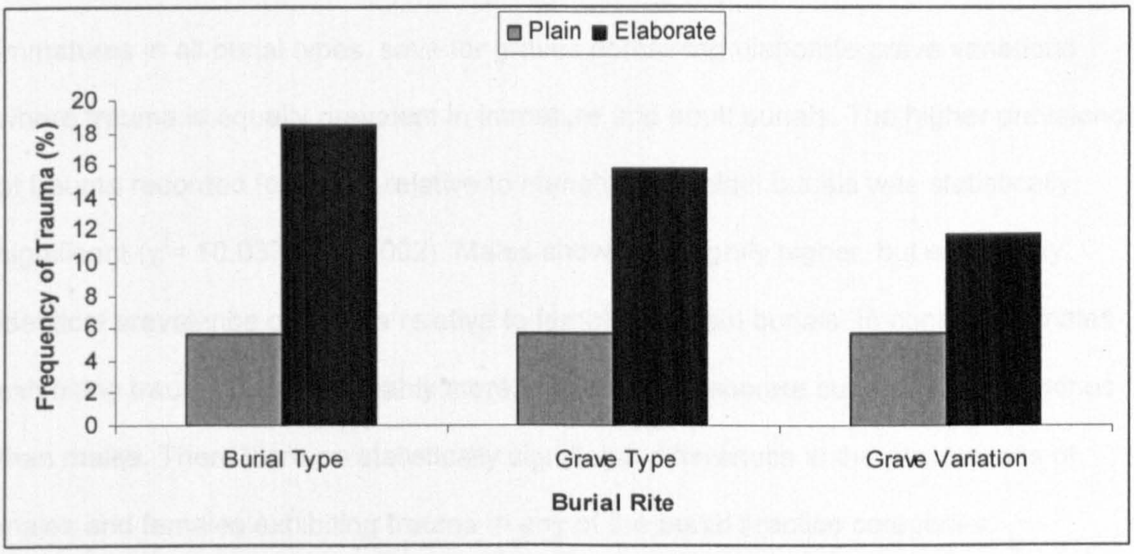


Figure 6.65 *Frequency of trauma for plain and elaborate burial types, grave types and grave variations (n = 606 recordable individuals)*

Of the 579 plain burial types for which trauma could be recorded, 5.7% (33/579) exhibited skeletal modifications consistent with fractures (Figure 6.65). Trauma was observed in 18.5% (5/27) of elaborate burial types within which at least one element was recordable. The greater prevalence of trauma observed in elaborate burial types than in plain burials was statistically significant ($\chi^2$= 7.213; P = 0.007). Amongst the recordable elaborate burial types, 15.8% (3/19) of elaborate grave types and 11.8% (2/17) of graves containing elaborate variations exhibited skeletal trauma. There was no statistically significant difference in the frequency of trauma observed in either elaborate grave types or variations in comparison to plain burials.

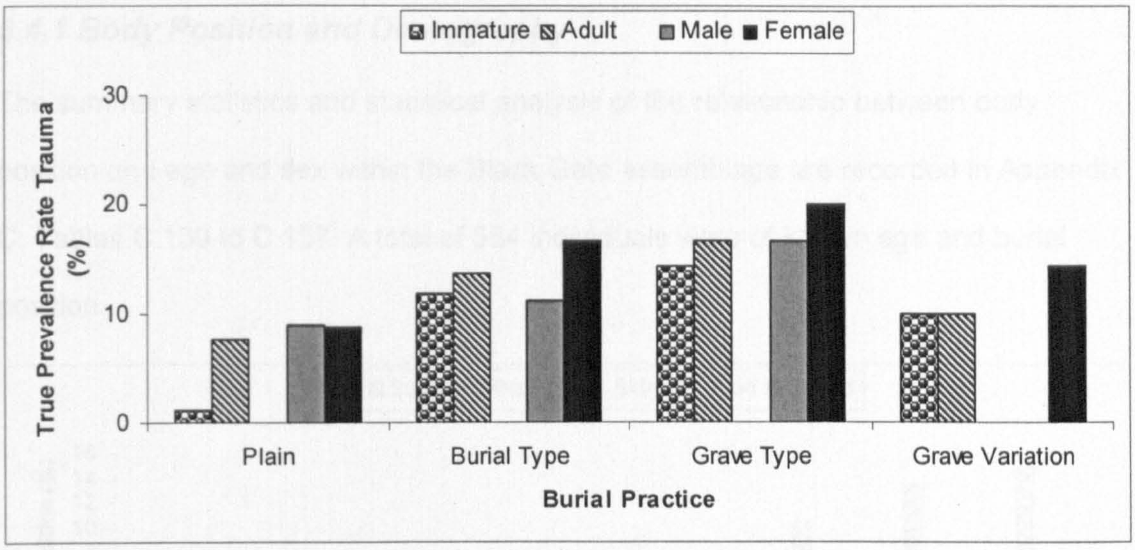


Figure 6.66 *Frequency of trauma for plain and elaborate burial types, grave types and grave variations recorded for immatures and adults, males and females*

Figure 6.66 shows that adults exhibited signs of skeletal trauma more frequently than immatures in all burial types, save for graves containing elaborate grave variations where trauma is equally prevalent in immature and adult burials. The higher prevalence of trauma recorded for adults relative to immatures in plain burials was statistically significant ($\chi^2$= 10.037; P = 0.002). Males showed a slightly higher, but essentially identical prevalence of trauma relative to females in plain burials. In contrast, females exhibiting trauma were noticeably more prevalent in elaborate burials in all categories than males. There were no statistically significant differences in the prevalences of males and females exhibiting trauma in any of the burial practice categories.

### 6.4 Body Position

To explore potential relationships between disposition of the body and social status within the Black Gate assemblage comparisons were made between supine, prone, and flexed burials and those interred on either their left or right side and their age, sex and health indicators.

#### 6.4.1 Body Position and Demography

The summary statistics and statistical analysis of the relationship between body position and age and sex within the Black Gate assemblage are recorded in Appendix C: Tables C.130 to C.137. A total of 554 individuals were of known age and burial position.

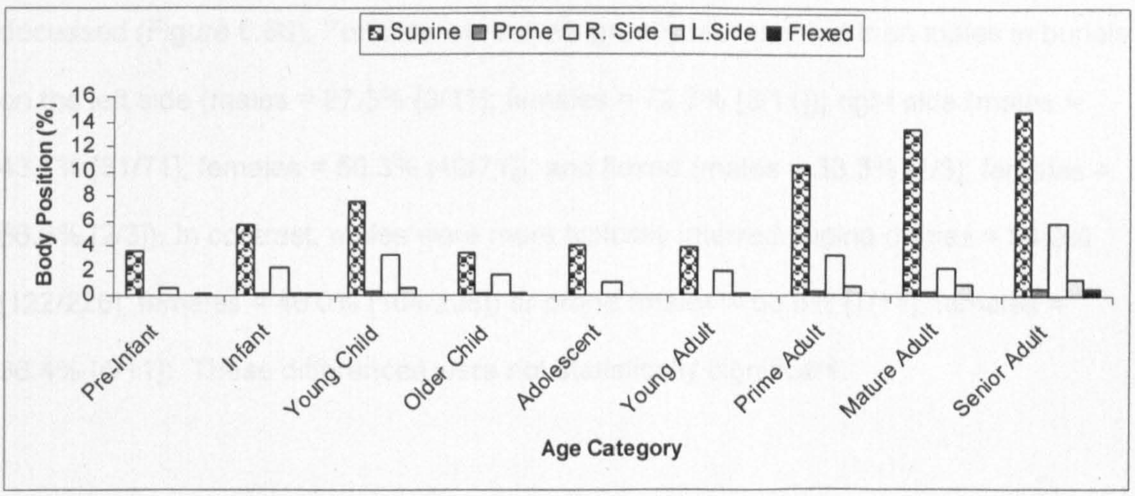


Figure 6.67 *Frequency of body positions within the grave (supine, prone, right side, left side, flexed) for each age category within the Black Gate cemetery (n = 554 individuals of known age and body position).*

There was no statistically significant difference in body disposition between immatures and adults (Figure 6.67). There was no statistically significant relationship between age category and body position when including individuals in all age categories from pre-infant to senior adult. There was an increase in the variability of body positions with advancing age from adolescent through to senior adult, but this relationship also lacked statistical significance. Flexed burials were only observed amongst senior adults. Individuals in the pre-infant, infant, older child, adolescent and young adult age categories were only buried supine or on their right side.

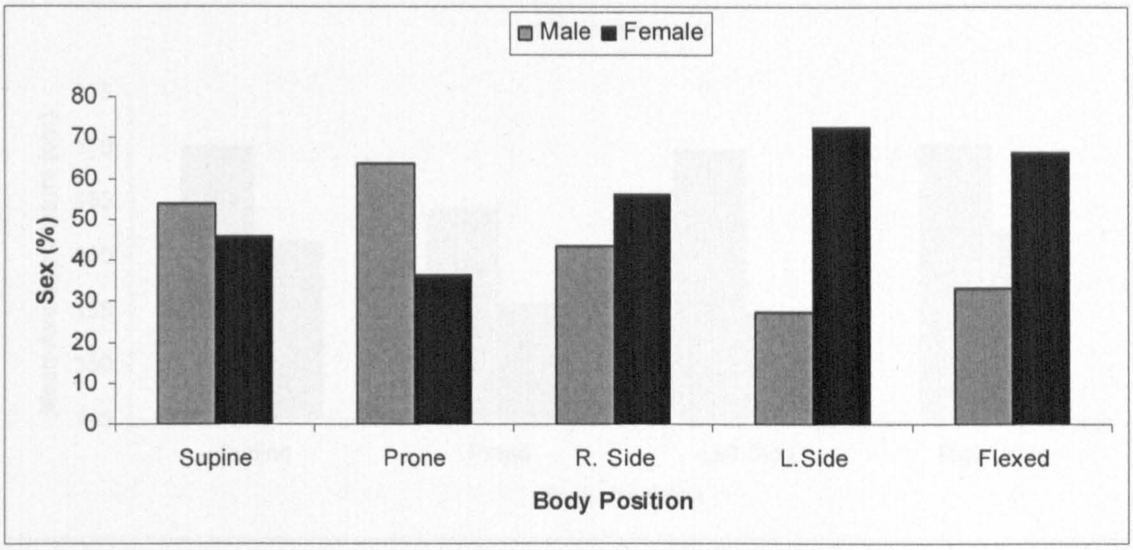


Figure 6.68 *Frequency of body positions within the grave (supine, prone, left side, right side and flexed) for each adult sex category within the Black Gate cemetery (n = 322 individuals of known sex and body position)*

There were no relationships between body position and the biological sex of the deceased (Figure 6.68). Females were more greatly represented than males in burials on the left side (males = 27.3% [3/11]; females = 72.7% [8/11]), right side (males = 43.7% [31/71]; females = 56.3% [40/71]), and flexed (males = 33.3% [1/3]; females = 66.6% [2/3]). In contrast, males were more typically interred supine (males = 54.0% [122/226]; females = 46.0% [104/226]) or prone (males = 63.6% [7/11]; females = 36.4% [4/11]). These differences were not statistically significant.

### *6.4.2 Body Position and Palaeopathology*

#### *6.4.2.1 Indicators of Environmental Stress: Adult Stature*

The summary statistics and statistical analysis of the relationship between body position and adult stature within the Black Gate assemblage are recorded in Appendix C: Tables C.138 to C.139. A total of 554 individuals were of known age and body position.

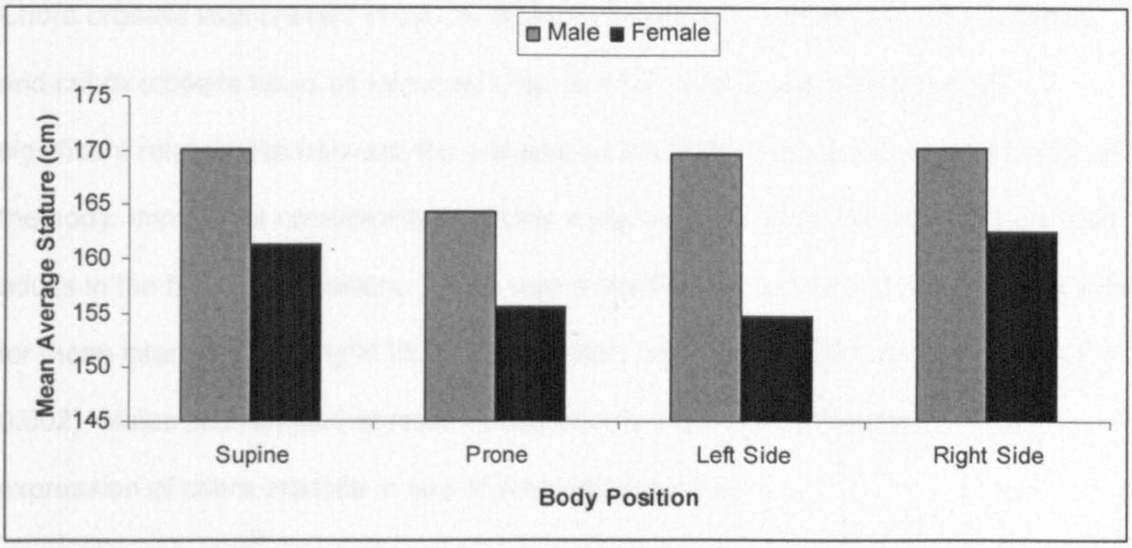


Figure 6.69 *Relationship between adult stature and body position (supine, prone, left side, right side and flexed) within the Black Gate cemetery (n = 322 individuals of known sex and body position)*

There was no statistically significant difference in mean adult stature between the four body positions (Figure 6.69). One-way ANOVA analysis revealed that neither male nor female mean stature varied significantly between all the body positions.

### *6.4.2.2 Indicators of Environmental Stress: Non-Specific Stress*

The summary statistics and statistical analysis of the relationship between body position and non-specific stress indicators (cribra orbitalia and dental enamel hypoplasia) within the Black Gate assemblage are recorded in Appendix C: Tables C.140 to C.147.

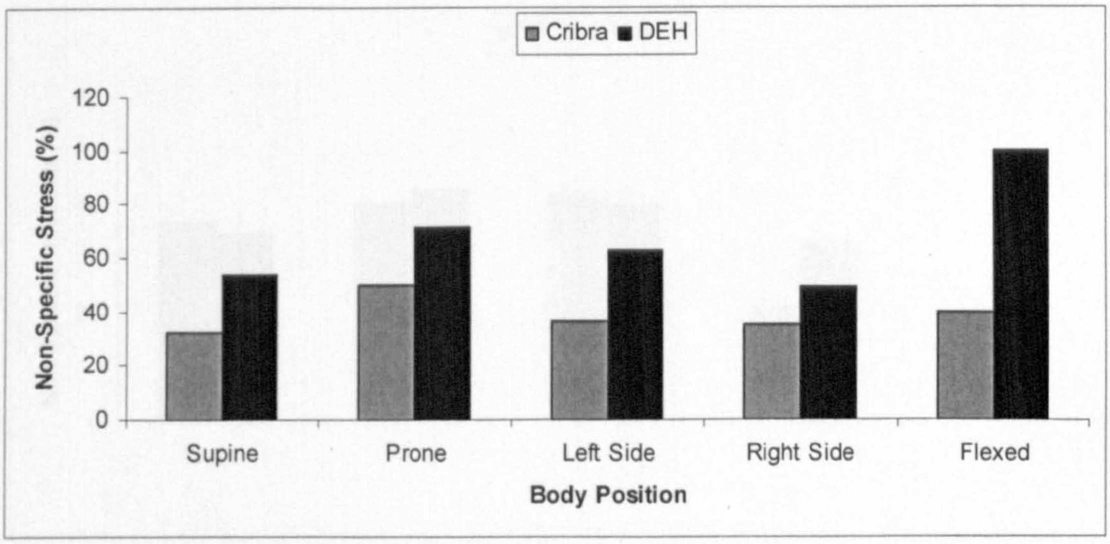


Figure 6.70 *Frequency of non-specific stress (cribra orbitalia and dental enamel hypoplasia) for each burial position (n= 312 recordable individuals for cribra orbitalia; 218 recordable individuals for dental enamel hypoplasia)*

Cribra orbitalia was present in 34.0% of the 312 burials for which both body position and cribra orbitalia could be recorded (Figure 6.70). There was no statistically significant relationship between the prevalence of cribra orbitalia and the disposition of the body. Immatures consistently exhibited a higher prevalence of cribra orbitalia than adults in the five body positions. There was a significantly greater immature prevalence for those interred supine ($\chi^2$= 19.697; P = 0.000) and on their right side ($\chi^2$= 9.651; P = 0.002). Males and females showed no statistically significant difference in their expression of cribra orbitalia in any of the body positions.

Of the 218 burials for which both body position and DEH could be recorded, 54.1% (118/218) exhibited dental enamel disruption. There was no statistically significant relationship between the prevalence of dental enamel hypoplasia and the disposition of the body. Neither immatures and adults nor males and females displayed any significant difference in the prevalence of DEH in the four body positions.

### *6.4.2.3 Indicators of Environmental Stress: Non-Specific Infection*

The summary statistics and statistical analysis of the relationship between body position and non-specific infection (TPNB and maxillary sinusitis) within the Black Gate assemblage are recorded in Appendix C: Tables C.148 to C.155.

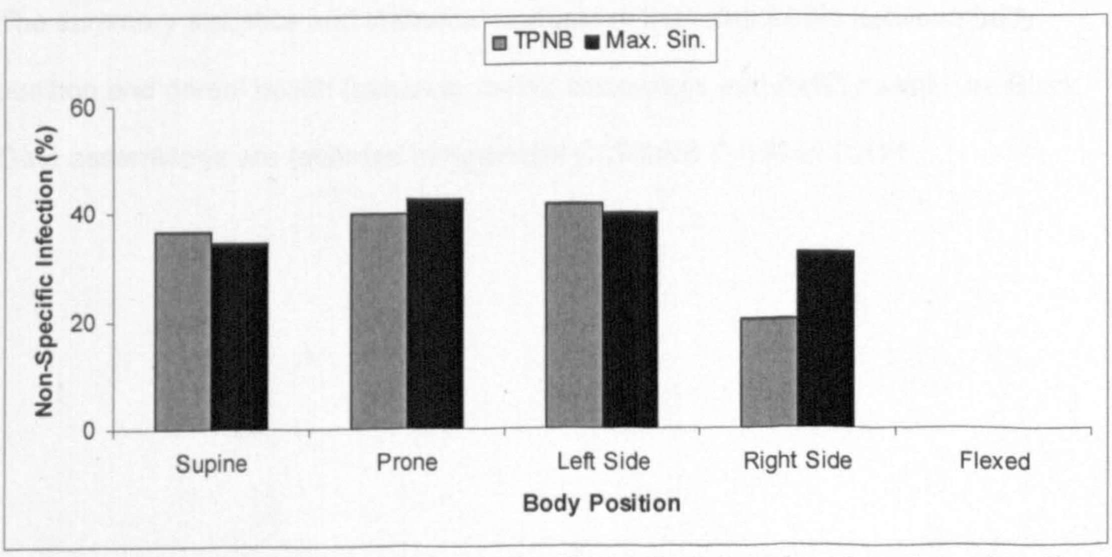


Figure 6.71 *Frequency of non-specific infection (tibial periosteal new bone formation and maxillary sinusitis) for each burial position (n = 315 recordable individuals for tibial periosteal new bone formation; 216 recordable individuals for maxillary sinusitis)*

Of the 315 burials for which both body position and TPNB could be recorded, 33.0% (104/315) exhibited new bone formation (Figure 6.71). There was no statistically significant relationship between the prevalence of TPNB and the disposition of the body. There was a statistically significant difference between the percentage of cases of TPNB observed between supine and non-supine burials ($\chi^2$= 5.341; P = 0.021) resulting from the lower percentage of cases in right-sided burials. The higher prevalence of TPNB in the adults compared to the immatures in right-sided burials ($\chi^2$= 3.829; P = 0.050) was the only statistically significant difference in the prevalence of TPNB observed between adults and immatures, males and females.

Of the 216 burials for which both body position and maxillary sinusitis could be recorded, 34.3% (74/216) exhibited lesions or bone deposits consistent with sinusitis. There was no statistically significant relationship between the prevalence of maxillary sinusitis and the disposition of the body. Adult and immature TPRs for maxillary sinusitis were not significantly different for any of the body positions. Only the higher prevalence of females to males interred on their right side was statistically significant ($\chi^2$= 4.569; P = 0.033).

### *6.4.2.4 Indicators of Environmental Stress: Dental Health*

The summary statistics and statistical analysis of the relationship between body position and dental health (calculus, caries, abscesses and AMTL) within the Black Gate assemblage are recorded in Appendix C: Tables C.156 to C.171.

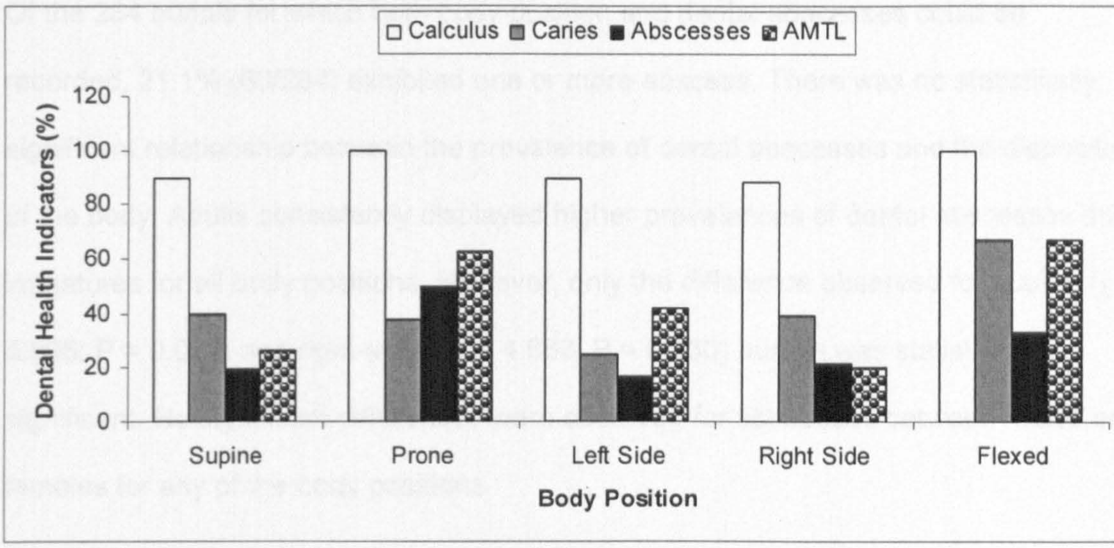


Figure 6.72 *Frequency of dental health indicators (calculus, caries, abscesses and ante-mortem tooth loss) for each burial position (n = 284 recordable individuals)*

Figure 6.72 shows the percentage of cases of dental calculus, caries, abscesses and AMTL within each of the body position categories. Of the 276 burials for which both body position and dental calculus could be recorded, 89.8% (248/276) exhibited calculus deposits. There was no statistically significant relationship between the prevalence of calculus and the disposition of the body. Comparisons of the prevalence of calculus between adults and immatures in each burial position revealed a statistically significant higher prevalence for adults relative to immatures for those interred supine ($\chi^2$= 36.095; P = 0.000) and on their left ($\chi^2$= 3.706; P = 0.054) and right ($\chi^2$= 3.703; P = 0.054) sides. Males and females exhibited no significant differences in the prevalence of calculus relative to burial position.

Of the 284 burials for which both body position and dental caries could be recorded, 39.0% (111/284) exhibited carious lesions. There was no statistically significant relationship between the prevalence of carious lesions and the disposition of the body. Adults interred supine exhibited a significantly greater frequency of dental caries relative to the immatures ($\chi^2$= 9.428; P = 0.002). No significant differences were observed for caries between males and females for any of the body positions.

Of the 284 burials for which both body position and dental abscesses could be recorded, 21.1% (60/284) exhibited one or more abscess. There was no statistically significant relationship between the prevalence of dental abscesses and the disposition of the body. Adults consistently displayed higher prevalences of dental abscesses than immatures for all body positions. However, only the difference observed for supine ($\chi^2$= 4.896; P = 0.027) and right-sided ($\chi^2$= 4.688; P = 0.030) burials was statistically significant. No significant differences were observed for abscesses between males and females for any of the body positions.

Of the 284 burials for which both body position and AMTL could be recorded, 26.8% (76/284) had lost at least one tooth before death. There was a statistically significant difference between the prevalence of AMTL and the disposition of the body ($\chi^2$= 10.536; P = 0.032) resulting from the high percentage of AMTL observed in the prone and flexed body position categories compared to spine, left-sided and right-sided burials. For both supine ($\chi^2$= 8.388; P = 0.004) and right-sided ($\chi^2$= 4.303; P = 0.038) burials the adult prevalence of AMTL significantly exceeded that of immatures. Females exhibited higher frequencies of AMTL than males for all body positions, but none of these differences were statistically significant.

#### *6.4.2.5 Indicators of Environmental Stress: Skeletal Biomechanical Stress*

The summary statistics and statistical analysis of the relationship between body position and skeletal biomechanical stress (DJD, ADJD, SDJD and skeletal trauma) within the Black Gate assemblage are recorded in Appendix C: Tables C.172 to C.184.

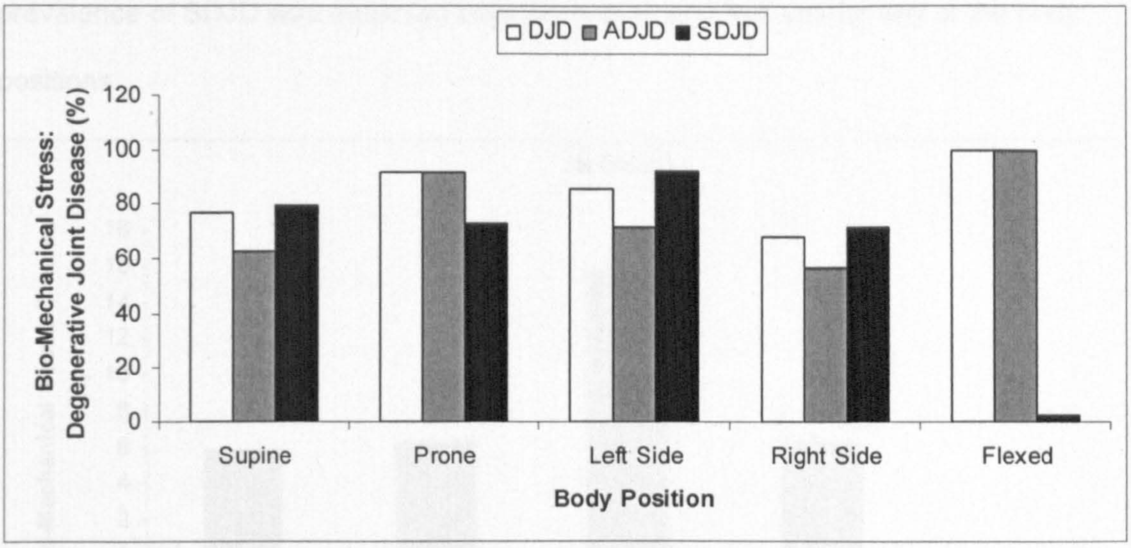


Figure 6.73 *Frequency of biomechanical stress (degenerative joint disease (DJD) n=382, appendicular degenerative joint disease (ADJD) n=732 and spinal degenerative joint disease (SDJD) n=302) for each burial position*

Of the 382 burials for which both body position and DJD could be recorded, 75.9% (290/382) exhibited one or more joint surface displaying signs of degeneration (Figure 6.73). There was no statistically significant relationship between the prevalence of DJD and the disposition of the body. No statistically significant difference in the prevalence of DJD was observed between males and females for any of the body positions.

Of the 372 burials for which both body position and ADJD could be recorded, 62.9% (234/372) displayed one or more appendicular joint surface exhibiting degeneration. There was no statistically significant difference between the prevalence of ADJD and the four body position categories. No statistically significant difference in the prevalence of ADJD was observed between males and females for any of the body positions.

Of the 302 burials for which both body position and SDJD could be recorded, 78.5% (237/302) exhibited one or more vertebral joint surface displaying signs of degeneration. There was no statistically significant relationship between the prevalence of SDJD and the disposition of the body. No statistically significant difference in the prevalence of SDJD was observed between males and females for any of the body positions.

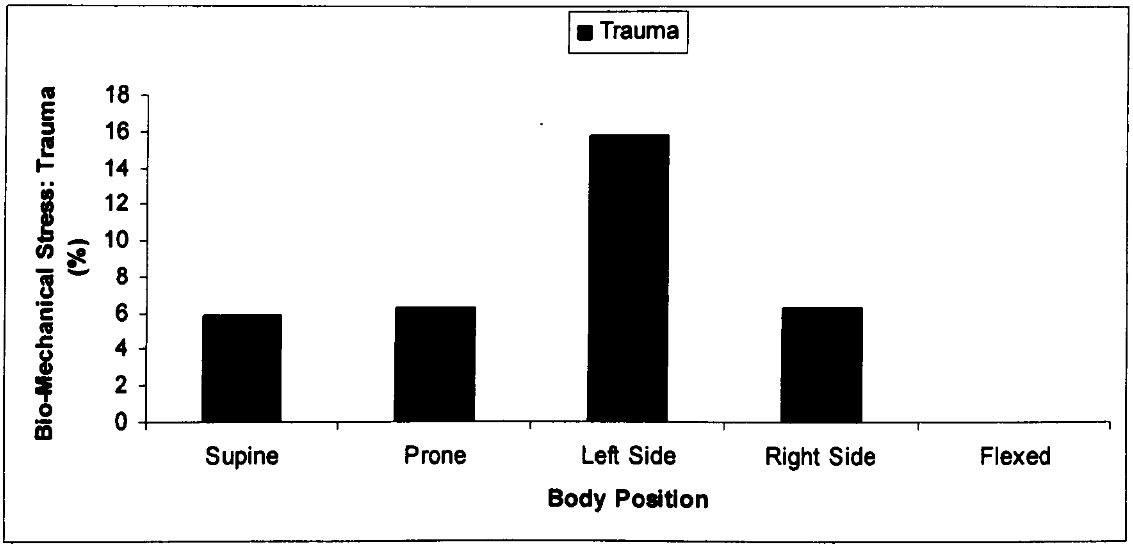


Figure 6.74 *Frequency of biomechanical stress (trauma) for each burial position (n = 596 recordable individuals)*

Of the 596 burials for which both body position and presence of skeletal trauma could be recorded, 6.2% (37/596) displayed one or more vertebral joint surface exhibiting degeneration (Figure 6.74). Adults consistently displayed higher frequencies of trauma relative to immatures for each body position, but only the higher adult prevalence recorded for right-sided burials was statistically significant ($\chi^2$= 4.555; P = 0.033). Males and females exhibited no significant differences in the prevalence of trauma for any of the body positions.

## 6.5 Summary and Discussion of Bioarchaeology Results of the Black Gate Cemetery

The following section provides a detailed synthesis and interpretation of the results presented in the preceding sections.

### *6.5.1 Burial Location, Density and Demographics*

The high density of burial, particularly of infants aged less than 1 year at age of death, and also the high proportion of rubble cist and stone cist burials alongside the building represented by structures A, B and 68 strongly supports Nolan's interpretation that this building was a late Saxon stone church, possibly preceded by a smaller ecclesiastical building (Nolan 2010: 256-8). If the elite, wealthy and people of high social status sought preferential burial, as close to the church and *Ad Sanctos* as possible, it would be expected that there would be a high concentration of burial close to the church, dwindling the further away from the church that burials are located. This does appear to be the case for Black Gate, where there was a high density of burials, many of which were inter-cutting, beneath the Railway Arches and in Area C (to the north and south of the proposed church building). The high number of inter-cutting burials may represent successive burials within this preferential locality. The density of burial in the western (the Compound) and far north (Area D) areas of the excavation was much lower (Appendix A: Figure A.1). The high proportion of immature burials alongside the building further supports its religious function, as the immature burials would have been in the catchment area for the 'eaves drip' of sanctified water proposed to run-off from the roofs of 'holy' buildings (Daniell 1997: 128; Crawford 1999: 85-9).

The bio-cultural study revealed distinct characteristics for the four burial zones.

***The Compound (179 burials)***

- *Significantly more adults (104/160; 65.0%) than immatures (56/160; 35.0%)*
- *More adult females (57/101; 56.4%) than males (44/101; 43.6%)*
- *Plain and coffined burials only*
- *All body positions present – right side most prevalent (44.5%), then supine (43.4%)*

***Area C (150 burials)***

- *Significantly more immatures (76/128; 59.4%) than adults (52/128; 40.6%)*
- *Significantly more adult males (36/51; 70.6%) than females (15/51; 29.4%)*
- *Plain, coffin, elaborate grave variations (pillow stones) and elaborate grave types (rubble cist and stone cists)*
- *All body positions present (supine burial most prevalent (82.2%))*

***Railway Arches (282 burials)***

- *Significantly more adults (181/242; 74.8%) than immatures (61/242; 25.2%)*
- *Marginally more adult females (89/172; 51.7%) than males (83/172; 48.3%)*
- *Plain, coffin, elaborate grave variations (pillow stones, earmuffs and head cists) and elaborate grave types (chest burials and rubble cists)*
- *All body positions present (supine most prevalent (82.0%))*

***Area D (18 burials)***

- *More adults (10/16; 62.5%) than immatures (6/16; 37.5%)*
- *More adult males (6/9; 66.7%) than females (3/9; 33.3%)*
- *Plain and coffined burials only*
- *Supine and flexed burials only (supine most prevalent (94.4%))*

The Railway Arches were similar to the Compound and Area D in that adult burials significantly exceeded the number of immature burials. The Compound and the Railway Arches both showed a higher representation of female than male skeletons. Area C differed from the other burial locations in that there were more immatures than adults interred in this burial zone. Furthermore, females were greatly underrepresented in Area C. The predominant burial of immature and adult male remains in Area C is striking. It is reminiscent of an area of burial found to the south of the church at Wearmouth – to the east of a building which initially formed a covered walkway leading south from the church – which contained only male and immature burials (Cramp 2005: 98, 358; McNeil and Cramp 2005: 86-8). McNeil and Cramp (2005: 88) argued that the burials to the south of the church at Wearmouth could 'reasonably be interpreted as the burial ground for the monastic community'. In his *Historia Abbatum*, Bede notably describes the area to the south of the church at Wearmouth as a *sacrarium*, which translates to mean a sanctuary, which has in turn been interpreted to mean a monastic cemetery (HAB viii; HAB xx, Plummer 1896: 285, 372; Cramp 2005: 32, 34, 88). Admittedly, *sacrarium* can also simply mean 'cemetery', and so caution must be taken not to ascribe too much importance to the term when interpreting the distribution and nature of burials in Anglo-Saxon cemeteries; nonetheless, the burial evidence is certainly suggestive of the existence of a monastic burial ground at Wearmouth. At Black Gate, Area D also showed a majority of male burials, but the percentage of females was much greater than observed for Area C. The difference between the percentage of females and immatures found in this Area D was very small, making this sample more indicative of the norm for a burial assemblage, albeit a small sample of only 18 individuals.

The bias in male burials in Area C can be ascribed to two potential factors. Firstly, the male burials may represent a concentration of religious burials such as those of monks. Secondly, they may be elite members of the associated lay community. The interment of kings and members of religious communities, such as bishops and abbots, have been documented in contemporary written sources (such as saints' *Lives* and the writings of Bede) within churchyards such as Wearmouth and Whitby (Hadley 2000: 200; 2002: 210). Area C appears to be a zone of high-status burial, as demonstrated by the presence of elite grave types and close proximity to the church. In this context, the high proportion of prime and senior adult males to females interred in Area C may indicate that prime and senior adult males had a high social worth. Certainly, prime age men were valuable in terms of warfare and labour while senior adult males, who may no longer have contributed to labour or military service, nonetheless, had had longer to accrue wealth and status. There was little difference in the distribution of females in each of the age categories in Area C; however, there was a slight increase in the presence of females with age, culminating in the highest number of females in the senior adult age category. This implies that females either accrued wealth and status with age or acquired it through marriage (as will be discussed further below).

### *6.5.2 Burial Location and Burial Practice*

Elaborate burials were found exclusively in the Railway Arches and Area C, distinguishing these areas of burial from the Compound and Area D, which only contained plain or coffined burials. Pillow stones, earmuffs, head cists and chest burials, along with one rubble cist, were found in Railway Arches 28 and 29, whereas stone and rubble cists were found in Area C. The greater investment of time and money accorded to burials distinct from the norm in the Railway Arches and Area C may indicate that such burials represented elite members of the society. Subsequently, it could be inferred that Area C was a more desirable high-status burial location than the Railway Arches because more energy and expenditure would be required to construct a rubble or stone cist than placing a couple of head support stones within the grave. The variability in burial types could represent status hierarchies within the cemetery, that is, low-status individuals buried in plain earth-cut graves, intermediate-status individuals interred with pillow stones, earmuffs and head-cists, and high-status individuals interred in stone cists. Rubble cists may represent a transient state between intermediate and high-status burial.

A possible alternative explanation for the variations in burial practices observed in the different burial locations throughout the Black Gate cemetery may be that the various burial types in the different zones of burial were not so much linked to social status but rather represent changes in burial practice over time. Even though there was no clear phasing of the burials throughout the Black Gate cemetery there is evidence to suggest the Compound and Area D represented the earliest phases of burial, followed by the Railway Arches then Area C. The Compound and Area D were covered by the clay rampart of the 1080 Castle, medieval deposits in Railway Arch 28 overlay some of clay spreads of the rampart and burial in Area C overlaid the rampart and continued intermittently up to the mid-13$^{th}$ century (Nolan 2010: 147, 154-5). This suggests that the plain burials in the Compound and Area D predated the elaborate grave variations in the Railway Arches, which in turn were succeeded by elaborate grave types in Area

C. The presence of rubble cists in both the Railway Arches and Area C suggests a period of overlap between these two burial zones. However, there is evidence discounting the hypothesis that the changes in burial practices represent purely chronological trends. The radiocarbon dates for the cist burials BG368 (808-973) and BG375 (960-1160) from Area C were not the latest recorded for the Black Gate cemetery. BG368 was post-dated by three plain burials (BG646, BG575 and BG40) and a rubble cist (BG580) in the Railway Arches. The later cist burial in Area C (BG375) was post-dated by a plain prone burial (BG175) within the Compound, dating to between 1015 and 1155 (Table 6.7). The only skeleton radiocarbon dated from the Compound (BG175) had a date of 1015-1155, which suggests that it post-dated the period of burial at the Railway Arches and Area C. However, it is probable – based on the aforementioned archaeological evidence – that the Compound burials overall did pre-date those in the Railway Arches and Area C, and that BG175 represents an anomalous burial within the Compound. Indeed, BG175 is a prone adult male interred upon skeleton BG176 in what looks like a multiple-burial, which is abnormal for this cemetery. It is possible that the increasing investment in the construction of burials correlating with the temporal development of the cemetery represents an increased desirability of burial within the Black Gate cemetery over time. The late reference to a monastic settlement on the site may mean that the establishment of a monastery or church on the site attracted higher-status people than those interred in the Compound, which may pre-date the construction of the church or establishment of a religious building. To confirm the relationship between burial rite and changes in the cemetery over time, a more extensive radiocarbon dating program is clearly necessary.

| Skeleton No. | Radio-carbon Dates (AD) | Burial Location | Burial Type | Body Position |
|---|---|---|---|---|
| BG99 | 211-357[1] | Area C | Coffin | Supine |
| BG660 | 667-780[1] | Railway Arches | Plain | Flexed |
| BG422 | 670-900[2] | Area D | Plain | Flexed |
| BG477 | 799-883[3] | Area C | Plain | Supine |
| BG368 | 808-973[1] | Area C | Cist | Supine |
| BG646 | 831-915[3] | Railway Arches | Plain | Supine |
| BG575 | 832-916[3] | Railway Arches | Plain | Supine |
| BG506 | 876-962[3] | Area C | Coffin | Supine |
| BG22 | 880-1040[2] | Area C | Plain | Supine |
| BG40 | 880-1040[2] | Railway Arches | Coffin | Right Side |
| BG580 | 880-1050[2] | Railway Arches | Rubble Cist | Supine |
| BG375 | 960-1160[2] | Area C | Cist | Supine |
| BG175 | 1015-1155[1] | Compound | Plain | Prone |

Table 6.7 *Radiocarbon dates for burial location, burial practice and body disposition within the Black Gate Cemetery*.([1]Oxford Radiocarbon Laboratory.; [2]*Scottish Universities Environmental Research Centre (SUERC),;* [3]*Arizona State University Radiocarbon laboratory All radiocarbon dates presented in this table represent 95% confidence intervals [Sigma 2])*

Even though post-Conquest cists comparable to those found in Area C have been found elsewhere (e.g. St Marks, Lincoln (11th-12th century), St Nicholas Shambles, London (11th-12th century) and St Peters, Barton-upon-Humber (10th-12th century) there are no particular grounds for regarding cist burials as a later innovation in burial tradition. Stone cists have also been identified in the archaeological record of northern England and Scotland prior to the 7th century, and are strongly associated with British Christianity (Blair 2005: 16-17; Craig 2009: 54-5). Therefore, the cists may represent elite Christian burials associated with a religious focus at the Black Gate cemetery. The restricted presence of stone cists in what is proposed to be a later phase of the burial ground may indicate an increasing religious focus of the cemetery in the later period of its use. Indeed, the documentary references alluding to the presence of a monastery in the locality of the Black Gate cemetery suggest that the monastic settlement had ceased to exist by 1074 but had been active in 1072. Therefore, the cist burials in Area

C may be representative of an area of monastic burial, which is indicated by the aforementioned high proportion of male and immature burials in this area.

Regardless of the conceivable chronological impact upon the variation in burial practices, it is clear that the elaborate burials recovered from the Railway Arches and Area C represent a group of individuals distinct from the norm in those burial zones. The clustering of the two chest burials, pillow stones, earmuffs and head cists in the Railway Arches may represent elite family groupings. Studies of other cemeteries of a similar period have suggested that distinctive burial types may reflect the burial plots of particular families. For example, four domestic chests, dating to the 9$^{th}$ century, were recovered during excavations at York Minster, containing the remains of an adolescent, a young adult male, a middle-aged female and an elderly male. They were found in a close group, inter-cutting each other, suggesting that they occurred over several decades. The burial of these four individuals in such a specific fashion and in such a concentrated locality has been interpreted as suggesting that these burials were inter-connected in some way, perhaps a family group (Kjølbye-Biddle 1995: 488-9; Phillips 1995: 83-4; Hadley 2004: 312). The presence of chest burials at monastic sites such as Ailcy Hill, Ripon (Hall and Whyman 1996: 99) may suggest a monastic link but they have also been identified at high-status non-monastic cemeteries such as York Minster. Craig (2010: 138) identifies 17 sites containing chest burials in northern England from this period – each containing only a small number of such burials – suggesting them to be a predominantly northern phenomenon in the 8$^{th}$ and 9$^{th}$ centuries, but notes how little interpretation there is in the literature about the status and function of this burial practice (Craig 2009: 330). The two chest burials at Black Gate were classified as 'elaborate grave types' during the present analysis, but they only occur in the Railway Arches, not in Area C, indicating that they may not represent such an 'elite' burial practice as rubble cists and stone cists. The elaborate grave types in Area C may also represent burials of elite family members, elite individuals or a religious group. The interpretation of the meaning of these elite burials will be investigated further in sections 6.5.4 to 6.5.6 by considering the demographics of those interred in elaborate burials and their health in comparison to those interred in different burial locations and plain burials.

### *6.5.3 Burial Location and Body Position*

The predominant body position in the Black Gate cemetery was supine, which was the most common disposition of the body in cemeteries of the later Anglo-Saxon period. Nonetheless, there was a high occurrence of right-sided burial, which formed a slight majority in the Compound and was the second most favoured disposition of the body in the grave in Area C and the Railway Arches, albeit occurring at a much lower percentage than supine burials in these areas. Right-sided burials were in the majority amongst the pre-Norman burials at Wearmouth (McNeil and Cramp 2005: 82), while equal numbers of supine and right-sided burials were recovered from Jarrow (Cramp and Lowther 2005: 82; Lowther 2005: 176-7). Lowther (2005: 186) suggests that the high occurrence of right-sided burial recovered from Wearmouth, Jarrow and Black Gate indicates that it may be a characteristic of cemeteries in the north-east of England. Right-sided burials dating from the 8th to 10th century recovered from Addingham were explained as resulting from the narrowness of graves preventing supine burial, and it was suggested by the excavators that the narrow graves at Addingham were made to prevent inter-cutting of pre-existing graves (Adams 1996: 165, 182). There was no intercutting of graves in the Compound, which may support the argument that later graves were cut narrow to prevent disturbance of earlier interments. The argument that individuals may have been interred on their side due to restricted space within the grave is further supported by the right-sided body position of individuals interred in chest burials at York Minster. The individuals buried in chests at York Minster were slightly flexed on their side to fit within the confines of the chests, which were only 1 ft. 4 inches (40.6 cm) wide (Philips 1995: 84). If the right-sided burials in the Compound were a consequence of a desire not to disturb earlier graves, this may indicate that the Compound represents one of the earliest phases of burial.

Inter-cutting of graves was ubiquitous in later Anglo-Saxon cemeteries, and this has partially been ascribed to an increased familiarity with, and a subsequent decreased fear of, the dead due to increased urbanisation and the juxtaposition of churchyards and burial grounds to domestic settlements (Thompson 2004; Cherryson 2007; Hadley 2007). For example, the 10$^{th}$-century burials at Addingham showed that although great care was afforded to prevent inter-cutting of burials, graves were often reused indicating a lack of fear regarding disturbance of the dead. There were 27 instances of secondary burials disrupting earlier primary interments, some of which required extensive handling of the human remains to position them around the primary interment, which would have been fully exposed (Adams 1996: 166-7). Consequently, a desire to not disturb earlier burials was more likely to reflect beliefs in the earliest centuries of the use of the Black Gate cemetery (i.e. 8$^{th}$ and 9$^{th}$ centuries) when desensitisation of death had yet to fully develop and there was a greater availability of space within which to inter the deceased.

### *6.5.4 Burial Location, Health and Palaeopathology*

If the four burial zones represent areas of variable desirability, with Area C and the Railway Arches representing areas of more elite burial than Area D and the Compound, it might be expected that they would show differences in the levels of stress, dental health indicators and biomechanical stress. The following results were obtained:

- *There were no consistent trends in the statistically significant relationships between burial location and prevalence of health indicators*

- *Immatures exhibited higher prevalences of cribra orbitalia than adults in all the burial zones. Adults exhibited greater prevalences than immatures for calculus, caries, abscesses, AMTL and trauma*

- *There were no significant differences between males and females for cribra orbitalia, DEH, maxillary sinusitis, caries, abscesses, DJD, ADJD, SDJD or trauma*

- *Females exhibited statistically significant greater prevalences of AMTL than males in the only two burial zones which contained a comparable number of females to male burials i.e. the Compound and the Railway Arches*

- *Males were taller than females in all burial zones.*

Overall, there appears to be no relationship between burial location and health in the Black Gate cemetery. Indeed, it appears that age and biological susceptibility were more influential on health status in the Black Gate cemetery than burial location. The trend for higher prevalences of pathologies of adults relative to immatures for all the dental health indicators and trauma suggest these pathologies were more influenced by the accumulation of the deleterious effects of age than differences in diet or physical stress or exposure to hazards. The statistically higher prevalence of AMTL observed in females and taller stature for males in all the burial zones reflect general trends recorded for the population as a whole ( as detailed in Chapter 5). The higher prevalence of cribra orbitalia in the immatures relative to the adults indicates that cribra orbitalia was a manifestation of childhood stress. It can be inferred from the comparable levels of cribra orbitalia between the four burial zones that the underlying factors, which manifested as porosity within the orbit affected people universally throughout the cemetery. The similarity in levels of cribra orbitalia and dental enamel hypoplasia between the four burial zones alongside differences in dental health and non-specific infection rates and DJD suggest that the entire contributory population experienced the same degree of childhood exposure to nutritional stress and parasitic infections, but that there were differences in diet and occupational activities. The lack of a statistically significant difference in SDJD between the four burial zones corresponds with the findings of Knüsel *et al.* (1997), from their study of the Gilbertine priory at St Andrew's, Fishergate, that the forces of the curvature of the spine have a more degenerative effect on the vertebrae than any extrinsic factors.

The lack of consistent statistically significant differences for any of the health indicators between the four burial zones and males and females indicates that either burial location was not directly related to social status or that the health indicators were not sensitive enough to detect differences in social status between the burial zones and sexes. The relationship between demography, health status and social status and burial practices is now considered. If the health indicators are an accurate gauge for social status and elaborate burials do represent higher status members of the community it would be expected that relationships will be observed.

The true prevalence rates for cribra orbitalia and dental enamel hypoplasia were equivocal in the Compound, Area C and the Railway Arches, but lower in Area D. However, the difference observed for Area D may be a consequence of the small sample size ($n$ = 16). Maxillary sinusitis, all the dental health and degenerative joint disease indicators and trauma were lower in Area C, than the other burial areas. This may imply that the individuals interred in Area C were either buffered from environmental, nutritional and physiological stresses which affected those interred in the rest of the cemetery or, in accordance to the 'osteological paradox', they were less healthy than those interred elsewhere and consequently succumbed to the stresses before they could manifest skeletally.

### *6.5.5 Burial Practice and Demography*

Only 6.5% (35/535) of the graves for which burial type was known contained any support stones, were constructed from stone or contained wooden chests. Nonetheless, the small number of 'elaborate' burial types suggests that the people to whom they were accorded held some significance to the community who dealt with their death, which meant that they were provided with a form of burial different from the norm.

Some interesting observations can be made about the relationships between burial practices, age and sex in the Black Gate cemetery, which correspond with the findings from other studies on later Anglo-Saxon burial practices. All demographic groups, immatures, adults, males and females, were accorded elaborate grave types and grave variations. Each of the more elaborate grave types (chest, rubble cist and stone cist) and variations (pillow stones, earmuffs and head cists) were present in senior adult graves. Indeed, the burials of senior adults exhibited the greatest variety of grave types and variations. Senior adults are the only age group to be buried in chest burials. Senior adults also showed the greatest percentage of elaborate grave types. In contrast, pre-infants (foetal and neonates) and young adults showed the smallest amount of variability in their burial type and form. Among pre-infants and young adults, aside from plain earth-cut graves and coffins, there was only a single example in each demographic group of burial in a stone cist; there were no other grave variations present. The distribution of more elaborate graves throughout all age categories, but higher prevalence amongst senior adults, suggests, then, that elaborate burial was preferentially accorded, but not restricted, to senior members of the Black Gate population.

The greatest proportions of elaborate burial types, grave types and grave variations were seen amongst senior adult females. The provisioning of senior adult females with elaborate burial types can be interpreted in one of two ways. Firstly, their inclusion in elaborate burials may represent secondary status acquired from association with a male partner. Secondly, senior adult females may have been deemed of suitable or sufficient status to receive elaborate burial in their own right. Indeed, documentary evidence suggests that females held a certain social standing in their own right. For example, there were female abbesses heading double monasteries, females are listed as major landholders in the Domesday survey and they held legal rights. It is not until after the Norman Conquest that the automatic allocation of inheritance to the first born male (primogeniture) was introduced to England. Thus, at the time of use of the Black Gate cemetery male and female siblings may have been treated as being of equal status. An unmarried Anglo-Saxon woman had the right to do business on her own. Not only was she able to hold land, but she was also able to make wills and contracts, and could sue or be sued (Aethelberht 74, 78, 79 and Aethelred 26, 39 (Fell 1986: 56-61; Härke 1997: 130). Furthermore, there are several contemporary biographical works documenting the lives of prominent women in the later Anglo-Saxon period. For example, The *Life of Alfred*, written by Asser in approximately 893, documents the career of Eadburh who married the King of Wessex in *c*. 789 and subsequently gained almost complete autonomy over his realm, and is even reputed to have poisoned the king (Dietrich 1979: 35). Bede documents in his *Ecclesiastical History* that Abbess Hilda ruled over both men and women at the double monasteries of Whitby and Hartlepool and that both ordinary men and kings sought her counsel (Dietrich 1979: 36). Furthermore, females could reign if their husbands died. For example, the Anglo-Saxon Chronicle entry for 672 states that 'Cenwealth died, and his queen Seaxburh reigned one year after him' (Savage 1982: 51).

The fact that senior adult females were more often buried in elaborate burials than younger females suggests they probably accrued their status through association with a wealthy husband, and therefore are more frequently represented in elaborate burials than young adult women, who had possibly yet to marry. The role of a senior adult female as a mother and grandmother may have accorded them more social value than their economic influence, which may have been the focus of early Anglo-Saxon burials (i.e. 5$^{th}$ to 7$^{th}$ centuries), and when younger adult females were accorded more elaborate burials than senior adult females.

Within the Black Gate cemetery, all the immature age categories included at least one burial in an elaborate grave type (i.e. a rubble or stone cist) or elaborate grave variation (i.e. containing pillow stones, earmuffs or head cists). The exception was pre-infants for which there was only a single stone cist burial and no other elaborate grave type or grave variation. It is possible that the provisioning of immatures with elaborate burials represents that they were regarded as being of sufficient social status in their own right to be accorded such burial, or they acquired status from association with a high status family member. Anglo-Saxon documents indicate that children were accorded a great deal of care during life and it is, therefore, a fair assumption that they would continue to be bestowed such care in death. For example, Kuefler (1991: 827) lists several Anglo-Saxon laws that protected children from intentional harm at the hands of others (specifically rape and incest) and provided for them if their parents died, separated, or simply abandoned them. It has been argued that some children may have been regarded as 'miniature adults', a view apparently supported by the presence of child monks and nuns, known as 'oblates,' which appear to have been a common occurrence in Anglo-Saxon England from the 7th century (Kuefler 1991: 824). According to the writings of St Wilfred, in the 7th century, seven years was the accepted age for children to become monks. Considering the documentary evidence, it is unlikely that the immature cist burials observed in Area C represent oblates, as they were all aged less than seven years, and four were aged less than three years at the time of death. Nonetheless, it should be noted that Bede, writing in the early 8th century, stated that although he had entered a monastery at the age of seven, children as young as three could be ordained into monasticism (Kuefler 1991: 824-5). Overall, it seems unlikely that children were widely regarded as 'immature adults', and it is notable that oblates had to be accompanied in the monastery by an adult mentor or 'master' (Kuefler 1991: 825). Moreover, there is written evidence to suggest that children in general were not regarded as 'minature adults' and that they, accordingly, partook in different activities to adults and had different legal rights (Crawford 1999; 2001). Distinction between adults and children in the late Anglo-Saxon period is evidenced by the depiction of children and adults in the *Harley Psalter,* an illustrated copy of the Psalms dating to the mid-11th century. The drawings within the *Harley Psalter* represent children as smaller than adults, sometimes naked or dressed in 'short tunics clinched at the waist', whereas adults are shown wearing cloaks, which are never shown on young children (Crawford 1999: 48-9). Therefore, it does not seem likely that immatures were accorded equal burial practices to adults because they were regarded as 'immature adults'. Rather, it is more likely that the immatures, or at least some of them, inherited status from their parents, which was then reflected in the type of burial they were accorded.

It is probable that the children interred in elaborate burial types were the children of elite members of society, especially if the Black Gate cemetery served a monastery. King Oswiu consigned his baby daughter Aelfflaed to the minster at Hartlepool after the Battle of Winwaed in 655 (Foot 2006: 83). However, the children of parents with no significant wealth or status were also donated to monastic institutions in dedication to God in gratitude for the cure of a sick child in answer to their prayers. In the 7th to 8th century the parents of the future missionary Willibald swore an oath that they would dedicate their son to God at the age of five when he recovered from a period of severe illness during infancy after they took him and prayed for him at a standing cross (Foot 2006: 143, 311). Indeed, the gift of a child to a monastic community – oblation – was also done to secure the spiritual welfare of the oblates parents and entire family, or alternatively to 'dispose of the unmarried and unmarriageable' divorcing them from their rights to potential family inheritance (Foot 2006: 141).

It seems that the provisioning of immatures, particularly infants, and adult females with elaborate burials represents family status, and that everybody, regardless of age or sex, within a family would be accorded equal levels of mortuary investment. It is also likely that senior adult females 'earned' elaborate burial in their own right.
Males were typically associated with making claims to land and with wealth and family status in the Anglo-Saxon period, with their high status being inferred from their association with elaborate grave markers at Chester-le-Street, Durham, York and Ripon (Hadley 2004: 315-19). The low number, and disturbance, of grave markers within the Black Gate cemetery prevent investigation into the relationship between male socio-economic status and stone grave markers. There were, however, no statistically significant differences in the percentages of elaborate burial types, grave types or grave variations between males and females within the Black Gate cemetery, suggesting equality in status, at least as reflected in burial provision. The lack of differentiation between the burial practices accorded to males and females is consistent with Buckberry's (2004; 2007) analysis of the later Anglo-Saxon cemeteries

of York Minster, Swinegate, York, St Andrew's, Fishergate, York, St Peter's, Barton-upon-Humber, St Mark's, Lincoln and Barrow-upon-Humber which revealed no relationship between sex of the deceased and either grave type or grave variation. However, Buckberry only had sufficient data for the presence of head support stones from St Peter's, Barton-upon-Humber (Buckberry 2007: 121-2). The increase in variability and elaboration of burial practices seen with age at Black Gate, and the inference that age has a greater impact upon burial practices than sex also reflect the results of Buckberry's research (Buckberry 2004: 288).

### *6.5.6 Burial Practice and Palaeopathology*

Comparisons of the prevalence of health indicators in plain and elaborate burials revealed few statistically significant relationships, those that were observed can be summarised as follows:

- *Plain burials exhibited statistically significant higher prevalences of SDJD than elaborate burial types and grave types*
- *Elaborate burial types exhibited statistically significant higher prevalences of trauma and greater male stature than plain burials*
- *In plain burials, the prevalences of TPNB, calculus, abscesses, AMTL and trauma were significantly greater in adult burials relative to immatures*
- *In elaborate burial types and grave types dental caries were significantly greater in adults than in immatures*
- *In elaborate grave types and grave variations TPNB was significantly greater in immatures than adults*
- *In plain burials TPNB, DJD and ADJD were significantly more prevalent in males than females. Elaborate burial types, grave types and grave variations exhibited no significant differences between males and females for any of the health indicators*

There were several non-significant trends within the data:

- *Plain burials exhibited greater prevalences of dental abscesses and AMTL than elaborate burial types, grave types and grave variations*
- *Elaborate burial types, grave types and grave variations exhibited higher prevalences of cribra orbitalia and TPNB than plain burials*

- *Plain burials exhibited greater frequencies than grave types but lower frequencies than grave variations for DEH, maxillary sinusitis, calculus, and caries, DJD, ADJD and SDJD*
- *Ten of the thirteen health indicators were more prevalent in elaborate grave variations than elaborate grave types*
- *Cribra orbitalia in immatures exceeded the frequencies observed in adults in all burial categories*
- *Adults exhibited greater prevalences than immatures in all burial categories for calculus, caries, abscesses, AMTL and trauma. Caries, calculus and abscesses were only observed in immatures interred in plain burials*
- *In plain burials, DEH was more prevalent in immatures than adults. In contrast, adults interred in elaborate burial types, grave types and grave variations exhibited higher prevalences of DEH than the immatures*
- *In plain burials, TPNB and maxillary sinusitis were both greater in adults than immatures. In contrast, the frequency of TPNB and maxillary sinusitis was greater in immatures than adults in elaborate burial types, grave types and grave variations*
- *DEH, dental calculus and DJD were more prevalent in males than females in all the burial categories.*
- *AMTL was more prevalent in females in all the burial categories*
- *Cribra orbitalia, TPNB, dental caries, ADJD and trauma were all greater in females than males in plain burials but greater in males relative to females in elaborate burial types, grave types and grave variations*
- *Dental abscesses and SDJD were most prevalent in female plain burials, but more prevalent in males in elaborate burial types, grave types and grave variations*

Overall, there were few statistically significant correlations between burial practice and health status within the Black Gate cemetery. The majority of statistically significant relationships were observed for the plain burials. This higher number of statistically significant relationships observed in the plain burials probably reflects the large number of plain burials available for analysis and small number of elaborate grave types (n = 22) and variations (n = 19). To interpret the relationship between health and burial practice the statistically significant relationships were considered in conjunction with the non-significant trends in the data. The relationships between health and burial practices for the total population then the relationships between adults and immatures and males and females will be considered in turn.

There were no significant differences between plain and elaborate burial types, grave types and grave variations observed for indicators of non-specific stress, non-specific infection or dental health. The only significant differences were the greater male stature and prevalence of trauma in elaborate burial types relative to plain burials, and the reverse relationship observed for SDJD.

Trauma was statistically more prevalent in elaborate burial types, with both immature and adult burials showing a greater prevalence in elaborate burials, grave types and grave variations relative to plain burials. None of the studies of later Anglo-Saxon burial have investigated the relationship between trauma and burial practice (Buckberry 2004; Craig 2009; Craig and Buckberry 2010). One study that *has* undertaken such an analysis also revealed a distinct correlation between burial type and trauma, although the results of that study revealed an inverse relationship between trauma and elaborate burial practices (Robb *et al.* 2001). That study of the relationship between the total number of grave goods and trauma prevalence observed within the 7$^{th}$- to 3$^{rd}$-century BC cemetery at Pontecagnano (Salerno, Italy) by Robb *et al.* (2001: 219) may, however, simply indicate that the number of pottery grave goods, used as an indicator of status, was not an accurate measure of status in that cemetery. The fact that the greater prevalence of trauma in elaborate burials at Black Gate was statistically significant for all burial practices (burial type, grave type and grave variation) and for both immatures and adults implies that this is a real relationship. It indicates that those interred in elaborate burials experienced a greater risk of trauma from falls and accidents than those interred in plain burials. This difference between those interred in plain and elaborate burials may reflect differences in occupational or recreational activities, or in the environment within which they lived. Those interred in elaborate burials may have been involved in more dangerous leisure pursuits such as hunting and riding. Alternatively (or even in addition) they may have been people involved in trade and work crafts which involved a greater risk of trips or injury, but which simultaneously provided them, or their family members with the wealth to provide an elaborate burial.

The significantly greater male stature observed in elaborate burials indicates that males were accorded better resources than those buried in plain graves or elaborate grave variations. For example, males may have had better access to food and medical treatment etc. and a nutritional surplus during their growing years. Males interred in elaborate grave types experienced lower levels of dietary and environmental stress than those interred in plain and elaborate grave variations. In association with the almost exclusive burial of males in Area C, where the elaborate grave types were found, may suggest this was a group of elite males, specially selected for burial in this preferred burial location adjacent to the church. However, the burial location analysis revealed no consistent evidence for better health in Area C. If the higher stature of males interred in plain graves represents preferential treatment in life that treatment would have occurred during adolescence when there is a catch-up period in growth, which can disguise any earlier restrictions on growth. This contradicts the location data that shows that males in the Compound (in plain burials) were significantly taller than any other burial zone and that males in Area C were generally shorter than in any other burial zones. The fact females interred in different burial zones and burial positions did not exhibit significant differences in stature implies that females did not experience differences in diet and lifestyle particularly in the formative years fits with the burial archaeology and demography data which implies that female status is extrinsically linked to senior adult females and old age.

Both males and females exhibited a non-significant higher stature in elaborate burial types than plain burials. Females interred in graves containing and constructed from stone were significantly taller than those interred in plain graves. However, females interred in elaborate grave types (including chest burials) were shorter than those interred in plain graves (only by 1.7 cm). Analysis of elaborate grave types was carried out with and without the chest burials because it was possible that the use of the chest for burial of the two senior adult females may have been dictated by the short stature of these individuals. No stature was recorded for senior adult female BG644, but BG619 was short for the assemblage at only 156.61 cm. None of the other health indicators would have influenced the decision to place an individual in a chest burial, therefore the two chest burials are included into the elaborate grave category for all other statistical comparisons.

The significantly higher prevalence of SDJD in plain burials than in elaborate burial types and grave types could indicate that those interred in plain burials experienced greater physical stresses than those interred in elaborate burial types and grave types that displayed a lower prevalence. The lack of a significant difference for SDJD between those interred in plain burials and those interred with elaborate grave variations may indicate similar levels of physical stress experienced by these sub-groups of the total population. However, there is no further evidence to suggest that people interred in plain burials experienced greater levels of physical stress than those interred in elaborate burials. For example, neither DJD nor ADJD exhibited an elevated presence in plain burials. It is possible that those interred in Area C, which contained all the elaborate grave types, represent a related group with an increased susceptibility for degeneration of the spine. Alternatively, it may be that the osteophyte formation observed in these individuals was not activity related but representative of some other spondyloarthropathy, such as ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis (DISH). It has been suggested that monks had an increased susceptibility to DISH due to their rich diet (Rogers and Waldron 2001) and DISH is closely associated with obesity and type II diabetes (Jankauskas 2003). However, the association between DISH and monasticism has yet to be proven (Mays 2006: 187) so could just as easily be associated with wealthy secular elites who had access to a rich diet. If people buried in elaborate graves in the Black Gate cemetery represented individuals of higher status than those interred in plain graves, it might be expected that those interred in elaborate graves would exhibit higher prevalences of SDJD if the underlying causes of the osteophyte formation were associated with a rich, gluttonous diet. Most of the individuals exhibiting SDJD were interred in plain burials, indicating that this was not the case. Indeed, there were only six possible cases of DISH within the assemblage (three males and three females), all of which were individuals interred in plain graves. In light of this evidence it is most probable that the statistically significant higher prevalence of SDJD observed in the plain burials was a false positive, as discussed in Chapter 4.

Overall, it appears that individuals interred in elaborate burials showed either a greater susceptibility, or stronger biological response, to the factors causing cribra orbitalia, trauma and TPNB in childhood. Individuals in plain burials exhibited a greater prevalence of dental abscess and AMTL, suggesting an increased susceptibility to dental infections. This does not correlate, however, with the patterns observed for dental calculus and caries, which are intrinsically linked to dental abscesses and AMTL. The argument that the higher prevalence of abscesses and AMTL represents a higher risk of infection is supported by the higher prevalence of TPNB observed for adults buried in plain burials.

The greater prevalence of cribra orbitalia observed in elaborate burials contradicts the assumption that the poor in later Anglo-Saxon England would have been more susceptible to dietary deficiency conditions relative to individuals of higher socio-economic status. In theory, iron deficiency would also have been more prevalent amongst the poorer members of later Anglo-Saxon society who did not have regular access to iron-rich meat, fish or dairy produce which contain iron that is more easily absorbed than that attained from fruits, vegetables, beans, pulses and cereals (Hercberg *et al.* 2001: 541). Historical sources indicate substantial variation in the access to plant and animal foods between different social groups. In the Anglo-Saxon period, wealthy lay people and well-off monastic communities consumed large amounts of meat, predominantly beef and fish, while the lower classes derived most of their dietary protein from plants and dairy products (Dyer 1998; Müldner and Richards 2005; Woolgar *et al.* 2006: 273; Müldner and Richards 2007b: 162). The diet of wealthy peasantry and artisans in the later medieval period was reasonably good, especially as the products of horticulture from their gardens and small holdings supplemented it (Woolgar *et al.* 2006: 272). It is possible that similar small areas of cultivatable land were available in the later Anglo-Saxon period, but there is no surviving archaeological evidence. Poor people with little or no land, whether they lived in the town or country, would have experienced the most restricted diet of all. Some may have kept domestic fowl, such as chickens in the towns and ducks in the country, but the poor in neither urban nor rural settlements would have owned sheep, cattle or pigs (Woolgar *et al.* 2006: 271). Woolgar *et al.* (2006: 272) state that the monasteries and houses of the nobility would have occasionally assisted the poor with donations of leftovers and alms. In his letter to the monks of Eynsham – in approximately 1005 – Aelfric instructs the monks to wash the feet of three paupers who are regularly fed in the monastery and provide them with the same foods as consumed by the monks themselves (*LME* 62; Jones 2006: 141). In the later medieval period landowners provided their peasant labourers with food during and immediately after the grain harvest (Woolgar *et al.* 2006: 272), providing a further supplementation of the peasant diet. It is probable that similar enhancement of the diet of the poor and labouring forces also occurred in the Anglo-Saxon period. Bullough and Campbell (1980: 319) proposed that grain products such as bread produced from mixtures of rye, wheat or barley and broths composed of any produce available were the major contributory items of the diet of early medieval peasants. Indeed, it appears that cereal based foods were available to everybody, just in varying qualities. For example, different grades of bread are documented in historical sources. Wheat was the premier bread grain, producing the whitest and lightest loaf. Rye and maslin (a mixture of rye and a small quantity of wheat also known as 'mixed corn') were used to produce bread of a darker hue and inferior value. Barley and oats were milled and baked to produce coarse, cheap bread (Dyer 2000: 88; Stone 2006: 13).

Comparisons of the frequencies of health indicators between plain burials and those constructed from stone or from wooden chests and those containing head support stones and head cists revealed no consistent patterns. Those buried in elaborate grave types and grave variations did not show a common higher or lower prevalence in non-specific stress, non-specific infection, dental health or bio-mechanical stress. However, graves containing elaborate grave variations (such as stone supports around the head) were much more likely to exhibit stress indicators than elaborate grave types constructed from stone or containing chests. Ten of the stress indicators were more prevalent in elaborate grave variations, whereas only three were more prevalent in elaborate grave types. The ten health indicators most prevalent in elaborate grave variations were DEH, TPNB, maxillary sinusitis, calculus, caries, abscesses AMTL, DJD, ADJD and SDJD. For seven of these health indicators (DEH, maxillary sinusitis, calculus, caries, DJD, ADJD and SDJD) plain burials exhibited intermediate frequencies of health indicators relative to elaborate grave types and grave variations. This phenomena may be explained as those interred in elaborate grave types were less exposed to irritants in the air, consumed a diet less dependent on protein and sugar, or practiced better oral hygiene and experienced greater levels of physiological stress than those interred in plain and elaborate grave variations. Those interred in plain graves and with elaborate variations were exposed to similar environmental stresses to each other but greater than those interred in elaborate grave types. Those interred with elaborate grave variations survived longer in comparison to those interred in plain graves allowing time for physical manifestations of conditions to occur upon the skeleton.

The immatures consistently exhibited a greater prevalence of TPNB relative to adults in elaborate burials for all burial types, grave types and grave variations, to the point of significance for burial types and grave variations. This may be associated with the greater prevalence of trauma observed in immatures interred in elaborate burials. Rough and tumble play may have resulted in localised soft-tissue injuries to the shin causing localised sub-cutaneous bleeding. Alternatively, the higher prevalence of TPNB in immatures may support the 'osteological paradox' that these immatures represent those children who were healthy enough, and had a sufficiently robust immune system, to survive periods of systemic stress and haematogenous spread of bacterial infections of *Staphylococcus*, *Streptococcus* and *Pneumococcus* to the anterior tibia ( Roberts and Manchester 1995: 127-9; Larsen 1997: 83-4).

In elaborate burials, dental caries was greater amongst adults than immatures. This relationship most likely reflects the accumulative effects of age on these health indicators. Supporting evidence for this claim is that adult frequencies exceed those of immatures for all burial practices for dental calculus, caries, abscesses, AMTL and trauma. The frequencies for DEH, TPNB and maxillary sinusitis are contradictory between plain and elaborate burial types, with plain burials showing a greater immature prevalence relative to adults in plain graves and adult prevalences exceeding immatures in elaborate burials (DEH) or the other way around (TPNB and maxillary sinusitis). This correlates with the observations in Chapter 5 that dental health indicators and trauma accumulated with age, whereas DEH, TPNB and maxillary sinusitis were not accumulative.

Aside from dental caries in elaborate grave variations, no other stress or health indicator within the Black Gate assemblage revealed a difference between plain and elaborate burials specific to males or females, suggesting that individuals of the same sex interred in plain and elaborate burials did not experience vastly different environments and diets.

There does not appear to be a systemic difference between plain and elaborate burials overall. There are no clear differences in diet or activity and there appears to be no bias in the health status of males or females in elaborate burials compared to plain.

This implies that elaborate grave types and variations do not represent social differences in terms of socio-economic status or, alternatively, that the contributing population was not a hierarchical society to the extent that some members of the community were sufficiently polarised to experience differences in environmental, nutritional and physical stressors substantial enough to affect skeletal health.

### *6.5.7 Body Position and Demography*

Older individuals presented a greater variety of body positions with advancing age. Aside from young children, prime, mature and senior adults exhibited the greatest variation in the disposition of the body within the grave, with individuals in the pre-infant, infant, older child, adolescent and young adult age categories buried only supine or on their right side. Males were more typically interred supine or prone, whereas females were more commonly placed on their left-side, right-side or flexed. The only two flexed burials were of senior adult females. This finding challenges Buckberry's observations that flexed burials in later Anglo-Saxon cemeteries were typically of infants, who were too small to be laid out fully extended (Buckberry 2004: 170). The two flexed senior adult females were interred in chests, and their body position reflects the restricted space within such a burial and, therefore, in this instance body position does represent differential burial practices.

### *6.5.8 Body Position and Palaeopathology*

Statistical analysis revealed a significant difference in the prevalence of TPNB between supine and non-supine burials, and the prevalence of AMTL was statistically different between the five body positions. However, both these statistically significant results do not appear to represent a real relationship. There are no obvious reasons why being buried in a different position – e.g. on the left or right side – are not shown to be associated with different burial types, and the lack of relationship between palaeopathology and body position for any of the other stress indicators indicates that there is no real relationship between body position and health. Body position does not appear to be influenced by status, save for in certain instances, such as the chest burials whereby the restriction of space within that specific form of burial affected body position.

There are no relationships between body position, age, sex and health indicators. There is, however, a preponderance of right-sided burials in the Compound, the cause of which is most probably associated with the practicality of preventing inter-cutting of burials and a preponderance of space for burial than as a mode for socio-economic and cultural display.

## 6.6 Summary

There were a number of characteristics of the areas to the north (Railway Arches) and south (Area C) of the building represented by structures A, B and 68, which support Nolan's interpretation of this building as an Anglo-Saxon church. Firstly, there was a high density of burials in these locations. Secondly, elaborate burial types were exclusively found within these areas. Thirdly, there were concentrations of infant burials close to the walls of this structure. There was also evidence for preferential burial of males in Areas C and D, with a higher frequency of prime and mature adults in Area C. All these characteristics are found near other late Anglo-Saxon churches such as at Raunds Furnells (Northamptonshire) (Boddington 1996: xii, 45), Whithorn (Galloway) (Hill 1997: 139) and Wharram Percy (North Yorkshire) (Mays 2007: 87).

The bio-cultural analysis revealed that the relationship between age, sex, health and burial practice is complex. There appears to be no segregation according to socio-economic status, health or activity between males and females and it seems that the greatest influence upon burial practice was age. These observations correlate with the findings of Buckberry (2004) from her analysis of a range of later Anglo-Saxon cemeteries in Lincolnshire and Yorkshire. Buckberry and Hadley (Hadley and

Buckberry 2005: 141-2; Buckberry 2007: 121-6, Hadley 2009: 145-6; 2011: 293) both observe that there was no correlation between either age or sex and burial provision in the later Anglo-Saxon period. Other studies have shown that individuals interred in more elaborate burials exhibit less biological stress than those buried in plain graves (Craig and Buckberry 2010: 138). Indeed, this study shows a similar pattern between stress and elaborate grave types (i.e. those graves accorded the greatest investment in their construction) but that individuals interred with stone inclusions – i.e. with elaborate grave variations – presented greater prevalences of stress indicators than plain burials. This has been interpreted as indicating that those interred in elaborate grave types (chest burials, rubble cists and stone cists) represent the members of the community of greatest socio-economic status and were therefore culturally buffered from external stressors. Those interred with elaborate grave variations (pillow stones, earmuffs and head cists) represent an intermediary group between plain burials and elaborate grave types, which were subjected to the same environmental stressors as those interred in plain burials, but were able to survive periods of insult for longer, and therefore stress manifest upon the skeleton skeletally. This hypothesis that elaborate grave types and elaborate grave variations represent distinct groups of socio-economic status is supported by the fact that these burials are found in clearly separate locations. The lack of significant difference seen in some of the relationships between age, sex, stature, health and burial location and burial type may be an artefact of the small numbers of elaborate burial types, grave types and grave variations included within the Black Gate cemetery.

Several aspects of the Black Gate burials indicate the increased influence of concepts of family on the choice of burials. There were multiple burials containing adults and children indicating family relationships. The high number of infant burials, comparable to other later Anglo-Saxon cemeteries, but greater than earlier burial grounds, indicates an increase in family status enabling inclusion of the youngest family members in higher status cemeteries associated with churches and religious communities (Hadley

2010: 107; 2011: 294). Furthermore, the presence of immatures throughout the Black Gate cemetery agrees with the findings of Hadley (2010: 108), that family status, sex of the deceased child and their 'position within the family' contributed to the location within the cemetery that was chosen for their burial. The inclusion of immatures and senior adults – particularly females – in elaborate burials suggests there was no exclusion of the young and old which have been seen by researchers as 'non-active' members of the community (Bello and Andrews 2006: 9). It seems to the current author that to deem these members of the community as 'non-active' because they were not of working, fighting, marriageable, or childbearing age is erroneous. Senior adults have invested a lot into the community throughout their lives and children have potential to contribute greatly in the future. Senior adult females may be wealthy due to the death of a husband, can pass skills on to younger members of community, and maybe help with childcare. The interment of children in elaborate burials (which occurs less frequently that for senior adult females) is more complex and problematic.

# CHAPTER 7

# A COMPARISON OF THE BLACK GATE CEMETERY TO THIRTEEN SITES OF KNOWN CONTEXT

This chapter compares the stress and health indicators observed within the Black Gate assemblage with the thirteen sites of known – urban, monastic or rural – context, discussed in Chapter 4. Whereas Chapters 5 and 6 investigated the intra-cemetery relationships between health and social status within the Black Gate cemetery, this chapter provides an inter-cemetery comparison with thirteen sites of known settlement type. The intention of this chapter is to explore whether specific settlement types – urban, monastic and rural – experience differences in the levels of physiological stress that can be recognised in the osteological record. Comparative analysis of the health status between different sites can help place the Black Gate health profile in context, and enable us to establish whether the Black Gate people express levels of physiological stress that are analogous with other early medieval cemetery assemblages. A similarity in the prevalence of stress indicators between Black Gate and another cemetery population may suggest the contributing populations of the sites originate from a similar settlement type, illuminating the origin of the Black Gate contributory population. To investigate if the origins of the Black Gate cemetery population is identifiable via similarities in the prevalence of health indicators with one or more sites of known context, a two stage approach was implemented. Firstly, all the crude and true prevalence rates (CPRs and TPRs) available for each site were compared to provide an overall health profile, which would resolve which of the following hypotheses was most applicable:

Hypothesis 1

There is no difference in the overall health profile of the Black Gate cemetery from the comparative site indicating they derive from similar environments, possibly settlement type.

Hypothesis 2

There are differences in the prevalence of non-specific stress, non-specific infection, dental health, degenerative joint diseases and trauma great enough between the overall health profiles of the Black Gate and the comparative site to indicate different living environments and stressors, possibly different settlement types.

Secondly, each health indicator available between the Black Gate and the comparative site was compared independently to identify where similarities and differences between the two overall health profiles arise. For example, two sites may have a statistically homologous prevalence of childhood health indicators (cribra orbitalia and DEH), but may share no significant similarity between the dental health indicators, implying similarities in their lifestyles throughout childhood, but differences in adult diet and oral hygiene. The hypotheses tested in this instance were:

Hypothesis 1

There is no difference in the prevalence of each specific health indicator calculated for the Black Gate cemetery and the comparative site indicating similar causative factors responsible for the expression of that palaeopathological condition within the two sites.

Hypothesis 2

There are differences in the prevalence of each specific health indicator calculated for the Black Gate and the comparative site indicating different levels of the causative factors responsible for the expression of that palaeopathological condition within the two sites.

Thirdly, to enhance our understanding of the results of the comparisons between the overall health profile and specific health indicators between the Black Gate cemetery and each site of known context, the comparative sites were grouped into 'urban', 'monastic' and 'rural' contexts'. The urban sites were York Minster, Swinegate and St Andrew's, Fishergate in York and St Nicholas Shambles in London. The monastic sites were Wearmouth and Jarrow (Northumberland), Ailcy Hill, Ripon (North Yorkshire) and Llandough (Glamorgan, Wales). The rural cemetery assemblages were from Raunds Furnells (Northamptonshire), Wharram Percy (Yorkshire), Addingham (Yorkshire), North Elmham Park (Norfolk) and St Peter's, Barton-upon-Humber (North Lincolnshire). The hypotheses tested in this instance were:

Hypothesis 1

There is no difference in the prevalence of the specific health indicator between the Black Gate, urban, monastic and rural settlements, indicating similar environmental, social and cultural influences during the lives of people living at the settlements.

Hypothesis 2

There are differences in the prevalence of the specific health indicators between the Black Gate, urban, monastic and rural settlements, indicating different living environments and stressors during the lives of people living at the settlements.

Data pertaining to health in the later Anglo-Saxon period are often only interpreted in terms of their relationship to other periods (Wells 1997; Waldron 1989), particularly late medieval populations (Lewis *et al.* 1995; Lewis 2002a, b; Ribot and Roberts 1996; Roberts 2009). Roberts and Cox (2003) provide the most comprehensive attempt to date of placing the skeletal manifestation of stress and health in the early medieval period into an archaeological context. In a comparison of health in the early (mid-5th to mid-11th century) and late medieval (mid-11th to mid-16th century) periods, Roberts (2009) found several differences which were ascribed to rural settlements characterising the early medieval period while urban settlements made up the majority of late medieval sites in their comparative analysis. The differences in health between the predominantly rural early medieval and increasingly urbanised late medieval period suggested something about the impact of urbanisation, including the fact that air quality, hygiene and sanitation were poorer, the population denser and housing more crowded. Infectious disease load was also higher in urban environments, and there was an increase in the levels of industrial activity in towns and cities and deficiencies in the diets of some people and excesses in the diets of others (Roberts 2009: 308, 320). Maxillary sinusitis frequencies increased from 16-80% in the Anglo-Saxon period to 31-72% in the later medieval period (Roberts 2009: 312). Cribra orbitalia also increased with frequency from the early to late medieval period. Roberts suggests that these increases in respiratory infection and deficiency disease indicate poorer health, hygiene and sanitation, predisposing people to more infectious disease in the late medieval period urban environment (Roberts 2009: 315). She ascribes an increase in TB to the density of people living in urban populations, within sneezing and coughing distance from other people and in close proximity to infected animals (Roberts 2009: 315). An increase in DEH and decrease in adult height for both males and females represented an increase in childhood dietary stress (Roberts 2009: 316) and the increase in caries and DISH was associated with increasing excess in diet. The increase in caries was linked to an increased consumption of sugar and the increase in DISH attributed to an increase in protein within the diet (Roberts 2009: 316). Lewis

(2002a, b) compared childhood health in the early medieval Raunds Furnells assemblage with late medieval and post-medieval populations to investigate the impact of urbanisation on childhood mortality, growth, indicators of physiological stress and prevalences of metabolic and infectious disease. Lewis noted that individuals buried in cemeteries associated with urban settlements had higher levels of DEH and dental disease. In contrast, she observed that the agricultural communities were particularly susceptible to respiratory diseases and that both urban and rural settlements showed low levels of trauma (Lewis 2002a: 56-7). Lewis ascribed the differences observed between urban and rural settlements to 'environmental conditions, urban employment, differences socio-economic status, and changes in weaning ages and infant feeding practices' and identified that environmental pollution was not as damaging as is implied in the documentary evidence (Lewis 2002a: 57-8; 2002b: 211). It must be noted, however, that Lewis found no statistically significant differences in the prevalence of indicators of stress between the total immature populations of the urban and rural sites (Lewis 2002a: 56).

Comparative studies of urban and rural settlement in the early and late medieval periods are based on the assumption that the early medieval period was characterised by rural farming communities and that the late medieval period, in contrast, was typified by urbanised settlements. In general, such a characterisation is correct but the situation is not as straightforward as some studies suggest. The early medieval period was one of increasing urbanisation, and the origins of the urbanisation of England began in that period. The process of population growth and development of urbanisation, after the withdrawal of the Romans in 410, recommenced in the 7$^{th}$ century and was well established by the 9$^{th}$ century with the development of *wics*, *emporia*, *burghs*, monastic sites with associated lay settlements and more established urban settlements at York, London and Southampton. The current study focussed on the relationship between different settlement types broadly contemporary with the period of use of the Black

Gate cemetery, namely the 8th to 12th centuries, to identify if any patterns in stress and health existed between settlement types during this period.

Many comparative studies of skeletal stress markers work on a population level, comparing crude prevalence rates. The studies compare the number of individuals affected with a specific pathology as a percentage of the total population between different sites. Such studies, including the work by Roberts and Cox (2003) and Steckel and associates (Steckel *et al.* 2002a, b), allow overall temporal trends in the prevalence of stress and disease, and changes between the sexes over time to be assessed. Thus, they potentially provide important insights into the impact of changes in the physical, political and social environment upon health. However, studies comparing CPRs are extremely generalised and not particularly accurate assessments of health. The main problem of such studies are that they quantify the frequencies of diseases and skeletal modifications as a proportion of the entire population, with no regard as to the actual number of people for which that condition can be recorded. This dilutes the actual prevalences of conditions and weakens their interpretation. Many of these studies are direct comparisons of the total population, with no regard for the differences in health experienced by different members of that population throughout their life course. Furthermore, the comparisons made normally cover a large geographical area. For instance, Roberts and Cox (2003) were comparing different time periods for the whole of Britain and Steckel and associates (Steckel *et al.* 2002a, b) were comparing entire continents. Such large-scale projects are beneficial for identifying the global evolution and migration of diseases and people, but reveal little about the nuances of lives of individuals and communities in the past. Comparisons of stress within more localised temporal and geographical parameters, as attempted within the current study, may enhance our understanding of life and stress in the past to a greater degree than is possible from larger-scale studies.

## 7.1 Reasons for Differences in Mortality and Morbidity between later Anglo-Saxon Urban, Rural and Monastic settlements

The following section explores the current understanding of health and the transmission of infection and disease and how it relates to what is known about the later Anglo-Saxon period. The reasons for why it would be expected that urban and rural settlements in the early medieval period would exhibit different health profiles are considered based on the current knowledge of the impact of urbanisation on health and the archaeological evidence.

There is evidence, primarily from York, that urbanisation in early medieval England had a negative impact upon the health of people living in urbanised settlements in towns (Addyman 1972; Hall and Kenward 2004), and therefore, it is probable that differences in health existed between urban and rural settlements. At present, the main causes of death in developing countries are water borne diseases or conditions directly related to poor, stagnant or contaminated water supplies, such as malaria, dysentery and cholera (Checkley *et al.* 2004), and the same is likely to have been true of the later Anglo-Saxon period. Rivers and streams would have been the predominant water supply for both urban and rural inhabitants of later Anglo-Saxon England, supplemented where necessary by wells. Examples of wood-lined wells have been recovered from several sites, such as Portchester Castle (Hampshire) and *Hamwic* (Addyman 1972: 276, 290; Loveluck and Rogers 2007: 100). The rivers Ouse and Foss would have been the principal clean water supply for York. However, it is probable that, upon reaching York, the water may have become contaminated with the refuse from industrial activities such as tanning and metalworking in the 9th to 11th century. Indeed, a slight increase in lead levels has been observed in alluvial deposits recovered from North Street, York from the 10th century onwards (Hudson-Edwards *et al.* 1999; Hall and Kenward 2004: 391). Furthermore, an increase in the presence of more pollutant tolerant freshwater mussels such as *Unio tumidus* and *U. pictorum* recovered from Coppergate has been interpreted as indicating degradation of the water quality as York increased in size (Hall and Kenward 2004: 391). Nonetheless, Hudson-Edwards *et al.* (1999) have established that lead concentrations observed within the North Street river sample were consistent with, or lower than, Roman levels and that therefore, 'metal production ... had relatively little impact on the river environment at York' (Hudson-Edwards *et al.* 1999: 818). Therefore, it is most probable that this pollution derived from domestic activities and tanning not large-scale metal production. The levels of pollution within the rivers of York would not have been significant enough in the later Anglo-Saxon period to deter people from their use as a water supply. This is evidenced by the dearth of wells. For example, during the extensive campaign of excavation throughout York only one tentative barrel well has been recovered, from Coppergate (Hall and Kenward 2004: 394).

Diarrhoea and conditions such as hepatitis are closely associated with poor hygiene and increased contamination in overcrowded conditions (Stuart-Macadam 1989; 1992; Piontek and Kozlowski 2002; Walker *et al.* 2009). Supporting evidence for an increased pathogen load in urban settlements is provided by the abundant human faecal matter recovered from cesspits, yard surfaces and even on building floors from Coppergate. One faecal deposit, recovered from layer 36 in Trench IV at Coppergate, contained the eggs of two parasitic worms that live in the human gut — whipworm (*Trichuris trichura*) and maw worm (*Ascaris lumbricoides*) (Hall *et al.* 1983: 206; Hall and Kenward 2004: 402). The worms themselves live primarily in the small intestine and can cause indigestion, diarrhoea and symptoms akin to ulcers; therefore, the eggs provide indirect evidence for such ailments. These parasite infestations, like many ailments, are typically endemic due to poor levels of hygiene and it is possible that their presence results from organic waste and debris accumulation in and around domestic dwellings (Ottaway 1992: 149). In the streets of 9th-century York rubbish accumulated between and around the high density of industrial and domestic and was deposited in wicker-lined pits. Some of these pits contained human faecal matter and have provided evidence for wooden seats, indicating them to be latrines, although it is also possible that some were storage pits or waterholes (Addyman 1989: 254; Kenward and Hall 1995: 762). Several of these pits contained large numbers of beetles and fly pupae. The most commonly occurring fly species are *Musca domestica* and *Stomoxys calcitrans*, which are known carriers of poliomyelitis and salmonellosis amongst many other diseases (Kenward and Hall 1995: 762). The increase in population density was also accompanied by a high presence of human lice and fleas (*Pediculus humanus* and *P. irritans*), which are known vectors of various pathogens such as plague and typhus (Kenward and Hall 1995: 764; Roux and Raoult 1999). In contrast, a very interesting exclusion from domestic deposits in Anglo-Saxon York, are pubic lice (*Pthirus pubis*), which are found in abundance in the Roman and later medieval periods (Kenward 2001: 167). This may indicate an actual improvement in living conditions and lower population density than in both the preceding Roman and subsequent later medieval periods, as transmission of such lice is dependent on poor personal hygiene and close bodily contact.

One would expect a higher prevalence of tuberculosis developing in the later Anglo-Saxon period, resulting from the increase in urbanisation. The increased population numbers and close proximity of living quarters would have created a perfect environment for the respiratory transmission of tuberculosis (Manchester 2001: 142). Throughout the Anglo-Saxon period pigs, sheep, goats and domestic fowl were kept on orchards and in the gardens and backyards of landowners immediately around and within the town. If domesticates were kept in such close proximity to domestic households there would have been an increased risk of the transfer of disease from animals to humans. Examples of diseases transmissible between animals and humans (zoonoses) present today are parasitic conditions such as *cysticercosis*, which is contracted from swine, and bacterial zoonoses such as *salmonellosis* and *campylobacteriosis*. These zoonoses cause, amongst other symptoms, seizures, headaches fever, diarrhoea, abdominal pain, malaise and nausea (Lightowlers 2010).

*The Anglo-Saxon Chronicle* documents a number of outbreaks of disease affecting domestic animals. For example in 671 there was 'the great death of birds' and in 986 it is stated that 'this year first came the great murrain into England' (Savage 1982: 51, 141). It is possible that the 'great death of birds' was an outbreak of a viral infection such as avian influenza, whereas murrain is a medieval term for non-specific infectious disease which causes large-scale death amongst sheep and cattle. It is possible that some of these diseases were communicable to humans, but it is not possible to identify the type of infection described within Anglo-Saxon texts with any certainty (Hagen 1992: 18). However, the presence of zoonoses associated with domestic animals has been identified upon skeletons recovered from Anglo-Saxon England, the most convincing of which is tuberculosis. Even though tuberculosis is present in the Roman period – 0.2% (12/5716) of total number of individuals for which data were available to Roberts and Cox (2003: 119)) – the frequency of recorded cases increases in the early medieval period – 0.9% (18/2056) of total number of individuals included in Roberts and Cox (2003: 184). This increase has been accorded to increased contact with infected animals kept as domesticates. Such animals would not have had the genetic immunity to tuberculosis, that would have developed in wild animals over time and, therefore they would have been more susceptible to the disease (Roberts and Buikstra 2008: 115).

It also is to be expected that people living in rural, urban and monastic communities would be employed in different occupational activities, which harboured their own dangers and stresses upon the body. In rural settlements occupational activities centred upon the production and acquisition of food. The time of year would have dictated which activities occurred and when. The 'Labours of the Months', an ideological concept prevalent in late medieval art and manuscripts, illustrates that different farming activities occurred at specific times of the year. For example, ploughing occurred in March, May was dedicated to sheep tendering and August was reserved for reaping the harvest (Hagen 1992: 3; Henisch 1995; Judd and Roberts

1999: 236). Peasants were also employed in non-agricultural occupations that yielded cash incomes, such as fishing and the cutting and transport of wood. In addition, they worked in rural industries such as pottery manufacture and quarrying. Near towns, peasants worked the hemp and flax gardens supplying an important urban craft with the necessary raw materials (Dyer 2002: 40). Inhabitants from rural settlements also provided raw materials by mining iron and lead (Dyer 2002: 99).

Within urban settlements craft production was the predominant industry and occupation of their inhabitants. In York, the name Coppergate derives from the Old Scandinavian for 'street of the makers of wooden vessels', and both incomplete and finished examples of such wood working have been recovered in the form of iron tools and finished bowls and cups (Mainman and Rogers 2004: 469). The buildings from Coppergate were predominantly smithies. These smithies were constructed around a central stone or tile-lined clay hearth. The large quantities of metalworking debris, including various metal bars and strips, slag and iron tools such as hammers and files recovered from both around and within these buildings confirmed their identification as smiths (Ottaway 1992: 151). In approximately 975, major rebuilding was undertaken within Coppergate, after which metalwork ceased. It is possible that the smithies were removed to a location where their fires and noise were less troublesome. Other crafts practiced at the site include woodworking and the manufacture of textile (Ottaway 1992: 153). Large quantities of leather off-cuts suggest that buildings at Coppergate, and also Micklegate and Pavement, were used for leather working (Mainman and Rogers 2004: 469). Excavations of middle Anglo-Saxon Ipswich have similarly revealed evidence for localised areas of intensive craft activity, including copper-alloy working and pottery manufacture, while other artisan activities such as metalworking of copper-alloy and iron, bone and antler working and spinning and weaving were dispersed throughout the rest of the town. During the later Anglo-Saxon period there were no strict distinctions as to which occupational activities occurred where. Indeed, there are a number of shifts in the location of specific manufacturing activities throughout this period. During the 9th century the small-scale manufacture of hand-shaped pottery and cloth making in the countryside moved to more large-scale production in urban centres such as Thetford and Norwich, Lincoln, Torksey and York (Dyer 2002: 65) with weavers prolific in towns by the 11th and 12th centuries (Dyer 2002: 65). However, from the 12th century, this pattern was reversed, with crafts and industries such as weaving and pottery making a return to the countryside (Dyer 2002: 169). This shows, as with population movement, that nothing is dormant and people, objects and industries are always in a state of flux. Therefore, no general statements about the evolution of industries, settlements and population movement in the later Anglo-Saxon period as a whole can be sustained as there were many changes that occurred between the 8th and 12th century and these changes did not follow a linear trajectory (Wade 2001: 86).

Manual labour would certainly have been common within most Anglo-Saxon religious communities, but the extent and physicality of such labour is not entirely known. Bede documents that Eosterwine, a young aristocrat who became the second abbot of Wearmouth, shared with other monks the domestic work, which included winnowing, threshing and ironworking (HAB 8; Plummer 1896: 371-2; Cramp 2005: 360, 367). Monks and nuns at other institutions may have interpreted the concept of labour more liberally and engaged only in the less strenuous agricultural tasks, such as weeding or fruit picking, while the communities' slaves and tenants performed the more arduous work (Foot 1990: 52-3). To many commentators work was a form of prayer, undertaken (like fasting or keeping vigil) to subdue the flesh and to prevent idleness. 'Monks supplemented their prayer with labour so that sleep does not creep upon them' (*SC II*.14) wrote the monk John Cassian (*c.* 370 - *c.* 435) in *De Institutis coenobiorum,* his work on monastic life based upon his experiences in Egypt (Lake 2003; *Institutes* II. 14 (Guy 1965: 82-3). Even though Cassian was writing in the 4th century his works were still in circulation in the Anglo-Saxon period with both the anonymous author of the Life of St Cuthbert (*c.* 634-687) and Bede (*c.* 673-735) quoting *De Institutis coenobiorum* directly (Lake 2003: 34-5, 39). Several hagiographical accounts describe 'labour' activities engaged in by the religious males in minsters including reading, the copying of manuscripts and baking (Foot 2006: 211, 219). Women in minsters seem to have spent much time in weaving; making materials for various purposes such as altar coverings or ecclesiastical vestments as well as garments for themselves (Foot 2006: 214-16). The presence of craft workshops is well attested from known monastic sites that have been excavated such as at Jarrow where workshops exhibiting evidence for metal- and glass-working have been identified, which may have housed lay workmen (Cramp 2005: 241).

## 7.2 Comparison of Assemblage Composition of Black Gate and the Comparative Sites

The percentage of immature, adult, male and female skeletons observed for Black Gate and the comparative sites is shown in Table 7.1. For a more detailed assemblage composition of each of the 14 comparative sites, consult Appendix D.

| Site | Immature | Adult | Male | Female | Unknown sex* | Total Population (n) |
|---|---|---|---|---|---|---|
| Black Gate | 31.4 | 68.6 | 40.4 | 39.3 | 17.9 | 643 |
| York Minster | 22.0 | 78.0 | 63.3 | 22.5 | 14.1 | 91 |
| Swinegate | 36.0 | 64.0 | 45.3 | 43.8 | 10.9 | 100 |
| St Andrew's, Fishergate | 35.9 | 64.1 | 55.9 | 40.5 | 3.6 | 131 |
| Nicholas Shambles | 23.1 | 76.9 | 51.1 | 40.0 | 9.4 | 234 |
| Wearmouth | 35.5 | 64.5 | 46.0 | 33.6 | 20.4 | 327 |
| Jarrow | 42.9 | 57.1 | 42.3 | 33.0 | 24.7 | 170 |
| Llandough | 28.2 | 71.8 | 40.5 | 33.7 | 25.7 | 801 |
| Ailcy Hill, Ripon | 21.2 | 78.8 | 19.2 | 1.9 | 78.9 | 66 |
| Raunds Furnells | 47.1 | 52.9 | 52.4 | 42.9 | 4.7 | 361 |
| Wharram Percy | 22.4 | 77.6 | 58.1 | 39.4 | 21.7 | 255 |
| Addingham | 17.5 | 82.5 | 18.2 | 12.1 | 4.5 | 80 |
| North Elmham | 18.4 | 81.6 | 48.8 | 45.2 | 5.9 | 206 |
| Barton-upon-Humber | 25.3 | 74.7 | 46.2 | 31.8 | 21.9 | 446 |

Table 7.1 *Percentage of immature, adult, male and female skeletons within each assemblage under consideration. (*Immatures have not been assigned biological sex, and therefore are excluded from the unsexed individuals)*

The number of immature individuals present in the different populations ranged from 17.5% (Addingham) to 47.1% (Raunds Furnells). Within the Black Gate assemblage, 31.4% (202/643) of the total population comprised of immatures, which was well within the range observed. The number of immatures as a percentage of the total population was just above average (29.06%) as well as above the median value (26.8%) calculated from the comparative sites. The proportion of adult to immature skeletons observed at Black Gate (immature = 31.4%; adult = 68.6%) was most comparable to the relationship observed at Swinegate (immature = 36.0%; adult = 64.0%), St Andrew's, Fishergate (immature 35.9%; adult = 64.1%) and Wearmouth (immature 35.5%; adult = 64.5%). Of the other sites, 8 had representations of immatures lower than one-third of the total population, whereas Raunds Furnells (immature = 47.1%; adult = 52.9%) and Jarrow (immature = 42.9%; adult 57.1%) displayed noticeably higher frequencies of immatures.

| Site | Pre-Infant | Infant | Young Child | Older Child | Adolescent |
|---|---|---|---|---|---|
| Black Gate | 4.04 | 7.62 | 10.57 | 4.82 | 4.35 |
| York Minster | 0.00 | 1.10 | 10.99 | 7.69 | 2.20 |
| Swinegate | 0.00 | 7.00 | 16.00 | 8.00 | 5.00 |
| St Andrew's, Fishergate | 0.00 | 5.34 | 16.03 | 5.34 | 9.16 |
| St Nicholas Shambles | 0.85 | 2.14 | 6.84 | 3.85 | 5.56 |
| Wearmouth | 5.20 | 9.79 | 6.12 | 7.34 | 3.36 |
| Jarrow | 1.76 | 5.29 | 14.12 | 8.24 | 4.71 |
| Llandough | 1.62 | 2.25 | 9.49 | 6.87 | 4.49 |
| Ailcy Hill, Ripon | 0.00 | 3.70 | 0.00 | 0.00 | 14.81 |
| Raunds Furnells | 5.92 | 12.68 | 16.06 | 10.14 | 3.10 |
| Wharram Percy | 3.14 | 1.18 | 11.76 | 5.49 | 0.78 |
| Addingham | 0.00 | 1.20 | 2.41 | 7.23 | 2.41 |
| North Elmham | 0.49 | 1.46 | 9.22 | 4.85 | 2.43 |
| Barton-upon-Humber | 5.16 | 3.81 | 4.48 | 5.38 | 4.93 |

Table 7.2 *Percentage of each immature age category within Black Gate and comparative assemblages*

Young children displayed the greatest risk of death in Black Gate and most of the comparative sites (Table 7.2). The exceptions to this peak in mortality in young children were seen at Wearmouth, Addingham and Ailcy Hill. At Wearmouth, infants, young children and older children appeared to be equally susceptible to death, with a slightly higher risk observed for infants. The majority of immature deaths recorded for Addingham were in the older child age category and the highest proportion of deaths amongst the Ailcy Hill immatures was observed amongst the adolescents.

An interesting observation is that the Black Gate immatures exhibited a much higher frequency of pre-infant (neonate and foetal) and infant burials than most of the comparative sites. Higher numbers of pre-infant deaths have been documented for Wearmouth, Raunds and Barton-upon-Humber but none of these sites had frequencies of pre-infant deaths greater than 2.0% above that recorded for Black Gate. Wearmouth and Raunds Furnells exhibited notably greater levels of infant mortality than Black Gate. The more comparable levels of young child and older child mortality recorded for Black Gate relative to the other sites implies children over one year of age survived well enough in the population that used the Black Gate cemetery. It may also reflect more inclusive burial practices for pre-infants, i.e. pre-infants were being accorded burial within the cemetery or not excluded and buried elsewhere.

| Site | Young Adult | Prime Adult | Mature Adult | Senior Adult |
|---|---|---|---|---|
| Black Gate | 4.98 | 13.68 | 15.24 | 20.68 |
| York Minster | 8.79 | 8.79 | 13.19 | 15.38 |
| Swinegate | 5.00 | 5.00 | 13.00 | 10.00 |
| St Andrew's, Fishergate | 3.82 | 22.90 | 12.21 | 16.03 |
| St Nicholas Shambles | 12.82 | 21.79 | 13.68 | 7.26 |
| Wearmouth | 7.95 | 5.50 | 5.50 | 10.40 |
| Jarrow | 2.35 | 5.29 | 5.88 | 11.76 |
| Llandough | 10.86 | 15.86 | 12.73 | 13.61 |
| Ailcy Hill, Ripon | 14.81 | 37.04 | 25.93 | 3.70 |
| Raunds Furnells | 16.06 | 12.68 | 8.73 | 12.39 |
| Wharram Percy | 12.55 | 12.16 | 18.04 | 24.31 |
| Addingham | 3.61 | 16.87 | 4.82 | 8.43 |
| North Elmham | 7.77 | 15.53 | 26.21 | 11.17 |
| Barton-upon-Humber | 2.24 | 17.94 | 2.69 | 19.51 |

Table 7.3 *Percentage of each adult age category within Black Gate and comparative assemblages (percentage of total population)*

The highest percentages of deaths in the entire Black Gate assemblage were amongst senior adults (45+ years) (30.2%) (Table 7.3). A peak in mortality in senior adults was also observed at York Minster, Wearmouth, Jarrow, Wharram Percy and St Peter's, Barton upon Humber. At Swinegate and North Elmham Park, the majority of deaths occurred in the mature adult category. At St Andrew's, Fishergate, St Nicholas Shambles and Addingham the majority of deaths occurred in the prime adult category. The percentages of senior and prime adult deaths were comparable at St Peter's, Barton upon Humber (senior = 26.1%; prime = 24.0%), Ailcy Hill (senior = 45.4%; prime = 45.4%), Llandough (senior = 19.0%; prime = 19.0%) and Raunds Furnells (senior = 12.4%; prime = 12.7%). However, at Raunds Furnells the majority of adult deaths were in the young adult age category. Kolmogorov-Smirnov statistical tests (Appendix E: Table 1) revealed that most of the sites had a mortality profile comparable to the Black Gate. However, Ailcy Hill (KS = 1.930; P = 0.001), which lacks young and older children and Raunds Furnells (KS = 1.546; P = 0.017), which shows the greatest percentage of deaths in the young adult age category and low, but equivocal, mortality rates in prime and senior adults were statistically different.

| | Young Adult Male | Young Adult Female | Prime Adult Male | Prime Adult Female | Mature Adult Male | Mature Adult Female | Senior Adult Male | Senior Adult Female |
|---|---|---|---|---|---|---|---|---|
| Black Gate | 4.3 | 2.9 | 9.3 | 9.5 | 10.2 | 11.1 | 15.2 | 14.5 |
| York Minster | 5.6 | 4.2 | 2.8 | 8.4 | 12.7 | 4.2 | 16.9 | 1.4 |
| Swinegate | 4.7 | 3.2 | 4.7 | 3.1 | 10.9 | 9.4 | 7.8 | 7.8 |
| St Andrew's, Fishergate | 3.6 | 0 | 25 | 10.7 | 13.1 | 6 | 10.7 | 14.3 |
| St Nicholas Shambles | 10.5 | 5.5 | 12.2 | 16.1 | 9.4 | 7.8 | 5.5 | 3.9 |
| Wearmouth | 3.7 | 7.1 | 4.3 | 3.3 | 5.7 | 1.9 | 8.1 | 8.1 |
| Jarrow | 1 | 2.1 | 5.2 | 3.1 | 5.2 | 5.2 | 11.3 | 8.2 |
| Llandough | 5.4 | 6.6 | 9.7 | 11 | 9.7 | 6.6 | 11 | 6.4 |
| Ailcy Hill | 18.2 | 0 | 40.9 | 0 | 31.8 | 0 | 45.4 | 0 |
| Raunds Furnells | 11.5 | 17.8 | 12 | 11 | 12.6 | 3.7 | 52.4 | 42.9 |
| Wharram Percy | 7.6 | 8.6 | 5.5 | 10.1 | 14.1 | 8.6 | 21.2 | 10.1 |
| Addingham | 1.4 | 0 | 10.1 | 5.8 | 2.9 | 2.9 | 2.9 | 7.2 |
| North Elmham | 4.8 | 4.2 | 7.1 | 11.9 | 16.1 | 16.1 | 9.5 | 4.2 |
| Barton upon Humber | 0.3 | 2.1 | 12.6 | 10.5 | 2.7 | 0.6 | 16.8 | 31.8 |

Table 7.4 *Percentage of males and females in each adult age category within Black Gate and comparative assemblages*

The percentages of male and female deaths within each age category for all the sites under consideration are shown in Table 7.4. The greatest percentage of male and female deaths for the majority of sites was in the senior adult age category. At Swinegate and North Elmham Park, the majority of deaths for both males and females were amongst mature adults. There was a peak in deaths amongst mature adult males at St Andrew's, Fishergate. At Addingham, the greatest percentage of male deaths occurred amongst the prime adults. At York Minster and Llandough, there was a peak in mortality amongst prime adult females. St Nicholas Shambles showed a peak of both male and female mortality in the prime adult age category. At Wharram Percy, the female deaths occurred equally in the prime and senior adult age categories. These results show not only the expected high prevalence of male and female deaths in old age in the comparative sites, represented by the majority of peaks in death in senior adult age categories and occasional mature adult peaks, but also that prime adulthood showed a high level of deaths in some of these early medieval sites. Of the five sites that exhibit a peak in the prime adult age category, four showed a female peak in mortality in the prime adult years. Just one site showed a peak in male deaths only and at the other two sites the male peak was accompanied by an equivalent amongst the prime females. The Black Gate mortality profile did not have a peak in the prime adult age category for either males or females, but prime adulthood showed a marked increase on the percentage of deaths seen in immatures and young adults, which gradually increased with age culminating in the peak in deaths in the senior adults.

## 7.3 Palaeodemography: Life Cycles of the Black Gate Assemblage and Comparative Sites

Appendix E (Tables E3-E15) contains life tables constructed to assess the mortality pattern and life expectancy rates for the thirteen comparative skeletal assemblages. The life tables were creating using the methods provided by Chamberlain (2006: 2).

| Age Interval (Years) | No. of Deaths (Dx) | % of Deaths (dx) | % Survive (lx) | Probability of Death (qx) | No. Person Years Lived (Lx) | No. of Years of Life Remaining (Tx) | Age specific Life Expectancy ($e_x$) |
|---|---|---|---|---|---|---|---|
| 0-15 | 189 | 0.34 | 1.00 | 0.34 | 12.50 | 28.20 | 28.20 |
| 15-25 | 49 | 0.09 | 0.66 | 0.14 | 6.25 | 15.70 | 23.79 |
| 25-35 | 88 | 0.16 | 0.57 | 0.28 | 4.95 | 9.45 | 16.58 |
| 35-45 | 98 | 0.18 | 0.41 | 0.44 | 3.30 | 4.50 | 10.97 |
| 45+ | 133 | 0.24 | 0.24 | 1.00 | 1.20 | 1.20 | 5.00 |

Table 7.5 *Life Table constructed for the Black Gate skeletal assemblage (individuals aged only as 'immature or 'adult' are excluded) (No. of Deaths (Dx)* = the number of individuals assigned to each age interval; *% of Deaths (dx)* = proportion of deaths; *% Survive (lx)* = survivorship; *Probability of Death (qx)* = probability of death; *No. Person Years Lived (Lx)* = average number of years that an individual lives in each age interval; *No. of Years of Life Remaining (Tx)* = sum of average years lived within current and remaining age intervals; *Age specific life expectancy ($e_x$)* = average years of life remaining (average life expectancy) (Chamberlain 2006: 2)

Table 7.5 shows the life table constructed for the Black Gate skeletal assemblage, with explanations for each category provided. It is apparent from the life tables that the majority of these sites displayed very similar demographic profiles.

| Site | Average life expectancy at birth ($e_o$) | Average life expectancy at 15 years ($e_{15}$) |
|---|---|---|
| Black Gate | 26.19 | 23.79 |
| York Minster | 28.37 | 21.89 |
| Swinegate | 23.22 | 21.05 |
| St Andrew's, Fishergate | 26.83 | 19.88 |
| Nicholas Shambles | 27.20 | 16.61 |
| Wearmouth | 21.99 | 19.58 |
| Jarrow | 22.62 | 22.45 |
| Llandough | 27.31 | 19.27 |
| Ailcy Hill, Ripon | 29.34 | 15.38 |
| Raunds Furnells | 21.16 | 17.71 |
| Wharram Percy | 30.54 | 22.86 |
| Addingham | 28.14 | 19.33 |
| North Elmham | 30.29 | 21.08 |
| Barton-upon-Humber | 21.31 | 22.30 |

Table 7.6 *Average life expectancy at birth ($e_o$) and at 15 years for Black Gate and comparative assemblages*

The average life expectancy at birth ($e_o$) and at 15 years ($e_{15}$) calculated for Black Gate and the comparative sites is listed in Table 7.6. Life expectancy at a specific stage in the life cycle summarises the mortality experience of each population into a single value and is, therefore, a good singular measure with which to compare different life tables created for archaeological populations (Chamberlain 2006: 30). The average life expectancy at birth ($e_o$) amongst Black Gate and the comparative samples varied greatly from 21.2 years at Raunds Furnells to 30.5 years at Wharram Percy. Both Raunds Furnells and Wharram Percy were rural settlements, negating any hypotheses that the variance results from differences in settlement type. A Wilcox Mann-Whitney test, carried out following the recommendation by Chamberlain (2006: 44), revealed no statistically significant difference for the life expectancy at birth (*eo*) between Black Gate and any of the comparative sites (Appendix E: Table E.2).

A problem with comparing sites by expected life expectancy at birth is the under-representation of infants in archaeological populations (Larsen 1997: 338; Buckberry 2000), the reasons for which are discussed in section 7.6.1. The problem of infant under-representation and problems of possible differential burial practices between immatures and adults is avoided by calculating the expected life expectancy at 15 years of age ($e_{15}$). The average life expectancy at 15 years ($e_{15}$) amongst Black Gate and the comparative samples varied from 15.38 years at Ailcy Hill to 23.79 years at Black Gate. The low age at Ailcy Hill represents the specific nature of the burials, which are not representative of the entire population. The 23.79 years calculated for Black Gate is consistent with the life expectancy calculated for male peasants provided by Roberts and Cox (2003: 226) for 12th century populations in Britain. There was also no significant difference in the estimates for life expectancy between Black Gate and the comparative sites.

## 7.4 Palaeopathology: Comparisons of the Black Gate Assemblage and Comparative Sites

The prevalence rates of twelve skeletal health indicators observed in the total population (crude prevalence rate, CPR) and total recordable population (true prevalence rate, TPR) were compared between Black Gate and the thirteen comparative sites. Both CPRs and TPRs were investigated due to the small quantity of comparable TPRs available for some of the sites. The crude and true prevalence rates for the twelve health indicators within the Black Gate skeletal assemblage are shown in Tables 7.7 to 7.9. Appendixes F and G show the summary information for the crude and true prevalence rates for the total population and adult and immature assemblages for each of the sites included within this thesis. The TPRs for DJD, ADJD and SDJD were calculated for the adult populations only, as skeletal degeneration in response to physical stress was the focus of this study. Most instances of DJD in immatures were likely to be a consequence of trauma or some underlying disease (Petty 1997; Davidson 2000), hence they were excluded from the analysis. The similarity in the age and sex profiles of the thirteen sites and Black Gate enabled direct comparisons to be made of the pathological conditions observable between them.

| Black Gate: Total Population | | |
|---|---|---|
| **Health Indicator** | **CPR** | **TPR** |
| Cribra Orbitalia | 17.11 | 33.64 |
| DEH | 19.97 | 53.98 |
| TPNB | 16.64 | 29.15 |
| Maxillary Sinusitis | 11.51 | 33.64 |
| Calculus | 40.75 | 90.34 |
| Caries | 18.04 | 38.03 |
| Abscesses | 9.49 | 20.00 |
| AMTL | 12.44 | 26.23 |
| DJD | 47.59 | N/A |
| SDJD | 37.95 | N/A |
| ADJD | 39.19 | N/A |

Table 7.7 *Summary Statistics for the Crude and True Prevalence Rates for skeletal health indicators within the total Black Gate skeletal assemblage*

| Black Gate: Adult Population | | |
|---|---|---|
| **Health Indicator** | **CPR** | **TPR** |
| Cribra Orbitalia | 10.20 | 22.17 |
| DEH | 22.67 | 53.47 |
| TPNB | 17.91 | 30.86 |
| Maxillary Sinusitis | 12.70 | 34.15 |
| Calculus | 54.42 | 96.38 |
| Caries | 23.36 | 40.39 |
| Abscesses | 13.60 | 23.62 |
| AMTL | 17.91 | 31.10 |
| DJD | 69.39 | 75.55 |
| SDJD | 55.33 | 77.46 |
| ADJD | 57.14 | 64.12 |

Table 7.8 *Summary Statistics for the Crude and True Prevalence Rates for skeletal health indicators within the total adult Black Gate skeletal assemblage*

| Black Gate: Immature Population | | |
|---|---|---|
| **Health Indicator** | **CPR** | **TPR** |
| Cribra Orbitalia | 32.18 | 52.42 |
| DEH | 10.89 | 56.41 |
| TPNB | 13.86 | 22.58 |
| Maxillary Sinusitis | 8.91 | 32.14 |
| Calculus | 10.89 | 53.66 |
| Caries | 6.43 | 26.00 |
| Abscesses | 0.49 | 1.92 |
| AMTL | 0.49 | 1.92 |

Table 7.9 *Summary Statistics for the Crude and True Prevalence Rates for skeletal health indicators within the total immature Black Gate skeletal assemblage*

Appendix H shows the results of the statistical analyses comparing each health indicator individually and combined between Black Gate and each settlement in turn.

### *7.4.1 York Minster*

The crude prevalence rates (CPRs) for eleven skeletal health indicators were recordable for the total skeletal assemblage recovered from York Minster (Figure 7.1). The overall CPR health profile for York Minster was not statistically different from Black Gate. The differences between the CPRs of DEH ($\chi^2$= 5.772; P= 0.016), TPNB ($\chi^2$= 8.707; P= 0.003) and SDJD ($\chi^2$= 6.456; P= 0.011) observed for the total populations of Black Gate and York Minster were, however, significantly different.

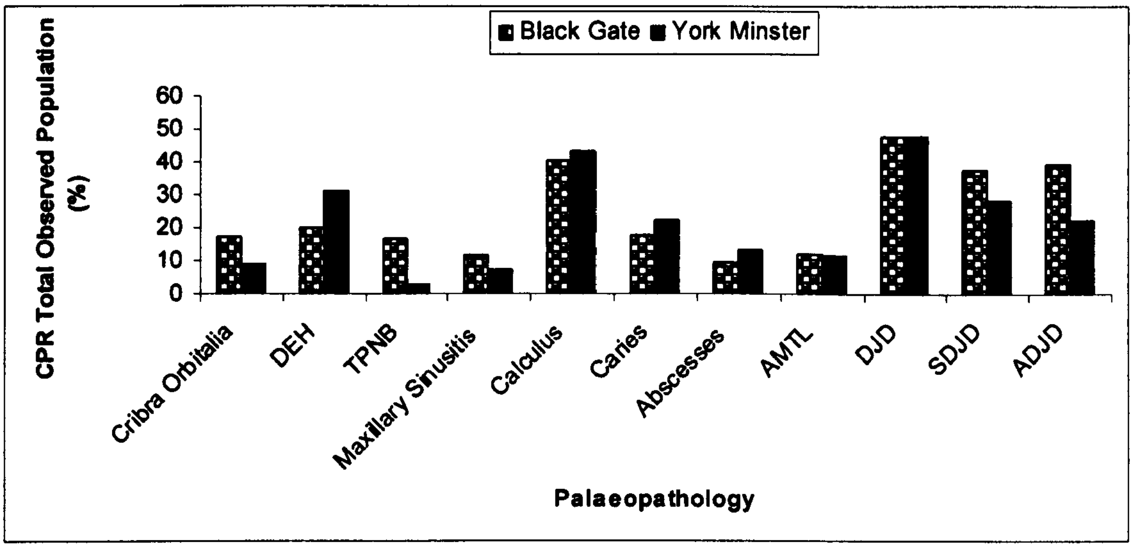


Figure 7.1 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and York Minster*

Figure 7.2 shows the comparisons of the true prevalence rates recorded for the total populations of Black Gate and York Minster. There was a statistically significant difference in the overall TPR health profile of York Minster in comparison to Black Gate ($\chi^2$= 12.712; P= 0.000). The TPRs for cribra orbitalia ($\chi^2$= 13.497; P= 0.000) and dental calculus ($\chi^2$= 20.337; P= 0.000) were significantly lower than the Black Gate values.

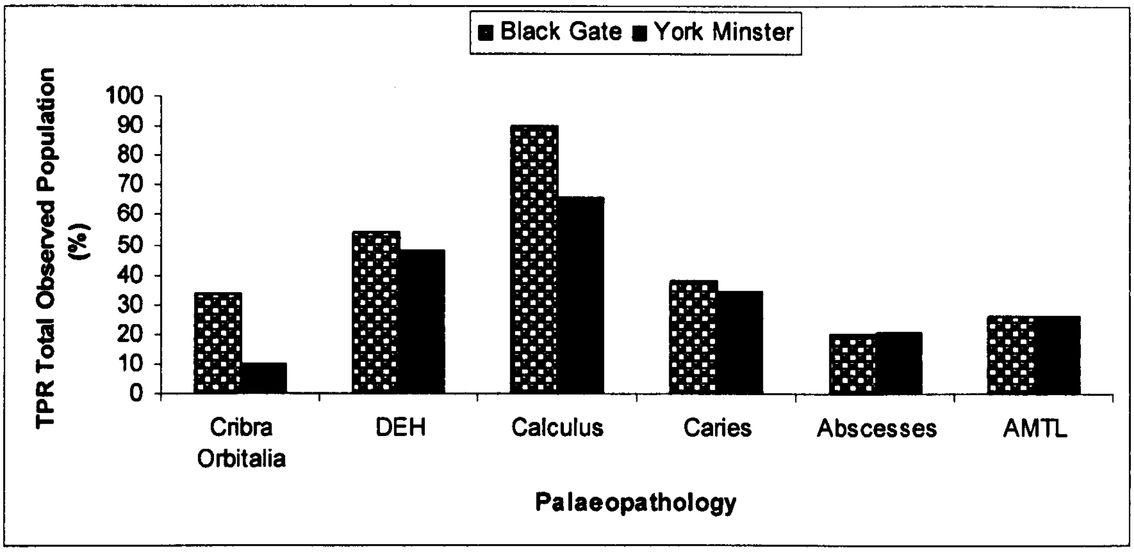


Figure 7.2 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and York Minster*

It was not possible from the published report on York Minster to distinguish between adult and immature burials. Therefore, no comparisons were made between the immature and adult assemblages.

### *7.4.2 Swinegate, York*

Neither the overall CPR nor TPR health profiles created for the Swinegate cemetery assemblage were significantly different from the Black Gate profiles. Only the crude and true prevalence rates of cribra orbitalia and DEH could be recorded for the total population of Swinegate (Figures 7.3 and 7.4). There was no statistically significant difference in either the CPRs or TPRs for either stress indicator between Swinegate and Black Gate.

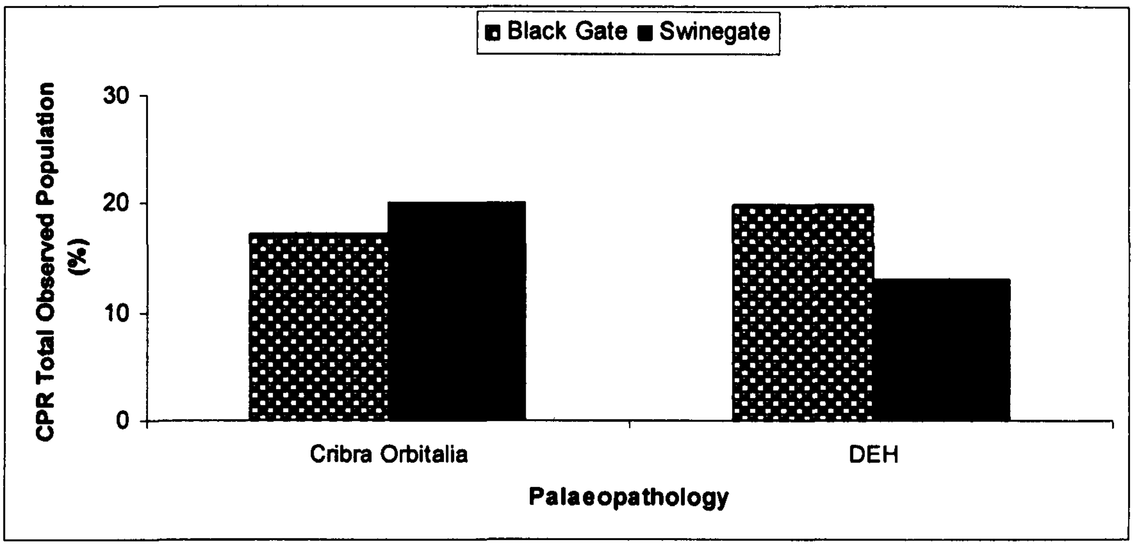


Figure 7.3 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Swinegate*

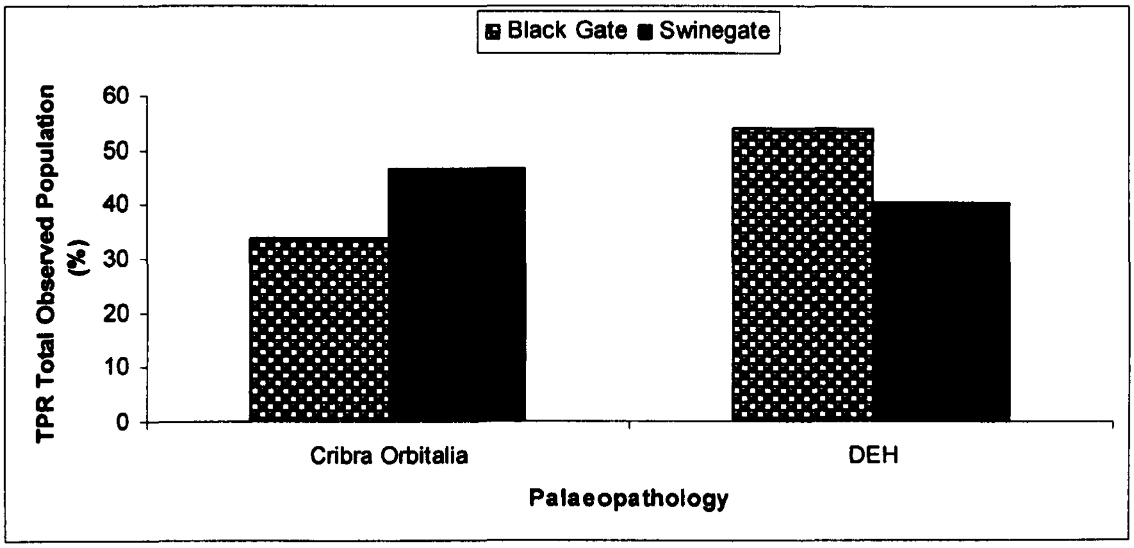


Figure 7.4 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and Swinegate*

It was not possible to quantify the crude or true prevalence rates of cribra orbitalia or DEH within the adult and immature populations of the Swinegate cemetery.

### *7.4.3 St Andrew's, Fishergate*

Neither the CPR nor TPR overall health profiles for St Andrew's, Fishergate were different enough from the Black Gate profiles to exhibit a statistically significant difference. There was no statistically significant difference between any of the crude prevalence rates comparable between the total populations of St Andrew's, Fishergate and Black Gate (Figure 7.5).

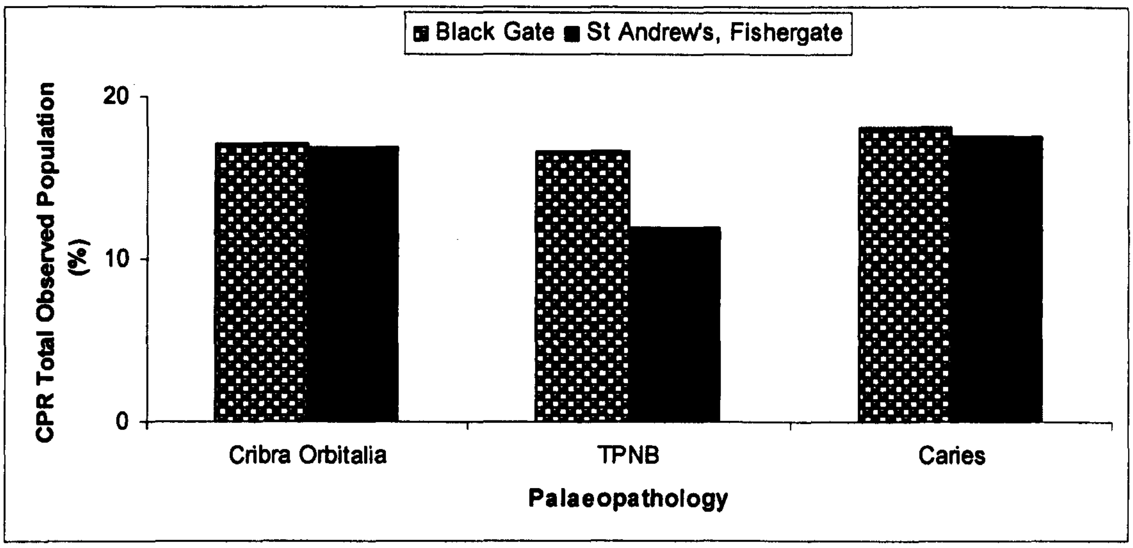


Figure 7.5 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and St Andrew's, Fishergate*

The only available TPR for the total skeletal assemblage of St Andrew's, Fishergate was that of cribra orbitalia, therefore a comparison chart was not created. The total TPR value for cribra orbitalia was not statistically different to the Black Gate value.

The overall health profiles for the adults and immatures of St Andrew's, Fishergate, were not significantly different from the Black Gate assemblage. The CPRs and TPRs for cribra orbitalia and dental caries were not significantly different from the Black Gate adult population. Only the TPR for cribra orbitalia was recordable within the immature population. The immature TPR values for cribra orbitalia in the Black Gate and St Andrew's, Fishergate assemblages showed no statistically significant difference.

### *7.4.4 St Nicholas Shambles*

Crude prevalence rates of the total St Nicholas Shambles skeletal assemblage could be calculated for seven health indicators, six of which were significantly different to the values calculated for the Black Gate total population (Figure 7.6). The overall difference between the two populations when all the health indicators were compared was almost approaching statistical significance ($\chi^2$= 2.830; P= 0.093).The CPR's for cribra orbitalia ($\chi^2$= 7.517; P= 0.006), TPNB ($\chi^2$= 24.470; P= 0.000), abscesses ($\chi^2$= 10.120; P= 0.001) and DJD ($\chi^2$= 14.469; P= 0.000) were all significantly lower than observed in the Black Gate cemetery. In contrast the CPRs for AMTL ($\chi^2$= 3.722; P= 0.054) and SDJD ($\chi^2$= 40.972; P= 0.000) were higher for the St Nicholas Shambles assemblage.

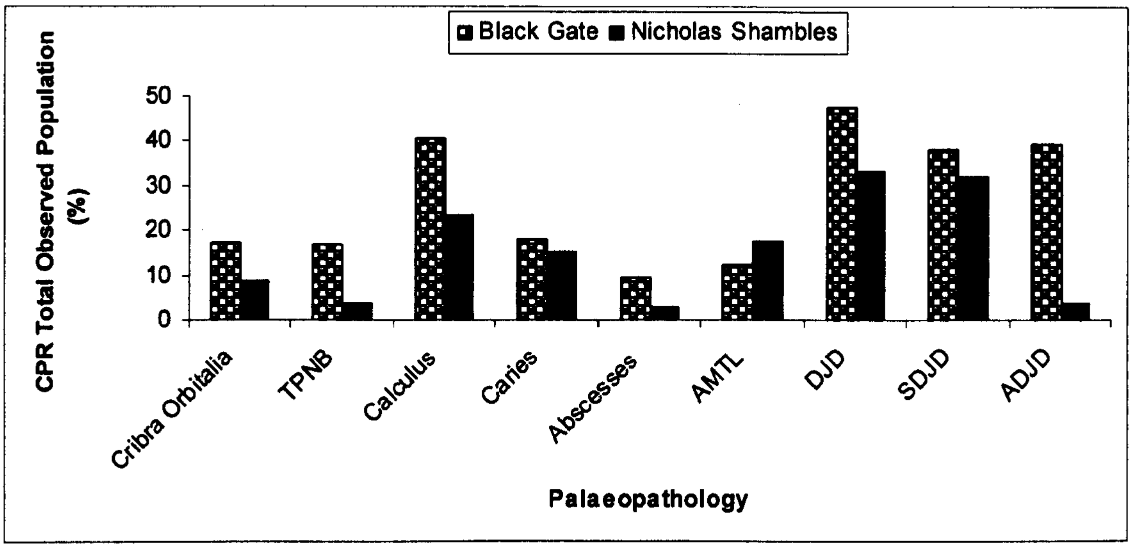


Figure 7.6 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and St Nicholas Shambles*

The overall difference between the total population TPRs for St Nicholas Shambles and Black Gate was statistically significant ($\chi^2$= 15.398; P= 0.000). The TPRs for dental calculus ($\chi^2$= 73.668; P= 0.000) and abscesses ($\chi^2$= 10.410; P= 0.001) were significantly lower than those observed for Black Gate. In contrast, the TPR for AMTL ($\chi^2$= 5.580; P= 0.018) was significantly higher (Figure 7.7).

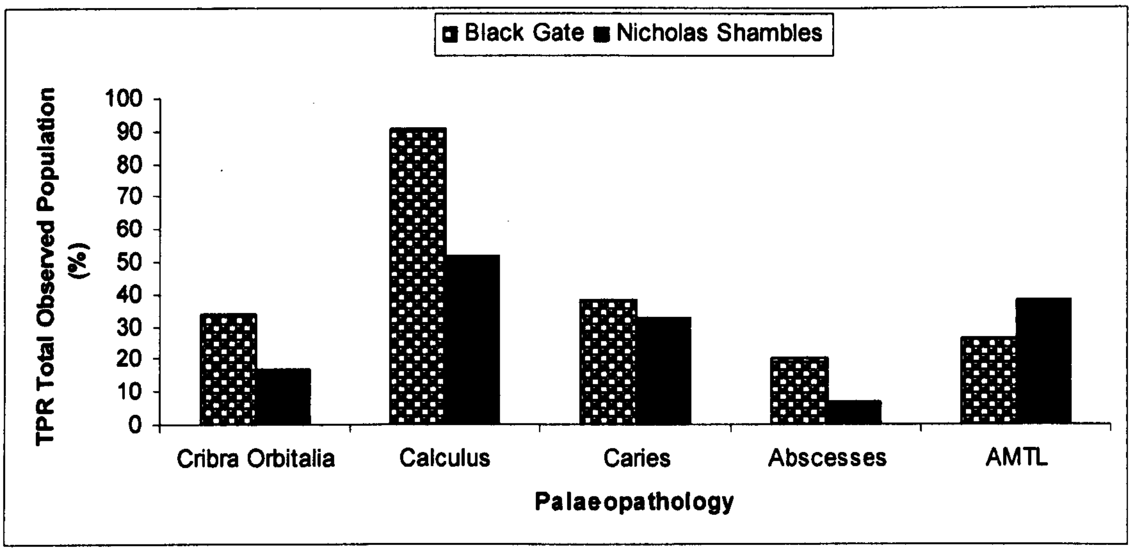


Figure 7.7 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and St Nicholas Shambles*

The difference between the CPRs for the adult populations of St Nicholas Shambles and Black Gate was statistically significant ($\chi^2$= 37.361; P= 0.000). CPRs could be calculated for nine health indicators of health within the St Nicholas Shambles adult population, seven of which differed significantly from the CPRS calculated for the Black Gate adults. TPNB ($\chi^2$= 6.074; P= 0.014), dental calculus ($\chi^2$= 29.196; P= 0.000), caries ($\chi^2$= 54.016; P= 0.000), abscesses ($\chi^2$= 49.369; P= 0.000), DJD ($\chi^2$= 43.039; P= 0.000), ADJD ($\chi^2$= 142.643; P= 0.000) and SDJD ($\chi^2$= 12.904; P= 0.000) all exhibited CPRs within the adult population significantly lower than Black Gate.

The overall difference in adult TPRs observed between St Nicholas Shambles and Black Gate was not statistically significant ($\chi^2$= 0.405; P= 0.525). TPRs for the St Nicholas Shambles adult population could be calculated for three of the dental health indicators. The adult TPR values for dental abscesses ($\chi^2$= 10.637; P= 0.001) and AMTL ($\chi^2$= 3.661; P= 0.056) were significantly different and close to statistical significance respectively relative to the Black Gate adult TPRs.

The overall difference in CPRs seen between the immatures of St Nicholas Shambles and Black Gate was statistically significant ($\chi^2$= 8.333; P= 0.004). The CPRs for the immature population of St Nicholas Shambles were recordable for four health indicators, two of which were statistically different from the Black Gate immature population. The CPR for cribra orbitalia ($\chi^2$= 13.279; P= 0.000) was significantly lower than observed amongst the Black Gate immatures. In contrast the immature CPR for AMTL ($\chi^2$= 7.094; P= 0.008) was significantly greater than the Black Gate prevalence.

The difference in the overall immature TPRs for St Nicholas Shambles and the Black Gate was not statistically significant. However, both of the pathologies for which data was available were significantly different from the Black Gate immature TPRs. The TPR for dental caries ($\chi^2$= 5.484; P= 0.019) was significantly lower relative to Black Gate. In contrast the TPR for AMTL ($\chi^2$= 5.533; P= 0.019) was significantly greater.

### *7.4.5 Wearmouth*

The overall CPR ($\chi^2$= 458.806; P= 0.000) and TPR ($\chi^2$= 51.411; P= 0.000) health profiles for the total population of the Wearmouth cemetery were significantly different from Black Gate. All of the eight skeletal health indicators, for which the crude prevalence rate could be calculated (Figure 7.8), exhibited CPR values significantly lower than the Black Gate total population.

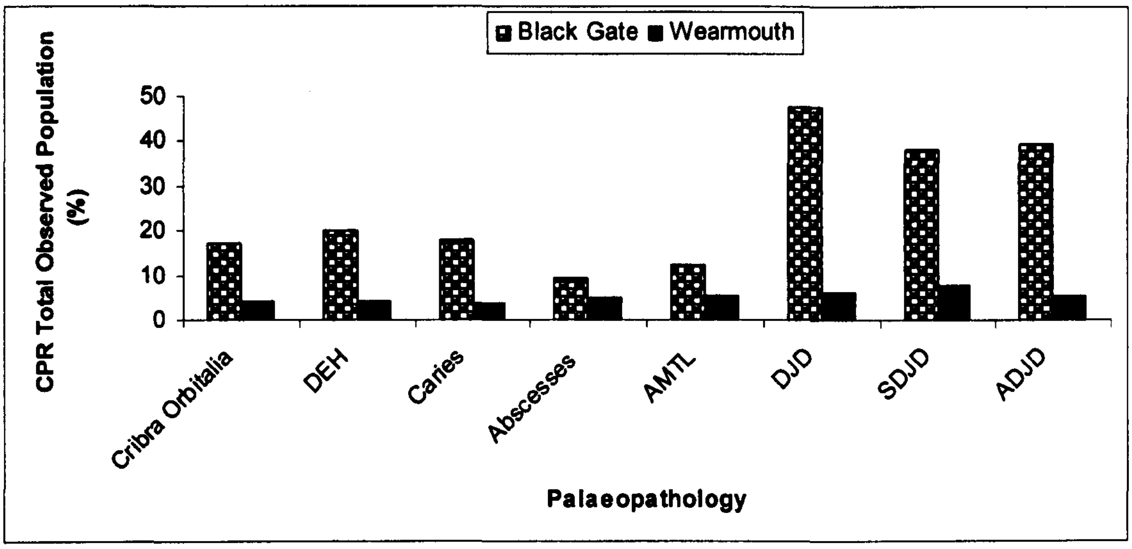


Figure 7.8 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Wearmouth*

True prevalence rates for the total population of the Wearmouth cemetery assemblage calculated for DEH, caries and dental abscesses were all lower than the Black Gate values (Figure 7.9). The lower TPRs for DEH ($\chi^2$ = 47.990; P= 0.000) and dental caries ($\chi^2$ = 23.611; P= 0.000) were both statistically significant.

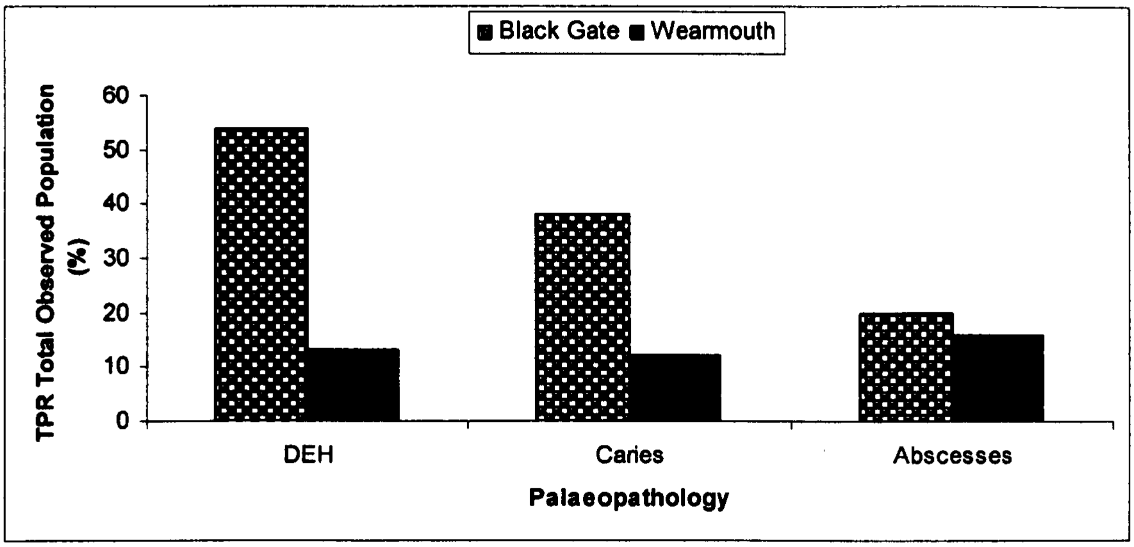


Figure 7.9 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and Wearmouth*

For the Wearmouth adult population both the overall CPR ($\chi^2$= 435.946; P= 0.000) and TPR ($\chi^2$= 39.632; P= 0.000) profiles were significantly different from the Black Gate adults. The crude prevalence rates for the eight skeletal health indicators recordable for the Wearmouth adult population were all significantly lower than those recorded for Black Gate. True prevalence rates were recordable for four skeletal health indicators within the Wearmouth adult population, all of which were lower than their Black Gate equivalent. The lower TPRs for DEH ($\chi^2$ = 42.466; P= 0.000) and dental caries ($\chi^2$ = 20.357; P= 0.000) were significantly different to the Black Gate adult assemblage.

Both the immature overall CPR ($\chi^2$= 7.040; P= 0.008) and TPR ($\chi^2$= 8.876; P= 0.003) health profiles were significantly different from Black Gate. The four dental health indicators that were observable for the Wearmouth immatures were all lower than was observed for the Black Gate immatures. Only the difference observed for dental caries was statistically significant ($\chi^2$= 3.639; P= 0.056) and DEH was approaching statistical significance ($\chi^2$= 3.001; P= 0.083).

### *7.4.6 Jarrow*

Crude prevalence rates could be calculated for eight skeletal stress indicators within the total population of the Jarrow cemetery assemblage (Figure 7.10). The difference observed between the overall CPRs of the total populations of Jarrow and Black Gate was statistically significant ($\chi^2$ = 174.796; P= 0.000). All the CPR values for the total population were lower than recorded for Black Gate. The CPRs for cribra orbitalia ($\chi^2$ = 24.278; P= 0.000), DEH ($\chi^2$ = 5.702; P= 0.017), caries ($\chi^2$ = 13.655; P= 0.000), DJD ($\chi^2$ = 99.052; P= 0.000), ADJD ($\chi^2$ = 41.464; P= 0.000) and SDJD ($\chi^2$ = 42.451; P= 0.000) were all significantly lower than observed in the Black Gate assemblage.

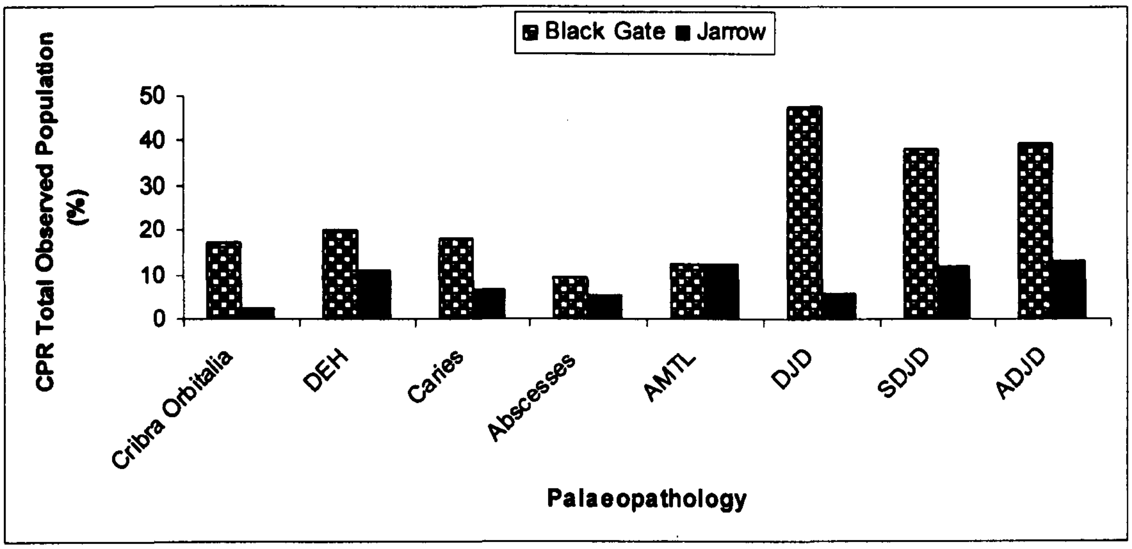


Figure 7.10 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Jarrow*

The TPRs for the total population were available for dental caries, abscesses and AMTL (Fig. 7.11). The overall total TPR values for Jarrow were significantly lower than observed for Black Gate ($\chi^2$ = 23.254; P= 0.000). All three dental health indicators were less prevalent than in the Black Gate assemblage. The TPRs for caries ($\chi^2$ = 24.263; P= 0.000) and abscesses ($\chi^2$ = 5.883; P= 0.015) were significantly lower than the Black Gate values.

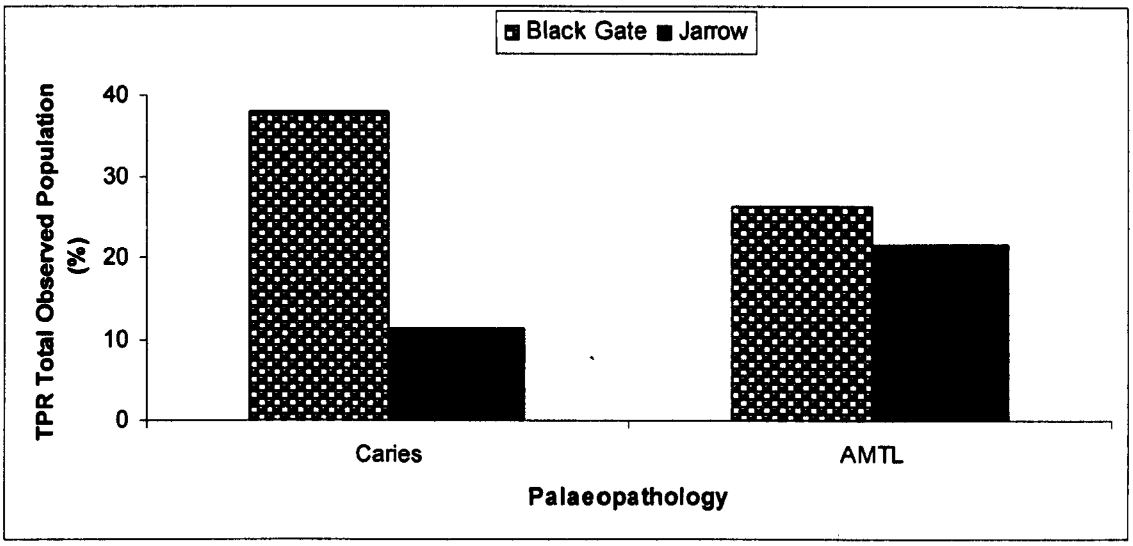


Figure 7.11 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and Jarrow*

Crude prevalence rates were calculated for eight skeletal health indicators within the Jarrow adult assemblage. The overall difference in CPRs observed between the adult populations of Jarrow and Black Gate was statistically significant ($\chi^2$ = 121.466; P= 0.000). All the adult CPRs – except for AMTL, which was not statistically different from the Black Gate value – were lower than observed at Black Gate. The CPRs for cribra orbitalia ($\chi^2$ = 10.801; P= 0.001), DEH ($\chi^2$ = 4.121; P= 0.042), caries ($\chi^2$ = 4.121; P= 0.042), DJD ($\chi^2$ = 114.501; P= 0.000), ADJD ($\chi^2$ = 37.786; P= 0.000) and SDJD ($\chi^2$ = 38.331; P= 0.000) were all significantly lower than those observed within the Black Gate adult assemblage.

The difference in overall TPRs observed between the total adult populations of Jarrow and Black Gate was statistically significant ($\chi^2$ = 11.469; P = 0.001). The adult TPRs for DEH, caries and dental abscesses were all lower than observed in the Black Gate adult assemblage. In contrast, the TPR for AMTL was greater. The lower adult TPR frequencies of DEH ($\chi^2$ = 42.466; P= 0.000) and dental caries ($\chi^2$ = 20.357; P= 0.000) were significantly lower relative to Black Gate.

The difference in overall CPRs observed between the immature populations of Jarrow and Black Gate was statistically significant ($\chi^2$ = 19.407; P= 0.000). All four health indicator CPRs calculated for the Jarrow immatures exhibited lower frequencies relative to Black Gate. The immature CPRs for cribra orbitalia ($\chi^2 = 20.336$; P = 0.000) and dental caries ($\chi^2 = 4.931$; P = 0.026) were both significantly lower.

The difference in immature TPRs between the Jarrow and Black Gate cemeteries was statistically significant ($\chi^2 = 38.680$; P = 0.000). The immature TPRs for both cribra orbitalia ($\chi^2 = 23.050$; P = 0.000) and DEH ($\chi^2 = 15.333$; P = 0.000) were significantly lower than those recorded for the Black Gate immature assemblage.

### 7.4.7 *Llandough*

Crude prevalence rates were calculated for five skeletal stress indicators for the total population of the Llandough assemblage (Figure 7.12). The overall difference in CPRs observed between the total populations of Llandough and Black Gate was statistically significant ($\chi^2 = 194.832$; P= 0.000). The total CPRs for DEH ($\chi^2 = 46.180$; P= 0.000), DJD ($\chi^2 = 112.228$; P= 0.000) and ADJD ($\chi^2 = 141.142$; P= 0.000) were all significantly lower than those recorded for Black Gate. The CPR for TPNB was also lower relative to Black Gate, but the difference was not statistically significant.

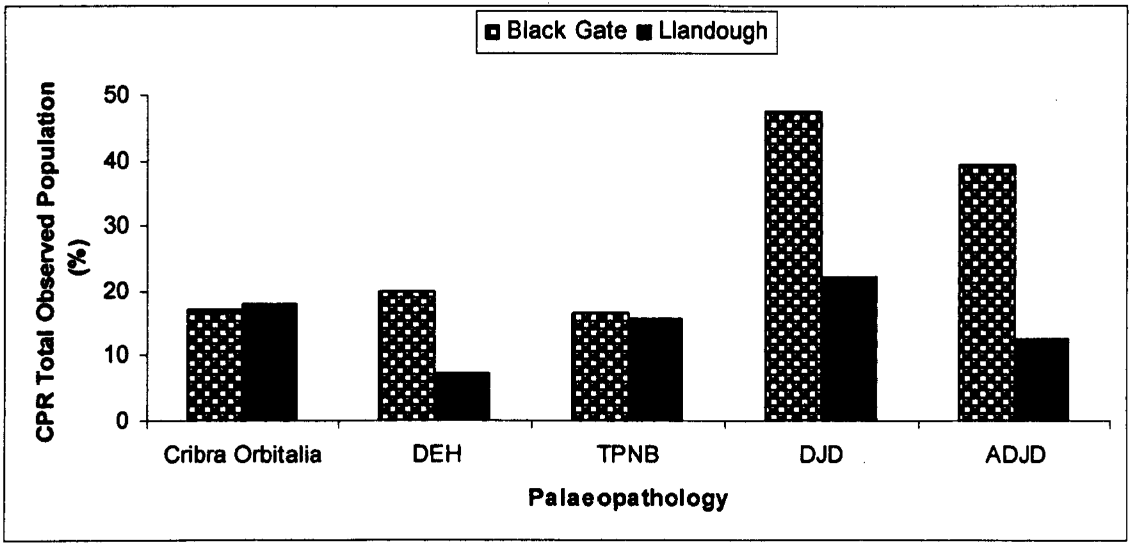


Figure 7.12 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Llandough*

True prevalence rates of skeletal stress indicators in the total population of the Llandough cemetery assemblage could only be calculated for cribra orbitalia (35.8%) and DEH (10.3%) (Figure 7.13). The overall difference in TPRs observed in the total populations of Llandough and Black Gate was statistically significant ($\chi^2$ = 75.808; P= 0.000). The TPR for cribra orbitalia was similar to that observed in the total Black Gate assemblage, whereas the TPR for DEH ($\chi^2$ = 1.721; P= 0.000) was significantly lower relative to Black Gate.

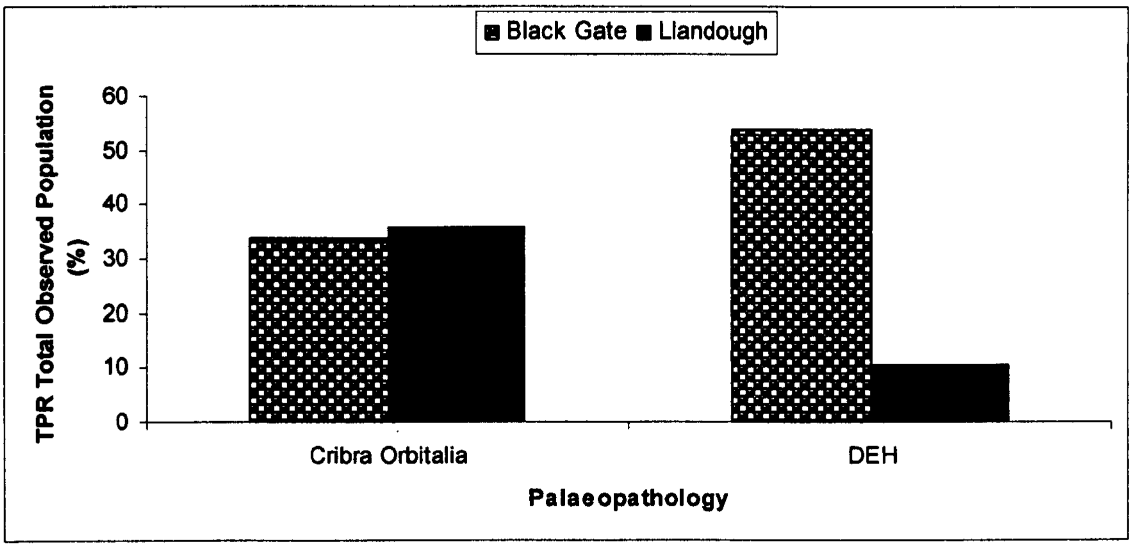


Figure 7.13 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and Llandough*

The crude prevalence rates for the adult population of the Llandough assemblage were calculated for four skeletal stress indicators. The overall difference in CPRs between the adult populations of Llandough and Black Gate was statistically significant ($\chi^2$ = 184.182; P = 0.000). The CPR for cribra orbitalia ($\chi^2$ = 6.430; P= 0.011) was significantly greater than that observed for Black Gate. In contrast, the CPRs for DJD ($\chi^2$ = 156.655; P= 0.000) and ADJD ($\chi^2$ = 177.719; P= 0.000) were significantly lower than their Black Gate frequencies. The adult CPR for TPNB was also lower than observed for Black Gate but the difference was only 2.8% and not statistically significant.

Only the true prevalence rate for cribra orbitalia could be calculated for the adult population of the Llandough assemblage. The adult TPR for cribra orbitalia ($\chi^2 = 4.721$; P= 0.030) was significantly greater than observed in the Black Gate adult assemblage.

There was no statistically significant difference in the immature either CPR or TPR profiles between Llandough and Black Gate. Crude prevalence rates were calculated for cribra orbitalia and TPNB within the Llandough immature population. Neither of these stress indicators exhibited frequencies statistically different from the Black Gate immatures. The immature TPR for cribra orbitalia also lacked a statistically significant difference from Black Gate.

### *7.4.8 Ailcy Hill, Ripon*

Crude prevalence rates were calculated for seven skeletal health indicators within the total population of the Ailcy Hill assemblage (Figure 7.14). The overall difference in CPRs observed between the total populations of Ailcy Hill and Black Gate was statistically significant ($\chi^2$= 18.900; P= 0.000). All of the CPRs were lower than observed in the Black Gate assemblage. However, only the total population CPRs for ADJD ($\chi^2$= 13.885; P= 0.000) and SDJD ($\chi^2$= 8.097; P= 0.004) were substantially low enough for the difference to be statistically significant.

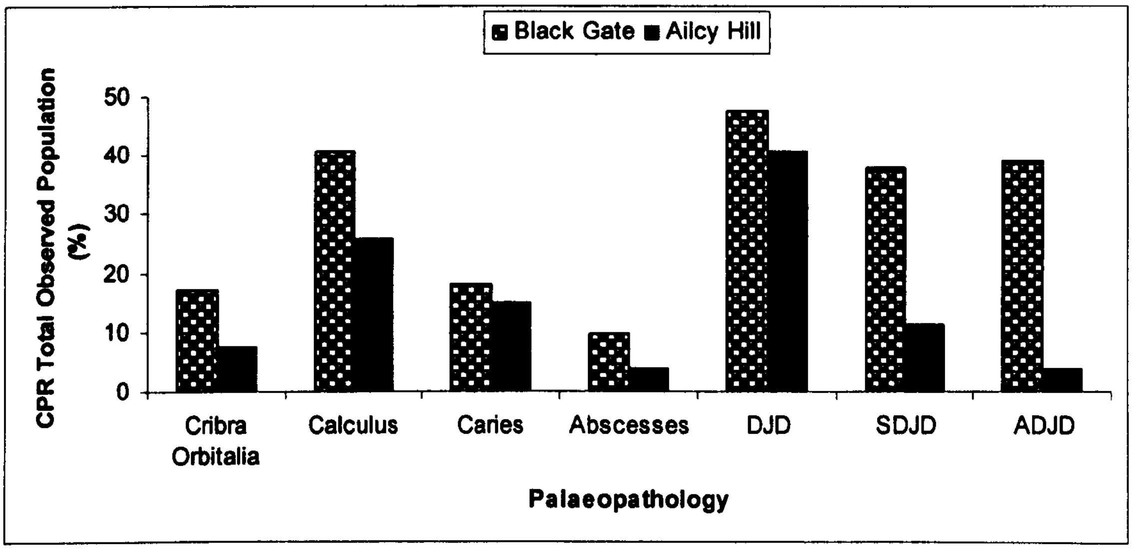


Figure 7.14 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Ailcy Hill*

Crude prevalence rates within the adult population of Ailcy Hill were calculated for eight health indicators. The overall difference in CPRs for the adult populations of Ailcy Hill and Black Gate was statistically significant ($\chi^2$ = 22.709; P= 0.000). The adult CPRs for dental calculus ($\chi^2$ = 4.302; P= 0.038), ADJD ($\chi^2$ = 12.867; P= 0.000) and SDJD ($\chi^2$ = 14.635; P= 0.000) were significantly lower than observed for Black Gate. The only exception was DJD ($\chi^2$ = 3.648; P= 0.056), which was significantly higher in the Ailcy Hill assemblage.

For the Ailcy Hill immatures, only the crude prevalences of the four dental health indicators were available. None of the immatures exhibited calculus, caries, abscess or AMTL. Thus, it is clear that the Ailcy Hill immatures exhibited a lower prevalence of dental health indicators, but this difference could not be tested statistically due to the high number of cells with missing values.

### *7.4.9 Raunds Furnells*

Crude prevalence rates were calculated for six skeletal health indicators within the total population of the Raunds Furnells assemblage (Figure 7.15). The overall difference in CPRs for the total populations of Raunds Furnells and Black Gate was statistically significant ($\chi^2$ = 10.891; P= 0.001). The CPRs for cribra orbitalia ($\chi^2$ = 13.159; P= 0.000), TPNB ($\chi^2$ = 17.019; P= 0.000) and DJD ($\chi^2$ = 9.948; P= 0.000) were all significantly lower than observed for Black Gate.

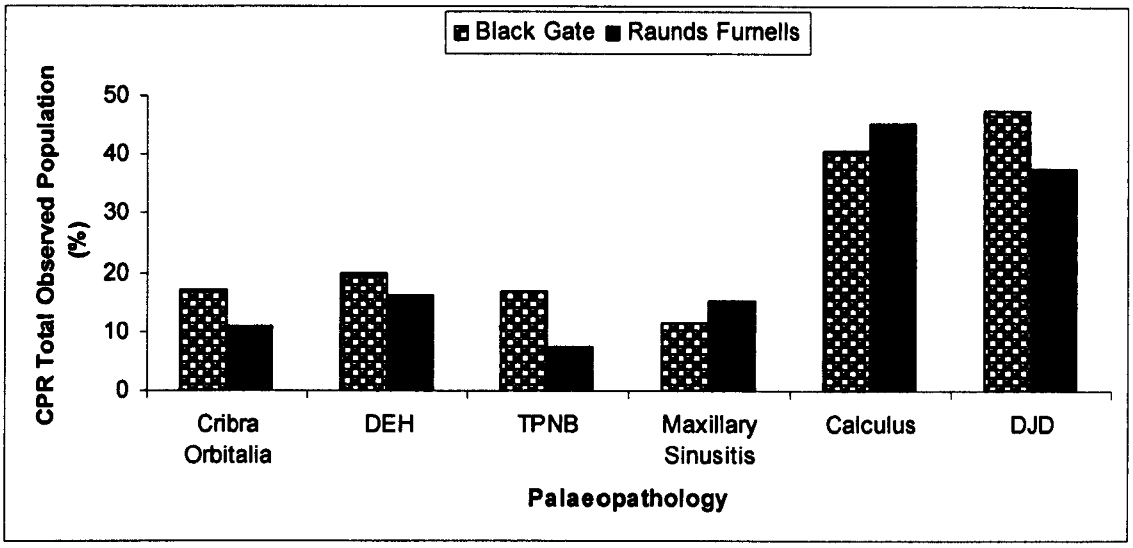


Figure 7.15 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Raunds Furnells*

Within the total population of the Raunds Furnells assemblage TPRs could be calculated for three health indicators (Figure 7.16). The overall difference in TPRs observed between the total populations of Raunds Furnells and Black Gate was statistically significant ($\chi^2$ = 61.233; P = 0.000). The total population TPRs of cribra orbitalia, DEH and TPNB for Raunds Furnells were all lower than observed for Black Gate. The TPRs for DEH ($\chi^2$ = 52.855; P= 0.000) and TPNB ($\chi^2$ = 41.026; P= 0.000) were significantly lower.

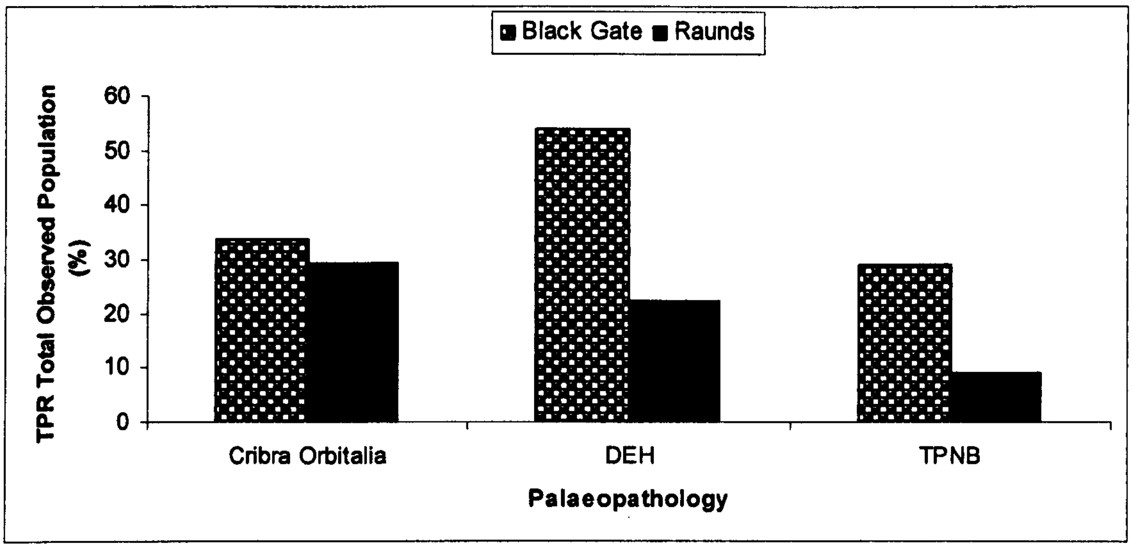


Figure 7.16 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and Raunds Furnells*

Crude prevalence rates could be calculated for six skeletal health indicators within the adult population of Raunds Furnells. The overall difference in CPRs observed between the adult populations of Raunds Furnells and Black Gate was statistically significant ($\chi^2$ = 24.716; P = 0.000). The CPRs for cribra orbitalia ($\chi^2$ = 29.719; P= 0.000), maxillary sinusitis ($\chi^2$ = 23.858; P= 0.000) and dental calculus ($\chi^2$ = 32.793; P= 0.000) were all significantly greater than observed for Black Gate. In contrast, the TPR for TPNB ($\chi^2$ = 4.060; P= 0.004) was significantly lower.

The difference in TPRs observed between the adult populations of Raunds Furnells and Black Gate was statistically significant ($\chi^2$ = 6.471; P = 0.011). The adult TPRs of cribra orbitalia ($\chi^2$ = 29.962; P= 0.000) and DEH ($\chi^2$ = 29.962; P= 0.000) were both significantly lower than observed for Black Gate.

The difference in CPRs between the immature populations of Raunds Furnells and Black Gate was statistically significant ($\chi^2$ = 16.715; P = 0.000). The immature CPRs of cribra orbitalia ($\chi^2$ = 3.911; P= 0.048), TPNB ($\chi^2$ = 13.617; P= 0.000) and maxillary sinusitis ($\chi^2$ = 15.919; P= 0.000) were significantly lower than observed for Black Gate.

The overall immature TPR was significantly different between Raunds Furnells and Black Gate ($\chi^2$ = 29.723; P= 0.000). The immature TPRs for cribra orbitalia ($\chi^2$ = 10.217; P= 0.001) and DEH ($\chi^2$ = 19.206; P= 0.000) were both significantly lower than observed for Black Gate.

### *7.4.10 Wharram Percy*

Crude prevalence rates were calculated for five skeletal health indicators within the total population of the Wharram Percy assemblage (Figure 7.17). The difference in CPRs observed between the total populations of Wharram Percy and Black Gate was statistically significant ($\chi^2$ = 44.400, P= 0.000). The CPRs for TPNB ($\chi^2$ = 19.472; P= 0.000), DJD ($\chi^2$ = 77.141; P= 0.000) and SDJD ($\chi^2$ = 52.307; P= 0.000) were all significantly lower than observed for Black Gate. In contrast the CPR for dental calculus ($\chi^2$ = 24.030; P= 0.000) was significantly greater than observed for Black Gate.

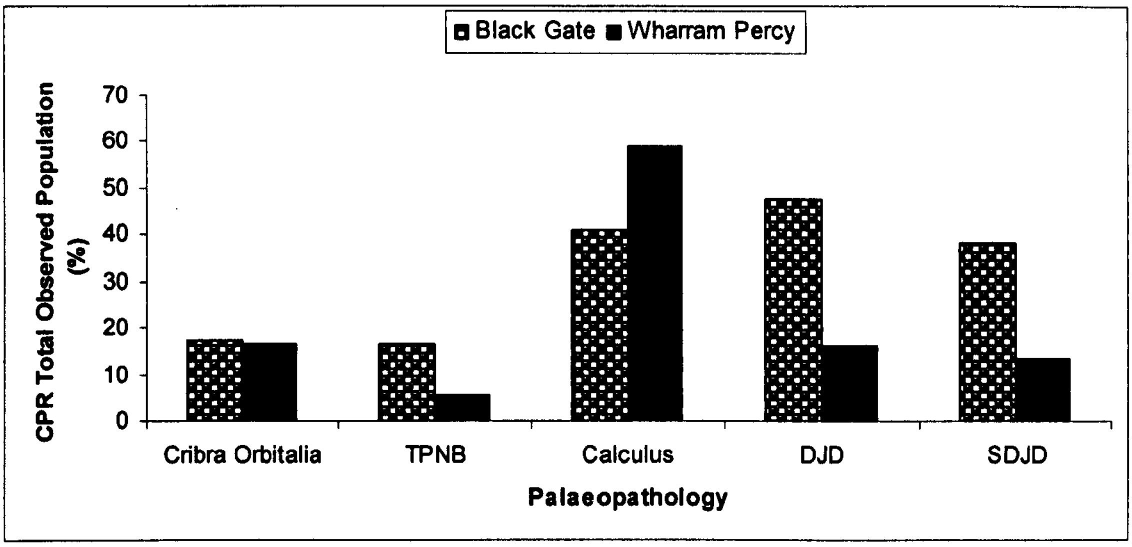


Figure 7.17 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Wharram Percy*

The TPR for the total population of the Wharram Percy assemblage could be only be calculated for cribra orbitalia ($\chi^2$ = 7.702; P= 0.006) which was significantly lower than observed for Black Gate

Crude prevalence rates were calculated for seven skeletal health indicators within the Wharram Percy adult population. The difference in CPRs observed between the adult populations of Wharram Percy and Black Gate was statistically significant ($\chi^2$ = 62.936; P= 0.000). There were no consistent patterns in the CPRs relative to Black Gate. The CPRs for TPNB ($\chi^2$ = 4.060; P= 0.044) and maxillary sinusitis ($\chi^2$ = 23.858; P= 0.000) were both significantly lower than the Black Gate frequencies. In contrast, the CPRs for cribra orbitalia ($\chi^2$ = 29.719; P= 0.000) and dental calculus ($\chi^2$ = 32.793; P= 0.000) were significantly higher.

True prevalence rates could be calculated for five skeletal health indicators within the adult population of the Wharram Percy assemblage. The difference in TPRs observed between the adult populations of Wharram Percy and Black Gate was statistically significant ($\chi^2$ = 50.615; P= 0.000). The adult TPR for dental calculus was significantly lower than observed for Black Gate. In contrast the Wharram Percy adults exhibit significantly greater prevalences of the other dental health indicators – caries ($\chi^2$ = 35.671; P= 0.000), abscesses ($\chi^2$ = 43.534; P= 0.000) and AMTL ($\chi^2$ = 26.924; P= 0.000).

The absence of TPNB amongst the Wharram Percy immatures resulted in a CPR of 0.00% which was significantly lower than the 13.9% recorded for Black Gate ($\chi^2$ = 8.859; P= 0.003). The overall difference in CPRs between the Wharram Percy and Black Gate immatures was statistically significant ($\chi^2$ = 6.256; P= 0.012).

The TPR for cribra orbitalia observed for the Wharram Percy immatures was significantly lower than observed for Black Gate ($\chi^2$ = 6.519; P= 0.011).

### *7.4.11 Addingham*

The CPR for four skeletal health indicators could be calculated for the total population of the Addingham assemblage, all of which were less prevalent than observed for Black Gate (Figure 7.18). The overall difference in CPRs observed between the total populations of Addingham and Black Gate was statistically significant ($\chi^2$ = 42.227; P= 0.000). The CPRs for cribra orbitalia ($\chi^2$ = 8.386; P= 0.004), ADJD ($\chi^2$ = 30.305; P= 0.000) and SDJD ($\chi^2$ = 12.831; P= 0.000) were all significantly lower than observed in the Black Gate assemblage.

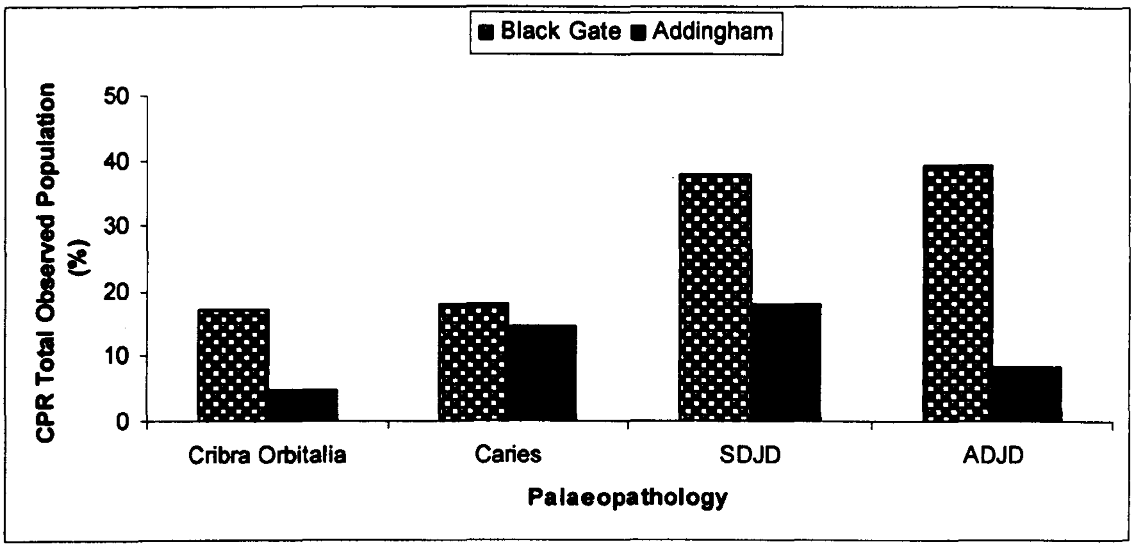


Figure 7.18 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and Addingham*

No TPR's for the total population nor the CPRs and TPRs for the total adult population were discernible from the published report.

The overall immature CPR for Addingham was not significantly different from Black Gate ($\chi^2$ = 0.454; P= 0.500). The CPRs of cribra orbitalia, dental caries, abscess and AMTL observed for the Addingham immature population were all lower relative to the values calculated for Black Gate. However, the differences were not large enough to result in a significant difference.

### *7.4.12 North Elmham Park*

Crude prevalence rates were calculated for ten skeletal health indicators within the total population of the North Elmham Park assemblage (Figure 7.19). The overall difference in CPRs observed between the total populations of North Elmham Park and Black Gate was not statistically significant ($\chi^2$ = 0.012; P= 0.728). The CPRs for cribra orbitalia ($\chi^2$ = 28.711; P= 0.000), maxillary sinusitis ($\chi^2$ = 23.539; P= 0.000) and dental calculus ($\chi^2$ = 19.333; P= 0.000) were all significantly lower than observed for Black Gate. The CPRs for AMTL ($\chi^2$ = 23.715; P= 0.000), DJD ($\chi^2$ = 3.600; P= 0.058) and SDJD ($\chi^2$ = 13.179; P= 0.000) were all significantly greater than those recorded for Black Gate.

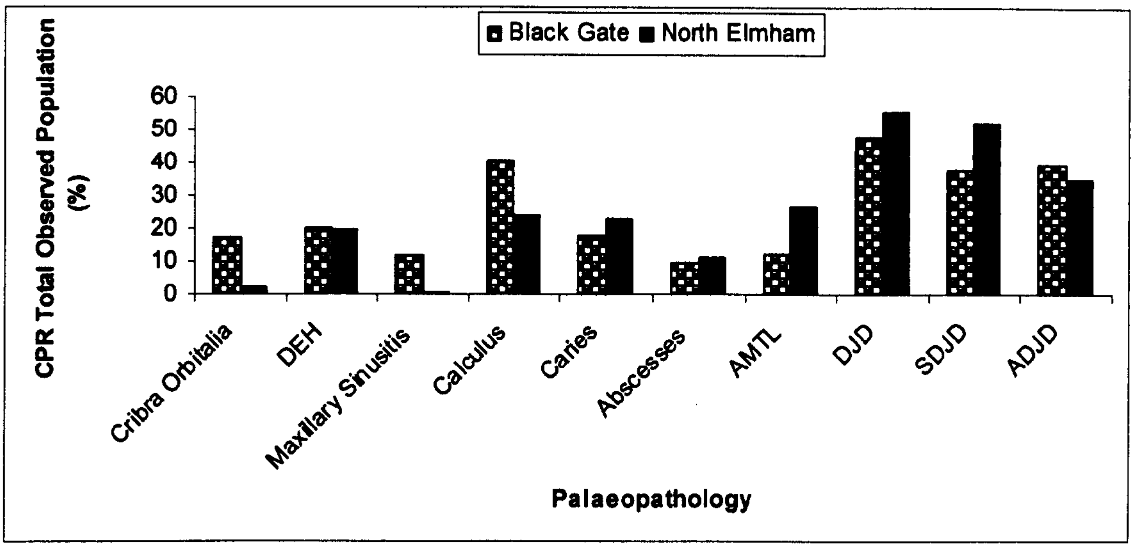


Figure 7.19 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and North Elmham Park*

True prevalence rates could be calculated for five skeletal health indicators within the total population of the North Elmham Park assemblage (Figure 7.20). The overall difference in TPRs observed between the total populations of North Elmham Park and Black Gate was statistically significant ($\chi^2$ = 21.118; P= 0.000). The TPRs for DEH ($\chi^2$ = 16.102; P= 0.000) and dental calculus ($\chi^2$ = 123.249; P= 0.000) were significantly lower than observed for Black Gate. In contrast, the TPR for AMTL ($\chi^2$ = 12.580; P= 0.000) was significantly greater relative to the Black Gate value.

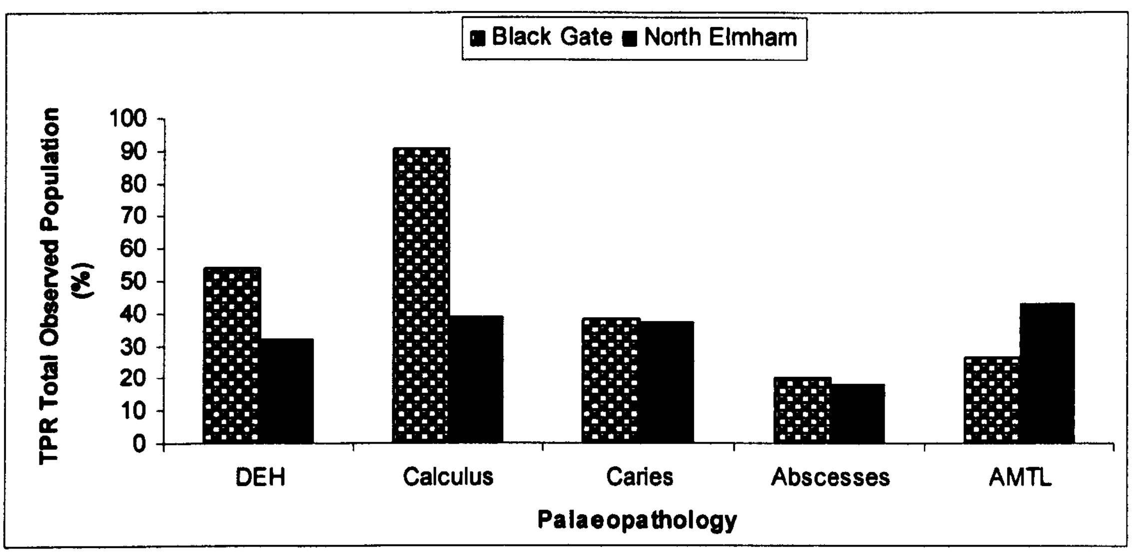


Figure 7.20 *Comparison of TPR of skeletal health indicators for the total observed populations of Black Gate and North Elmham Park*

Crude prevalence rates could be calculated for ten skeletal stress indicators within the adult population of North Elmham Park. The overall difference in CPRs observed between the adult populations of North Elmham Park and Black Gate was statistically significant ($\chi^2$ = 6.751; P= 0.009). The CPRs of cribra orbitalia ($\chi^2$ = 10.063; P= 0.002), maxillary sinusitis ($\chi^2$ = 21.006; P= 0.000) and SDJD ($\chi^2$ = 4.001; P= 0.045) were all significantly lower than was observed for Black Gate. The CPRs for AMTL ($\chi^2$ = 15.578; P= 0.000) and ADJD ($\chi^2$ = 9.972; P= 0.002) were significantly greater than observed for Black Gate.

True prevalence rates could be calculated for six skeletal stress indicators within the adult population of the North Elmham Park assemblage. The overall difference in TPRs observed between the total adult populations of North Elmham Park and Black Gate was statistically significant ($\chi^2$ = 18.758; P= 0.000). The TPRs for DEH ($\chi^2$ = 11.594; P= 0.001) and calculus ($\chi^2$ = 1.321; P= 0.000) were significantly lower than their Black Gate counterparts. In contrast, the TPR for AMTL ($\chi^2$ = 9.987; P= 0.002) was significantly greater than observed for Black Gate.

Crude prevalence rates could be calculated for seven skeletal health indicators within the total immature population of North Elmham Park. The overall difference in CPRs observed between the total immature populations of North Elmham Park and Black Gate was statistically significant ($\chi^2$ = 15.213; P= 0.000). The CPRs for all the health indicators were lower than observed for the Black Gate immature population. A significant difference from the Black Gate values was only observed for cribra orbitalia ($\chi^2$ = 14.005; P= 0.000) and maxillary sinusitis ($\chi^2$ = 3.661; P= 0.056).

True prevalence rates were calculated for three skeletal health indicators within the total immature population of the North Elmham Park assemblage. The overall difference in TPRs observed between the total immature populations of North Elmham Park and Black Gate was statistically significant ($\chi^2$ = 15.064; P = 0.000). The TPRs for DEH (23.5%), calculus (5.9%) and caries (5.9%) were all lower than those observed for

Black Gate. Only the difference between the sites observed for immature calculus was significant ($\chi^2$ = 11.463; P= 0.001).

### 7.4.13 St Peter's, Barton-upon-Humber

Crude prevalence rates were calculated for eight skeletal health indicators within the total population of the St Peter's, Barton-upon-Humber assemblage (Figure 7.21). The overall difference in CPRs observed between the total populations of St Peter's, Barton-upon-Humber and Black Gate was statistically significant ($\chi^2$ = 96.464; P= 0.000). All the health indicators exhibited lower CPRS than Black Gate. The lower prevalences of cribra orbitalia ($\chi^2$ = 38.256; P= 0.000), DEH ($\chi^2$ = 69.207; P= 0.000), TPNB ($\chi^2$ = 21.191; P= 0.000), maxillary sinusitis ($\chi^2$ = 52.291; P= 0.000) and DJD ($\chi^2$ = 98.859; P= 0.000) were statistically significant.

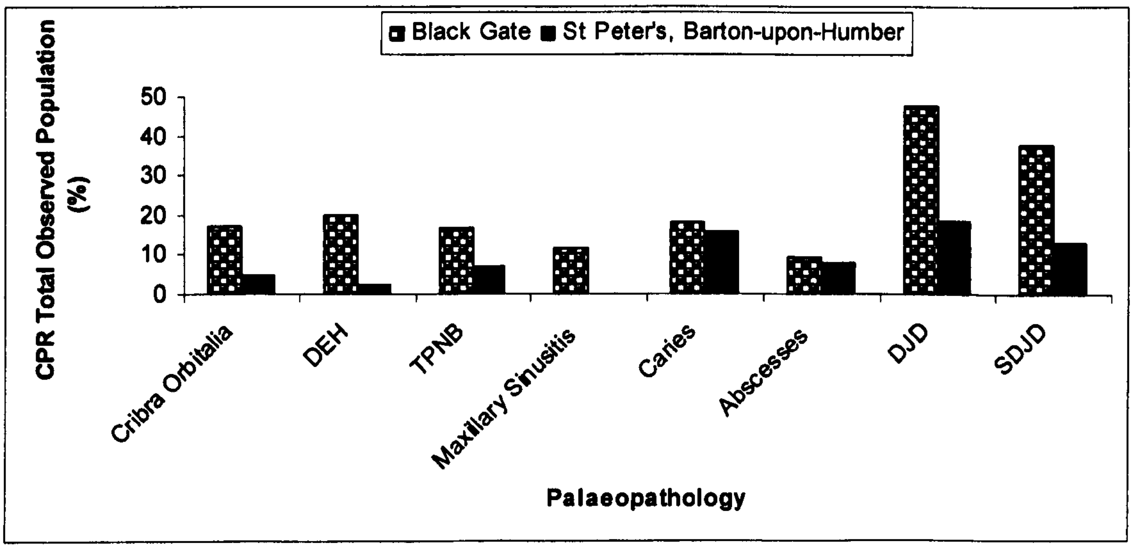


Figure 7.21 *Comparison of CPR of skeletal health indicators for the total observed populations of Black Gate and St Peter's, Barton-upon-Humber*

Crude prevalence rates were calculated for seven skeletal health indicators within the adult population of the St Peter's, Barton-upon-Humber assemblage. The overall difference in CPRs observed between the total adult populations of St Peter's, Barton-upon-Humber and Black Gate was statistically significant ($\chi^2$ = 192.272; P= 0.000). All of the adult CPRs were lower than in the Black Gate adult assemblage. The lower prevalence was statistically significant for the CPRs of cribra orbitalia ($\chi^2$ = 16.451; P=

0.000), DEH ($\chi^2$ = 67.412; P= 0.000), TPNB ($\chi^2$ = 16.526; P= 0.000), maxillary sinusitis ($\chi^2$ = 42.750; P= 0.000) and DJD ($\chi^2$ = 152.071; P= 0.000).

Crude prevalence rates were calculated for six skeletal health indictors within the total immature population of St Peter's, Barton-upon-Humber. The overall difference in CPRs observed between the total immature populations of St Peter's, Barton-upon-Humber and Black Gate was statistically significant ($\chi^2$ = 35.966; P= 0.000). The CPRs for cribra orbitalia ($\chi^2$ = 18.236; P= 0.000), DEH ($\chi^2$ = 6.728; P= 0.009), TPNB ($\chi^2$ = 6.880; P= 0.009) and maxillary sinusitis ($\chi^2$ = 10.680; P= 0.001) were all significantly lower than observed for the Black Gate immature population.

## 7.5 Palaeopathology: Comparisons of Specific Health Indicators between Black Gate and the Comparative Sites.

This section considers the relationships between the specific health indicators recordable for Black Gate and the comparative sites and addresses the relationships between stress indicator and settlement type. Where the indicators of environmental stress can be quantified as crude and true prevalence rates these will be addressed for the total population, and then the adult and the immature populations, respectively. This is to enable any differences in the expression of pathologies experienced during childhood and adulthood to be identified, and to see if immatures are a more sensitive indicator of physiological stress than adults.

### *7.5.1 Indicators of Environmental Stress: Adult Stature*

The mean adult statures for Black Gate and the comparative sites are presented in Table 7.10. The average stature for the total population (165.67 cm) and males (170.15 cm) of the Black Gate assemblage were within the range of statures represented for the comparative sites. The high average stature observed amongst the Black Gate females (163.60 cm) was greater than observed at any other of the comparative sites. Within all the sites, males had a taller mean stature than females.

| Site | Male | Female | Total Assemblage |
|---|---|---|---|
| Black Gate | 170.15 | 163.60 | 165.67 |
| York Minster | n/a | n/a | n/a |
| Swinegate | n/a | n/a | n/a |
| St Andrew's, Fishergate | 172.00 | 158.00 | 165.00 |
| Nicholas Shambles | 172.75 | 157.50 | 165.12 |
| Wearmouth | 171.90 | 159.50 | 167.15 |
| Jarrow | 171.00 | 159.10 | 166.60 |
| Llandough | 172.00 | 157.00 | 166.00 |
| Ailcy Hill, Ripon | 174.10 | 157.00 | 170.60 |
| Raunds Furnells | 167.00 | 162.00 | 164.50 |
| Wharram Percy | 167.00 | 162.00 | 164.50 |
| Addingham | n/a | n/a | n/a |
| North Elmham | 172.10 | 157.40 | 164.75 |
| Barton-upon-Humber | 169.00 | 161.00 | 165.00 |

Table 7.10 *Mean adult stature (cm) for Black Gate and comparative assemblages (n/a = no stature data available)*

### *7.5.2 Indicators of Environmental Stress: Non-Specific Stress*

The true prevalence rates and summary statistics for comparisons of the two non-specific stress indicators between urban, monastic and rural sites and the Black Gate skeletal assemblage are shown in Appendix J, Figures J.1-J.12.

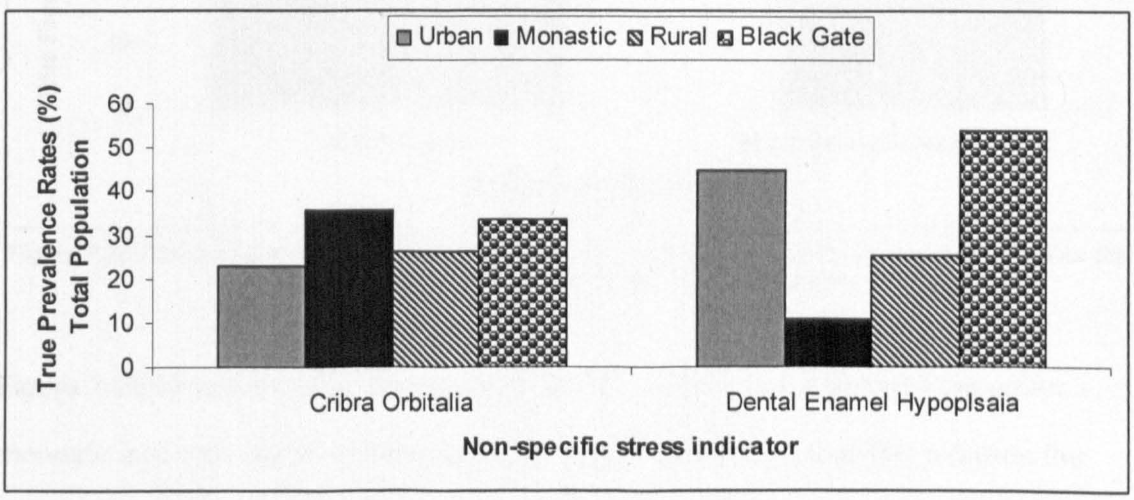


Figure 7.22 *True prevalence rates of non-specific stress indicators (cribra orbitalia and dental enamel hypoplasia) for the total populations of urban, monastic and rural settlements and the Black Gate cemetery*

Figure 7.22 shows the TPRs for cribra orbitalia and DEH recorded for the three settlement types. The TPR for cribra orbitalia observed at Black Gate was statistically higher than the average true prevalence rates calculated for the urban ($\chi^2$ = 10.643; P= 0.001) and rural ($\chi^2$ = 4.847; P= 0.028) settlements. The TPR for cribra orbitalia observed for the urban settlements was significantly lower than recorded for monastic sites ($\chi^2$ = 16.186; P= 0.000). A statistically significant greater TPR of cribra orbitalia was observed for the monastic settlements relative to rural sites ($\chi^2$ = 8.855; P= 0.003).

The TPR for DEH for the total population was significantly greater for Black Gate than both monastic ($\chi^2$ = 47.299; P= 0.00) and rural ($\chi^2$ = 30.877; P= 0.000) sites. The TPR was also greater than observed for the urban sites, but this difference was not statistically significant. The TPR for urban sites was significantly greater than both monastic ($\chi^2$ = 64.115; P= 0.000) and rural ($\chi^2$ = 11.846; P= 0.001) sites. Monastic sites had a significantly lower TPR of DEH than rural sites ($\chi^2$ = 37.735; P= 0.000).

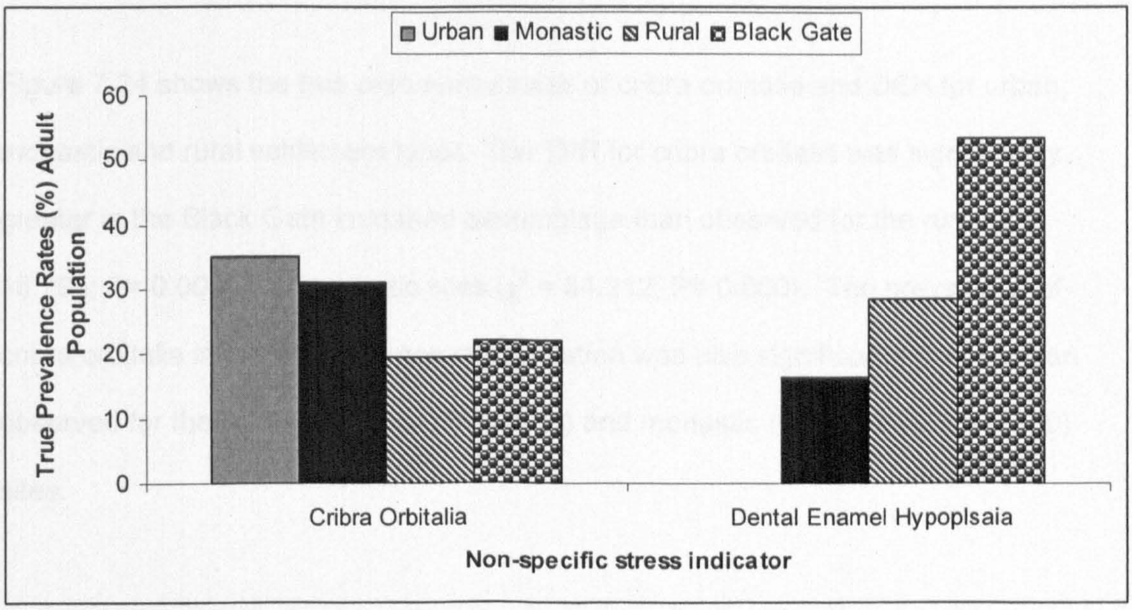


Figure 7.23 *True prevalence rates in percentages of cribra orbitalia and dental enamel hypoplasia for the adult populations of Black Gate and comparative sites*

Figure 7.23 shows the true prevalence rates for the adult populations of the urban, monastic and rural settlement types. None of the differences observed between the sites were statistically significant, suggesting a similar prevalence for cribra orbitalia amongst the adults for all of the settlement types. The TPR for DEH amongst the adults was not available for any of the urban sites. The true prevalence of DEH for the Black Gate adults was significantly higher than for the monastic ($\chi^2$ = 47.299; P= 0.000) and rural ($\chi^2$ = 30.877; P= 0.000) populations. The rural TPR for DEH was significantly higher than that observed for monastic sites ($\chi^2$ = 7.442; P= 0.006).

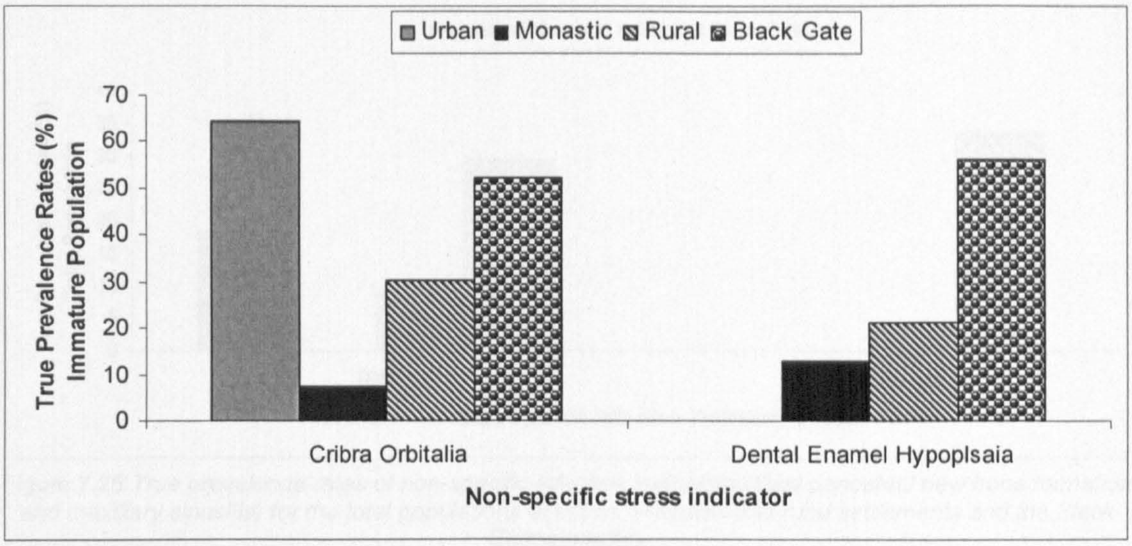


Figure 7.24 *True prevalence rates in percentages of cribra orbitalia and dental enamel hypoplasia for the immature populations of Black Gate and comparative sites*

Figure 7.24 shows the true prevalence rates of cribra orbitalia and DEH for urban, monastic and rural settlement types. The TPR for cribra orbitalia was significantly greater in the Black Gate immature assemblage than observed for the rural ($\chi^2$ = 16.795; P= 0.000) and monastic sites ($\chi^2$ = 34.212; P= 0.000). The prevalence of cribra orbitalia in the urban immature population was also significantly greater than observed for the rural ($\chi^2$ = 7.564; P= 0.006) and monastic ($\chi^2$ = 12.790; P= 0.000) sites.

Immature DEH TPRs were unavailable for the urban sites. However, it was possible to observe that the Black Gate immature TPs for DEH was significantly greater than observed for the rural ($\chi^2$ = 5.870; P= 0.015) and monastic ($\chi^2$ = 5.395; P= 0.020) sites.

### *7.5.3 Indicators of Environmental Stress: Non-Specific Infection*

The true prevalence rates and summary statistics for comparisons of the two non-specific infection indicators between urban, monastic and rural sites and the Black Gate skeletal assemblage are shown in Appendix J, Figures J.13-J.24.

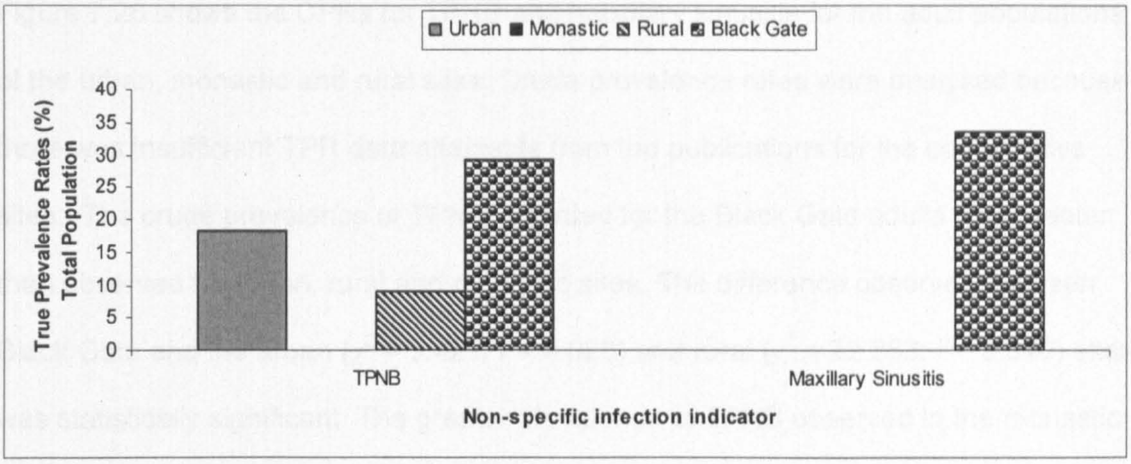


Figure 7.25 *True prevalence rates of non-specific infection indicators (tibial periosteal new bone formation and maxillary sinusitis) for the total populations of urban, monastic and rural settlements and the Black Gate cemetery*

Figure 7.25 shows the true prevalence rates of TPNB and maxillary sinusitis for the total populations of the urban, monastic and rural sites included within this thesis. Maxillary sinusitis TPR data were not available for any of the comparative sites. No monastic TPR data were available for TPNB; therefore, statistical analysis could only be undertaken to explore the relationship between urban and rural sites and the Black Gate assemblage. The Black Gate cemetery exhibited a statistically greater prevalence of TPNB than the rural sites ($\chi^2$ = 41.026; P= 0.000).

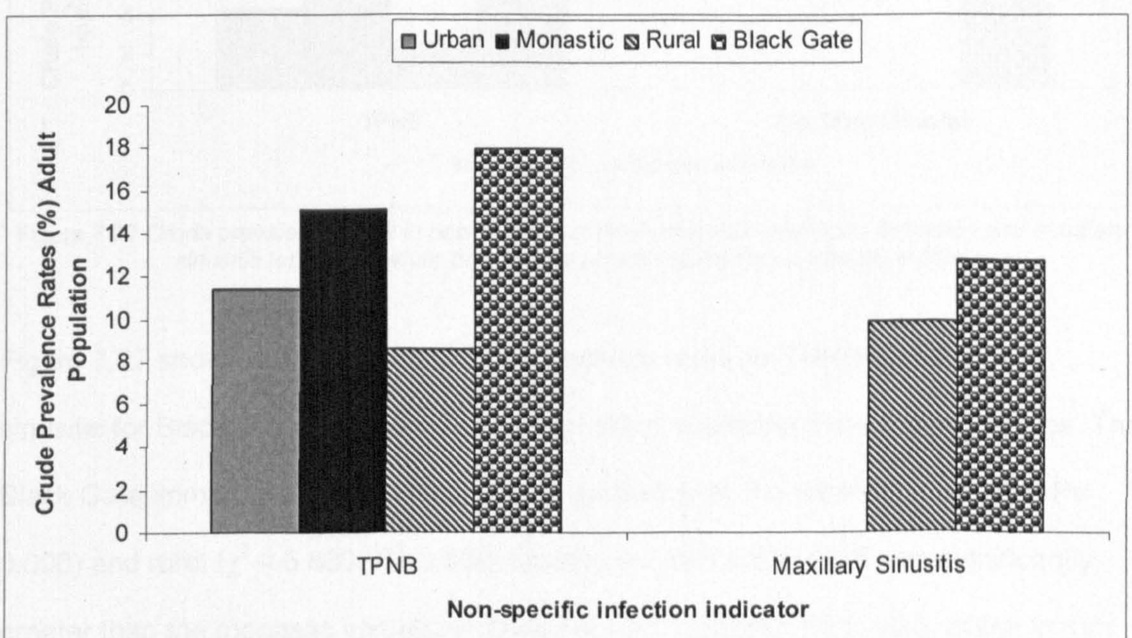


Figure 7.26 *Crude prevalence rates in percentages of tibial new bone formation and maxillary sinusitis for the adult populations of Black Gate and comparative sites*

Figure 7.26 shows the CPRs for TPNB and maxillary sinusitis for the adult populations of the urban, monastic and rural sites. Crude prevalence rates were analysed because there was insufficient TPR data attainable from the publications for the comparative sites. The crude prevalence of TPNB recorded for the Black Gate adults was greater than observed for urban, rural and monastic sites. The difference observed between Black Gate and the urban ($\chi^2$ = 5.421; P= 0.020) and rural ($\chi^2$ = 22.353; P= 0.000) sites was statistically significant. The greater prevalence of TPNB observed in the monastic population in comparison to the rural sample was also significant ($\chi^2$ = 13.564; P= 0.000). The crude prevalence of maxillary sinusitis was only available for rural assemblages, which was significantly lower than observed in the Black Gate adults ($\chi^2$ = 74.855; P= 0.000).

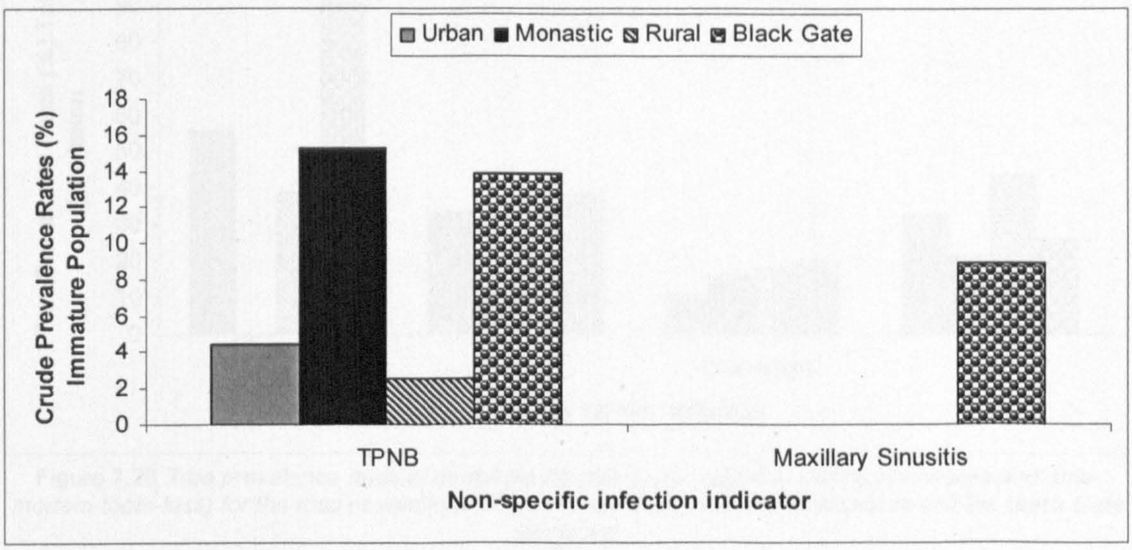


Figure 7.27 *Crude prevalence rates in percentages of tibial periosteal new bone formation and maxillary sinusitis for the immature populations of Black Gate and comparative sites*

Figure 7.27 shows the immature crude prevalence rates for TPNB and maxillary sinusitis for Black Gate and the comparative urban, monastic and rural cemeteries. The Black Gate immature CPR was significantly greater than the urban ($\chi^2$ = 19.424; P= 0.000) and rural ($\chi^2$ = 6.880; P= 0.009) immatures. The urban CPR was significantly greater than the monastic immature prevalence ($\chi^2$ = 23.350; P= 0.000), which in turn exhibited a greater immature TPNB prevalence than the rural sample ($\chi^2$ = 8.858; P= 0.003). Crude prevalence rates of maxillary sinusitis were only available for the immatures from three rural sites (Raunds Furnells, North Elmham Park and St Peter's, Barton-upon-Humber), none of which exhibited presented any cases of porosity or new bone formation within the maxillary sinus. The higher prevalence of maxillary sinusitis observed in the Black Gate immatures, relative to the three rural sites was statistically significant ($\chi^2$ = 26.624; P= 0.000).

### *7.5.4 Indicators of Environmental Stress: Dental Health*

The true prevalence rates and summary statistics for comparisons of the four dental health indicators between urban, monastic and rural sites and the Black Gate skeletal assemblage are shown in Appendix J, Figures J.25-J.48.

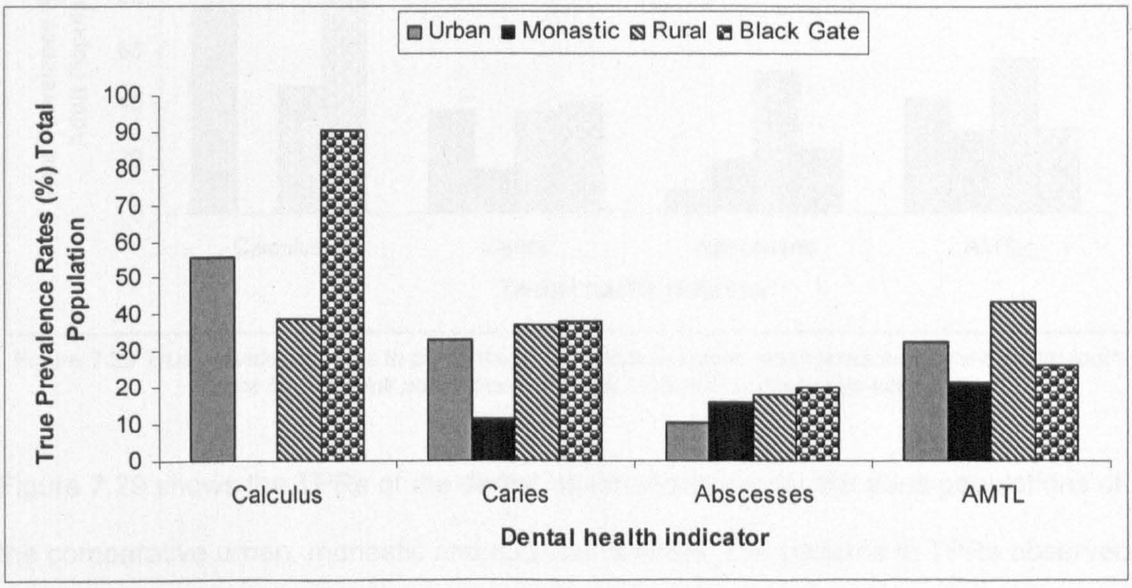


Figure 7.28 *True prevalence rates of dental health indicators (calculus, caries, abscesses and ante-mortem tooth-loss) for the total populations of urban, monastic and rural settlements and the Black Gate cemetery*

Figure 7.28 shows the true prevalence rates of all the dental health indicators (calculus, caries, abscesses and AMTL) for Black Gate and the comparative urban, monastic and rural sites. No TPR information was available for dental calculus for the monastic assemblages. The TPR of calculus observed in the Black Gate population was significantly greater than that observed for both urban ($\chi^2$ = 70.805; P= 0.000) and rural ($\chi^2$ = 1.232; P= 0.000) sites. The TPR for dental caries for the monastic settlement type was significantly lower than recorded for Black Gate ($\chi^2$ = 41.530; P= 0.000) and rural assemblages ($\chi^2$ = 29.730; P= 0.000). In contrast, the monastic TPR was significantly greater than observed in the urban sample ($\chi^2$ = 23.698; P= 0.000). The TPRs for dental abscesses for the Black Gate and urban settlement type represent the extremes of the range of variation in TPR between the sites and, therefore, were significantly different ($\chi^2$ = 74.855; P= 0.012). AMTL was greatest within the rural settlement category. The difference in TPR observed between the rural sites and the Black Gate ($\chi^2$ = 12.580; P= 0.000) and monastic sites ($\chi^2$ = 11.809; P= 0.000) were significant.

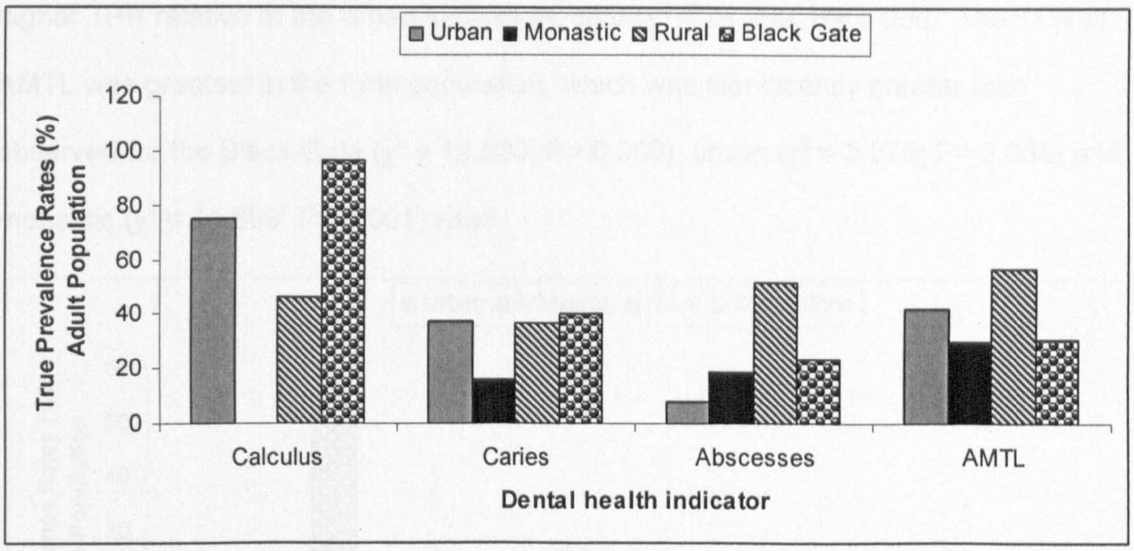


Figure 7.29 *True prevalence rates in percentages of calculus, caries, abscesses and ante-mortem tooth loss for the adult populations of Black Gate and comparative sites*

Figure 7.29 shows the TPRs of the dental health indicators for the adult populations of the comparative urban, monastic and rural cemeteries. The patterns in TPRs observed for each of the sites for each dental health indicator were essentially identical to those seen for the total populations, save for the high prevalence of dental abscesses seen in rural sites in comparison to the Black Gate, urban and monastic settlements. The TPR for dental calculus observed in the Black Gate adult assemblage was significantly higher than observed for urban ($\chi^2$ = 34.523; P= 0.000) and rural settlements ($\chi^2$ = 56.644; P= 0.000). The TPRs for carious lesions observed in the monastic sites was significantly lower than observed for the Black Gate ($\chi^2$ = 64.183; P= 0.000), urban ($\chi^2$ = 48.254; P= 0.000) and rural ($\chi^2$ = 1.370; P= 0.000) sites. The TPR observed for the rural population was statistically lower than those observed for Black Gate ($\chi^2$ = 18.275; P= 0.000) and urban ($\chi^2$ = 17.115; P= 0.000) sites. There were statistically significant differences of the TPRs of dental abscesses between all of the settlement types, save for between the Black Gate and monastic sites. The Black Gate adult TPR for abscesses was significantly greater than observed for the urban sites ($\chi^2$ = 82.902; P= 0.000). In contrast the Black Gate adult TPR for dental abscesses was significantly lower relative to the rural sites ($\chi^2$ = 17.683; P= 0.000). Dental abscesses were also significantly more prevalent in the rural sites in comparison to urban ($\chi^2$ = 36.969; P= 0.000) and monastic ($\chi^2$ = 18.295; P= 0.000). Monastic sites exhibited a significantly higher TPR relative to the urban settlement date ($\chi^2$ = 74.299; P= 0.000). The TPR of AMTL was greatest in the rural population, which was significantly greater than observed for the Black Gate ($\chi^2$ = 12.580; P= 0.000), urban ($\chi^2$ = 3.675; P= 0.055) and monastic ($\chi^2$ = 11.809; P= 0.001) sites.

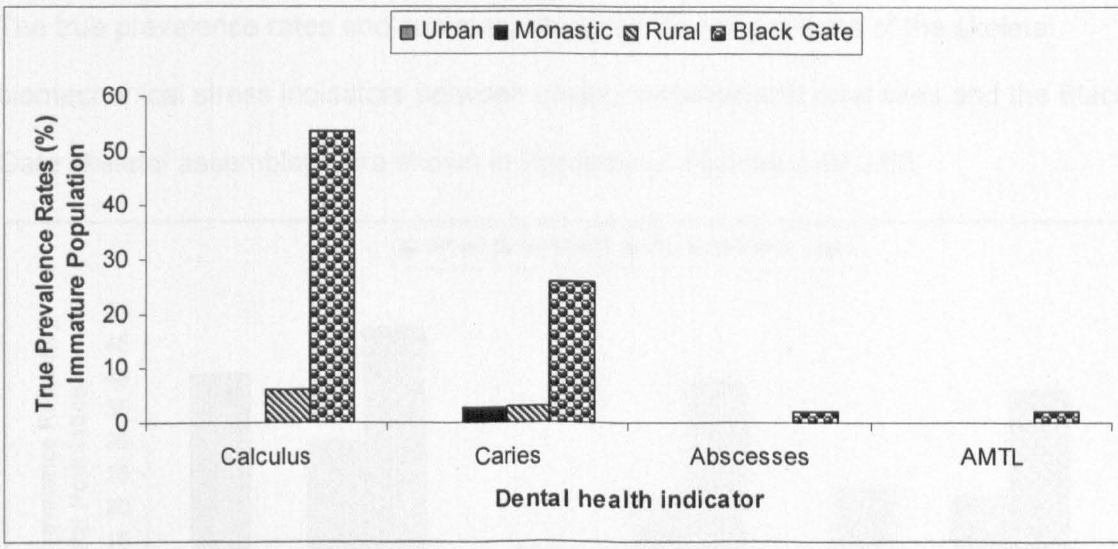


Figure 7.30 *True prevalence rates in percentages of calculus, caries, abscesses and ante-mortem tooth loss for the immature populations of Black Gate and comparative sites*

Figure 7.30 shows the relationship between dental health indicators in the immature populations of Black Gate and the urban, monastic and rural settlement types. There was limited immature dental health data available for the comparative sites, therefore the incidences of only calculus and caries could be compared. The TPR for immature calculus observed for the Black Gate assemblage was significantly greater than that observed for the rural ($\chi^2$ = 11.463; P= 0.000) and urban ($\chi^2$ = 14.696; P= 0.000) cemetery samples. The TPR for caries calculated for Black Gate was also significantly greater than for the urban ($\chi^2$ = 5.484; P= 0.019) cemetery assemblage. The TPR for caries recorded for Black Gate was also greater than observed for rural and monastic sites; the differences were not statistically significant, although the difference between the monastic site and Black Gate was close to significant ($\chi^2$ = 3.619; P= 0.057). There was a statistically significant greater prevalence of AMTL observed in the Black Gate immature assemblage than for urban populations ($\chi^2$ = 5.533; P= 0.019), for which there was only three recorded cases of immature tooth loss prior to death. The urban immatures exhibited a significantly higher prevalence of AMTL than the monastic assemblage ($\chi^2$ = 12.261; P= 0.000).

### *7.5.5 Indicators of Environmental Stress: Skeletal Biomechanical Stress*

The true prevalence rates and summary statistics for comparisons of the skeletal biomechanical stress indicators between urban, monastic and rural sites and the Black Gate skeletal assemblage are shown in Appendix J, Figures J.49-J.60.

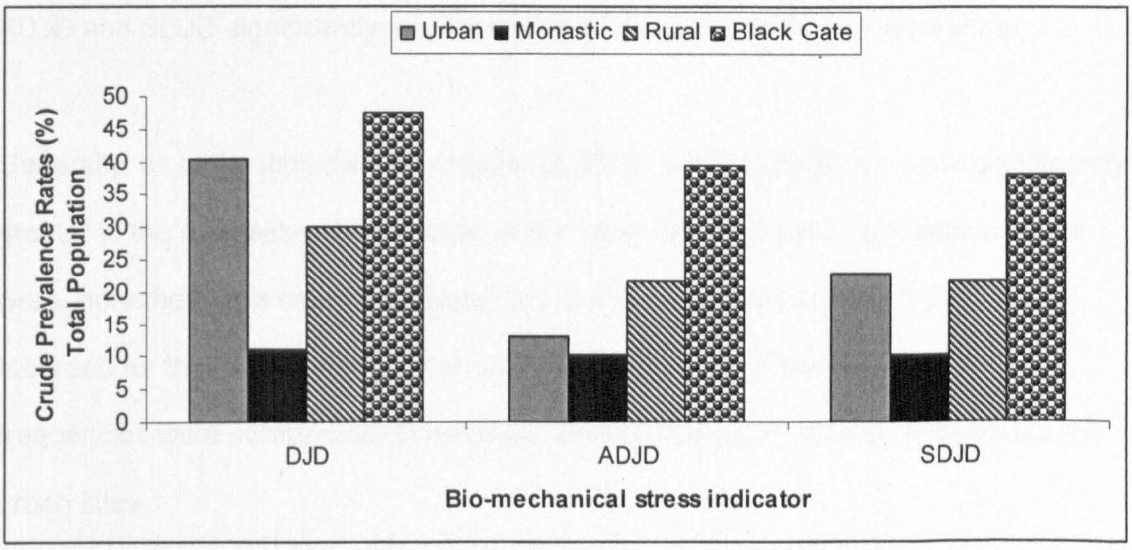


Figure 7.31 *Crude prevalence rates of bio-mechanical stress indicators (degenerative joint disease, appendicular degenerative joint disease and spinal degenerative joint disease) for the total populations of urban, monastic and rural settlements and the Black Gate cemetery*

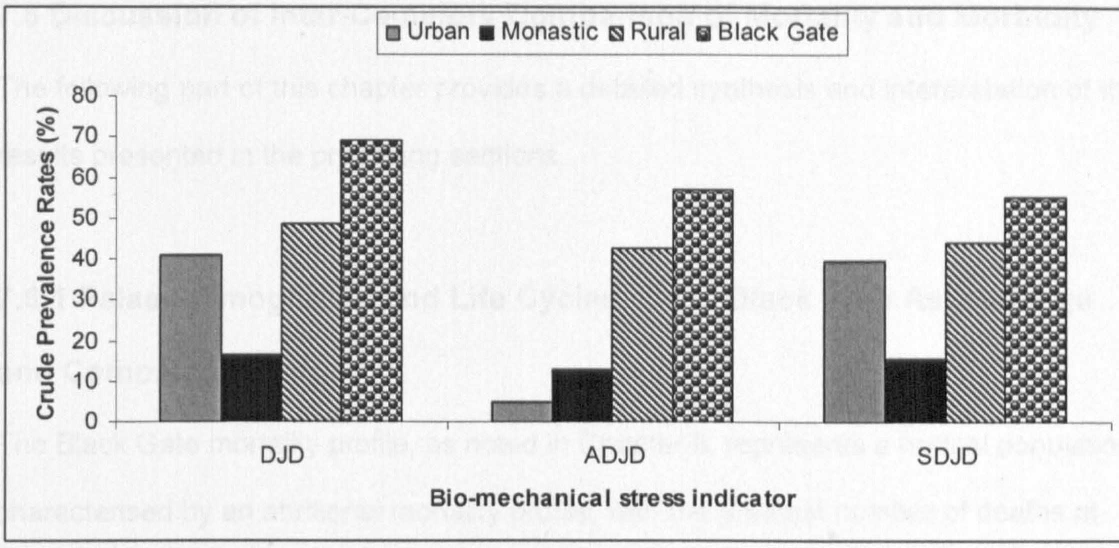


Figure 7.32 *Crude prevalence rates in percentages of degenerative joint disease, appendicular degenerative joint disease and spinal degenerative joint disease for the adult populations of Black Gate and comparative sites*

Figures 7.31 and 7.32 show the crude prevalence rates of the degenerative joint diseases in the total and adult populations of urban, monastic and rural cemetery assemblages. The total and adult populations of Black Gate exhibited CPRs of DJD, ADJD and SDJD significantly greater than the urban, monastic and rural sites.

Generally, all of the joint disease categories (DJD, ADJD and SDJD) were significantly greater in the rural assemblages than in the urban and monastic populations. There were, nonetheless, a couple of exceptions. Comparable frequencies of DJD were recorded for the total populations of rural and urban sites. Rural adult ADJD frequencies were comparable to monastic sites and adult SDJD was comparable to urban sites.

## 7.6 Discussion of Inter-Cemetery Comparison of Mortality and Morbidity

The following part of this chapter provides a detailed synthesis and interpretation of the results presented in the preceding sections.

### 7.6.1 Palaeodemography and Life Cycles of the Black Gate Assemblage and Comparative Sites

The Black Gate mortality profile, as noted in Chapter 5, represents a normal population characterised by an attritional mortality profile, with the greatest number of deaths at the beginning and end of the life cycle. Amongst the immatures, the peak in deaths in the young child age category is consistent with the majority of other sites. The consistent surge in mortality in young children across the sites included in the current study indicates similar environmental, biological or cultural stressors were experienced by this age group throughout early medieval England. This may represent increased exposure of young children to pathogens and hazards due to cultural behaviours (e.g. weaning) or physical developments such as crawling and walking increasing the mobility of children within their physical environment and thus increasing their exposure to pathogens on the ground and increased risk of accidental falls and drowning (Orme 2001: 99-100).

The Black Gate cemetery assemblage exhibits a comparably high percentage of pre-infant and infant deaths relative to the majority of the comparative sites. This may be explained in several ways. Firstly, it is possible that the Black Gate immatures aged less than one year at the time of their death were better preserved and more successfully recovered than at the comparative sites. Alternatively, the high number of pre-infant and infant burials meant this age group were more susceptible to fatal diseases than those interred elsewhere were. Burials of the very young immatures in the Black Gate cemetery may be indicative of a cultural practice. Foetal, neonate and infant burials are found throughout the Black Gate cemetery in the compound, Area C, the Railway Arches and Area D. This suggests that there was no location specific for immature burials, which may be the case at other sites, such as at Whithorn (Galloway, Scotland) (Hill 1997).

The later age for the peak in immature mortality observed at Addingham (older children) and Ailcy Hill (adolescents) may be an artefact of small sample size. Only 11 immatures of known age were recovered from Addingham (Boylston and Roberts 1996: 175) and young and older children were totally absent at Ailcy Hill (Hall and Whyman 1996). Explanation for the high frequency of deaths observed in the infants, declining in young children then increasing for older children at Wearmouth is more complex. Inaccuracies in ageing may explain the variation in the percentage of deaths observed in the three age categories. However, the ageing techniques for young children incorporate several distinct developmental characteristics of the skeleton and dentition, including stages of tooth eruption, skeletal development (epiphyseal fusion and formation of osseous centres) and skeletal growth (diaphyseal length) enhancing the accuracy with which the age of an immature skeleton can be determined. It is more probable that cultural influences account for the different mortality pattern observed at Wearmouth. The high number of infant deaths may indicate that weaning – which has been strongly linked to the peak in young child deaths elsewhere – occurred earlier for the infants interred at Wearmouth and exposed them to the associated risks to their health, discussed in Chapter 5. As part of their pastoral care, monasteries often took in sick and orphaned infants and children (Crawford 1999: 128, 136; Foot 2006: 141, 309-10). Therefore, it is likely a number of the immatures at Wearmouth had been separated from their mothers and needed a food to replace breast milk. The lack of documentary or archaeological evidence for wet nursing from Anglo-Saxon monasteries (Foot 2006: 145) supports the argument for premature weaning causing the peak in mortality in the Wearmouth infants. A similar change in diet may be responsible for the higher mortality rate seen in the older children. The older children may include 'oblates' which, as discussed in the previous chapter, typically entered into the monasteries at around five to seven years of age (Kuefler 1991: 824; Foot 2006: 140, 143-4). These children may have been introduced to an adult diet or fed a specific diet that affected their overall health. However, none of the literature addressing Anglo-Saxon monastic diet or oblates mentions any evidence for a diet specific to oblates (Kuefler 1991; Crawford 1999; Foot 2006: 232-9). Oblates were often given to the monasteries as thanks from their families for the monasteries curing the child of sickness or as an oath given during prayer whilst the child was sick, as was the case for St Willibald (Crawford 1999: 136; Foot 2006: 143, 311). Consequently, oblates may have brought diseases with them and died as a result whilst at the monastery. Alternatively, they may have been exposed within the monastery to new pathogens and stresses, which were detrimental to their health and for which they had not acquired the necessary immunological response capacity to survive. This explanation for the fluctuations in mortality observed in infant, young and older children at Wearmouth could be investigated further by comparing morbidity rates within the three age groups to see if the high mortality rates in infants and older children correspond with elevated levels of non-specific, infectious, nutritional or bio-mechanical stress. The high levels of infant mortality and second peak in older children at Wearmouth, in contrast to the other monastic sites – Jarrow, Ailcy Hill and Llandough – may also be explained by different levels of preservation, selective burial practices or the proportion of lay burials present within the cemeteries. The presence of relatively high numbers of young children at Jarrow and Llandough indicates that some of the children, who were of insufficient age to become oblates, were children of the laity. It is possible that the higher presence of infants within the Wearmouth assemblage was due to better levels of preservation and a careful excavation strategy; such a hypothesis is supported by the high number of foetal and neonate remains recovered during the excavation. However, this hypothesis is undermined by the comparatively low numbers of pre-infant and infant burials recovered from Jarrow, which is located in close proximity to Wearmouth with similar environmental and geological conditions, and which was excavated under the same director (Cramp 2005: 9, 15). The similarity in conditions and excavation at Jarrow would be expected to produce comparable frequencies of infants to Wearmouth, if preservation and recovery were the key factors in the high number of infants recorded for Wearmouth. The excavations at Wearmouth had revealed an area of burial which was specifically designated for the interment of immatures and adult male remains (Cramp 2005: 98, 358; McNeil and Cramp 2005: 86-8), which may have included the interment of orphans, unbaptized infants and oblates. An area of such specific burial, probably the monastic burial ground, was not recovered at Jarrow and Llandough, and, therefore, the representation of immature mortality at those sites reflects the lay community associated with the monastery and hence there is a peak in mortality in the young children at these sites consistent with the rest of the comparative assemblages.

The elevated proportion of senior adults at Black Gate, York Minster, Wearmouth, Jarrow, Wharram Percy and St Peter's, Barton upon Humber is as would be expected for a typical attritional mortality model. A peak in senior adult mortality indicates high life expectancy in a stable population, that is one in which there is no migration into or out of the population and the rates of fertility and mortality are constant, preventing an increase or decline in the population (Wood *et al.* 1992: 344; Jenkins 1993: 121). It is, however, highly unlikely that the populations analysed within this thesis were 'stationary'. It is well documented that there was migration into York during the early medieval period. The Anglo-Saxon Chronicle documents the arrival of Danish men to England accompanied by their wives and children. For example, in 893, the '*wif* ('wife/woman') and two sons' of the Viking leader Hæsten were taken to King Alfred when the Viking fortress at Benfleet in Essex was captured (Savage 1982: 102). There are also references to Danish men marrying into indigenous families such as the marriage between Sihtric, the Hiberno-Norse king of York and the sister of King Athelstan of Wessex in 926 (Savage 1982: 119; Hadley 2002: 61). Furthermore, there would have been localised migrations instigated by economic and cultural factors, such as work and marriage. Consequently, the high proportion of senior adults at these sites may be a consequence of falling birth-rates decrease in immigration or increase in emigration from rural settlements to urban centres (Mays 1998: 71; 2007: 89).

The peak in prime adult mortality seen in the males at Addingham, females at York Minster, Llandough and Wharram Percy, and both sexes at Nicholas Shambles can be explained by a number of potential occurrences. Firstly, an increased mortality in prime adults may represent the effects of warfare. It would be expected that males of fighting age would be more susceptible to death during periods of warfare. Indeed, during the 9th and early 10th century England was subjected to a series of Viking raids (Hindley 2006: 176, 182-3). There are numerous references to Viking attacks on York. The presence of charred wood, melted lead and glass at Wearmouth has been tentatively linked to 9th-century Viking attacks (Hadley 2006: 194). However, if warfare was responsible for the peak in prime adult mortality in these sites, it would be expected that males would be more greatly represented than females and there would be extensive unhealed traumatic injuries indicating elevated levels of violence (Loe 2003: 341). No osteological evidence indicative of inter-personal violence or combat exists for Black Gate or any of the other sites included in the current study. Furthermore, Wearmouth and Jarrow, which were likely to have been at the forefront of a Viking attack did not exhibit the peak in prime adult mortality. Secondly, as is mentioned in Chapter 6, there were episodes of drought and famine throughout the early medieval period, which would have exerted nutritional stress upon the populace. Nonetheless, episodes of famine or drought, or even an outbreak of infectious disease such as plague, would affect the weakest members of a community such as the young, old and infirm, not individuals in their 'prime' of life. Moreover, there is little evidence of nutritional deficiency diseases such as scurvy, rickets, osteomalacia or osteopenia, which would be expected if these populations had experienced prolonged periods of drought or famine. A third explanation for the high mortality seen in prime adults could be the aforementioned migration between rural and urban settlements. The high number of prime female deaths at York Minster and Llandough could reveal these sites to be settlements experiencing female immigrations, possibly to fulfil labour demands for domestic service and craft industries (Mays 1998: 72). Such a model would fit for York Minster and possibly even for Llandough if monastic settlements were accompanied by increases in craft activities and a need for domestic services. However, Wharram Percy was a rural settlement, and there is documentary evidence for the late medieval period that people emigrated from Wharram Percy to York. The late medieval Inquisitions Post Mortem (*c.* 1240-1660)[1] indicate that people emigrated the 40 miles from Wharram Percy to York (Mays 1998: 71-2), and it is probable that such migration also occurred in the early medieval period as York became increasingly urbanised. Immigration of both prime males and females to urban London and York may have exposed this age group to a greater range of diseases than the less mobile individuals who remained within rural settlements. This could explain the peak in prime male and female mortality in the St Nicholas Shambles and York Minster assemblages. The increase in trade seen from the 9th century may have resulted in a more fluid, short-term mobility of peoples between urban and rural settlements for the transport and sale of food and other commodities. If prime adults were the age category most likely to travel between different settlements they would have been exposed to a greater number of pathogens in the markets and trading settlements vectored by tradesmen and their animals. Consequently, the exposure to new pathogens, to which they had no natural resistance from their own environment, would have resulted in increased risk of illness and subsequent death in this age group.

The diversity of settlement contexts exhibiting a peak in mortality amongst the prime adults demonstrates that variation in mortality is not determined by settlement type in the later Anglo-Saxon period. Whatever the cause of the peak in prime adult mortality it was something universal to all settlement types, and females were more susceptible than males. This brings us to the fourth possible causative factor of high prime adult

[1] The Inquisitions Post Mortem were reports of the property and heirs of the deceased who possessed land directly from the Crown, collected by Royal officials.

mortality rates, which was childbirth. The relationship between childbirth and prime adult female mortality has been discussed previously in Chapter 5. As childbirth occurs naturally in all communities there must be other factors at play which would mean that childbirth would be more fatal in some settlement sites but not in others. Furthermore, if the peak in prime adult female mortality was associated with childbirth, it would be expected that populations exhibiting high levels of prime female mortality would also experience elevated levels of neonate deaths. This relationship is observed in the Black Gate cemetery, which has one of the highest percentages of pre-infant (foetal and neonate) deaths in the study. There was no evidence of such a relationship observed for the comparative sites. The four sites showing a peak in prime female mortality show pre-infant mortality rates ranging from 0.0% (York Minster) to 3.1% (Wharram Percy), which are lower than the highest pre-infant mortality rate of 5.9% recorded for Raunds Furnells. This evidence suggests that childbirth itself was not responsible for the peak in prime female deaths, but does not discount the deleterious effects on health of pregnancy and lactation. It can be concluded that the peak in prime adults, particularly females, in some sites results from a combination of factors but it appears more likely to be a combination of factors such as childbirth, childrearing and increased mobility than periods of warfare, famine or drought.

The Black Gate's average life expectancy at birth ($e_0$) of 26.2 years was securely within the range for the comparative samples which spanned from 21.2 years at Raunds Furnells to 30.5 years at Wharram Percy. The sites exhibiting the lowest and highest predicted life expectancy at birth were both rural settlements, negating any hypotheses that the principal influence upon life expectancy was settlement type, and that urban sites would exhibit lower life expectancies. The diversity in the average life expectancy at birth calculated from life tables and the lack of relationship between settlement type and life expectancy may be due to methodological problems with the life tables or that different settlements of the same type may be highly varied in their environmental conditions, access to resources and population status composition. The life tables and life expectancy at birth calculations revealed that the Black Gate population exhibited longevity well within the range observed for the early medieval period.

### 7.6.2 Comparisons of Health Indicators in the Early Medieval Period

The crude and true prevalence rates for all the skeletal health indicators observed at Black Gate were consistently greater than those calculated for the entire early medieval period by Roberts and Cox (2003) (Figure 7.11).

| Pathology | Roberts and Cox (2003) Average (%) | Black Gate Average (%) | Comparative Sites Average (%) | Roberts and Cox (2003) Range | Comparative Sites Range |
|---|---|---|---|---|---|
| Cribra orbitalia | 7.6 | 17.1 | 18.1 | 0.6-50.0 | 2.4-20.0 |
| DEH | 18.8 | 20.0 | 10.9 | 0.9-60.1 | 2.2-31.3 |
| TPNB | - | 16.6 | 7.4 | - | 3.0-15.6 |
| Maxillary sinusitis | 4.7 | 11.5 | 9.6 | 0.1-14.9 | 0.2-15.2 |
| Calculus | 35.0 | 40.8 | 26.6 | 2.5-80.0 | 23.5-58.8 |
| Caries | 4.7 | 18.0 | 12.0 | 0.0-100.0 | 3.7-22.8 |
| Abscess | 4.8 | 9.5 | 6.7 | 2.9-28.1 | 3.0-13.4 |
| AMTL | 4.6 | 12.4 | 18.7 | 4.3-100.0 | 5.2-26.7 |
| DJD | - | 47.6 | - | - | 5.9-55.3 |
| ADJD | 8.3 | 38.0 | - | 1.6-50.0 | 3.7-35.0 |
| SDJD | 12.1 | 39.2 | 62.4 | 1.6-50.0 | 8.0-52.4 |

Table 7.11 *Crude prevalence rate data from Roberts and Cox (2003), Black Gate and comparative sites included within this study*

The lower CPRs documented by Roberts and Cox (2003), relative to the Black Gate, may be explained by the incorporation of early Anglo-Saxon sites in their early medieval sample. Early Anglo-Saxon sites predate the increased urbanisation that occurred in the 9$^{th}$ century and would have experienced less environmental stress than the Black Gate cemetery if it represents an urban population.

All of the early medieval CPRs calculated by Roberts and Cox (2003) are within the lower ranges observed for the comparative sites included within the current study – save for AMTL which has a lower prevalence than the lowest percentage observed in the comparative sites (but may be an artefact of the vast variation in prevalence from 4.3-100.0%). The low prevalence of health indicators in the early medieval sites suggests their inhabitants' experienced lower levels of physiological stress, better oral hygiene and a diet with fewer cariogenic components than the later Anglo-Saxon populations included within this thesis. It would be expected that the comparative CPRs

would be higher than the general early medieval period because the populations inhabiting these settlements existed during a period of increased urbanisation.
The Black Gate cemetery CPRs were not only higher than the Roberts and Cox (2003) data, but were also consistently at the higher end of the ranges recorded for the comparative sites. Indeed, the CPRs for TPNB and ADJD exceeded the higher limits of the comparative ranges.

### 7.6.3 Comparisons of Health Indicators between Black Gate and Sites of Known Context

This section reviews the results of the comparisons of CPRs and TPRs between Black Gate and the comparative sites. The comparison of the overall health profile combining the prevalence of all the available health indicators was examined. The aim of this analysis was to identify if the overall health profile of the Black Gate total, adult and immature populations bore similarities to one or more settlements, which would suggest similarities in exposure to stress, possibly identifying the type of settlement from which the Black Gate cemetery served. Such a comparison may also help determine the reasons for the high prevalence of CPR for the overall Black Gate total, adult and immature populations relative to the early medieval period.

Table 7.12 provides a summary of the results of chi-square statistical tests comparing the overall CPRs and TPRs recorded for the total, immature and adult populations of each settlement with the Black Gate cemetery. The number of health indicators for which data could be acquired for each age group (total population, adult or immature) are also included.

| SITE | TOTAL CPR | N | TOTAL TPR | N | ADULT CPR | N | ADULT TPR | N | IMMATURE CPR | N | IMMATURE TPR | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| York Minster | x | 11 | ✓ | 6 | n/a | 0 | n/a | 0 | n/a | 0 | n/a | 0 |
| Swinegate | x | 2 | x | 2 | n/a | 0 | n/a | 0 | n/a | 0 | n/a | 0 |
| St Andrews, Fishergate | x | 3 | x | 1 | x | 2 | x | 2 | x | 3 | x | 1 |
| St Nicholas Shambles | x* | 7 | ✓ | 4 | ✓ | 7 | x | 3 | ✓ | 3 | x | 0 |
| Wearmouth | ✓ | 8 | ✓ | 3 | ✓ | 8 | ✓ | 4 | ✓ | 2 | ✓ | 2 |
| Jarrow | ✓ | 8 | ✓ | 2 | ✓ | 8 | ✓ | 5 | ✓ | 2 | ✓ | 2 |
| Llandough | ✓ | 5 | ✓ | 2 | ✓ | 4 | ✓ | 1 | x | 2 | x | 1 |
| Ailcy Hill | ✓ | 6 | n/a | 0 | ✓ | 5 | n/a | 0 | n/a | 0 | n/a | 0 |
| Raunds Furnells | ✓ | 6 | ✓ | 3 | ✓ | 6 | ✓ | 2 | ✓ | 5 | ✓ | 1 |
| Wharram Percy | ✓ | 5 | ✓ | 1 | ✓ | 7 | ✓ | 5 | ✓ | 2 | n/a | 1 |
| Addingham | x* | 4 | n/a | 0 | n/a | 0 | n/a | 0 | n/a | 1 | n/a | 0 |
| North Elmham | x | 10 | ✓ | 5 | ✓ | 10 | ✓ | 5 | ✓ | 7 | ✓ | 3 |
| St Peters, Barton-upon-Humber | ✓ | 7 | n/a | 0 | ✓ | 7 | n/a | 0 | ✓ | 6 | n/a | 0 |

Table 7.12 *A summary of the results of the $\chi 2$ statistical analysis comparing the overall CPR and TPR health profiles in the total, immature and adult population between the Black Gate and comparative sites (✓ = statistically significant difference (P = <0.05); x = no statistically significant difference (P = >0.05); n/a = insufficient data was available to perform statistical test; N = number of stress and health indicators with available prevalence information; * = approaching statistical significance)*

The chi-squared tests comparing the overall relationship of several health indicators between Black Gate and each comparative site generated the following results:

- *The overall CPR and TPR values for the total, adult and immature populations recorded for Wearmouth, Jarrow, Ailcy Hill, Raunds Furnells and Wharram Percy were significantly different from Black Gate*

- *For North Elmham Park all the CPR and TPR overall values were significantly different from Black Gate, except for Total CPR*

- *All the overall CPR and TPR comparisons made between Black Gate and the skeletal assemblages from Swinegate and St Andrew's, Fishergate in York revealed no statistically significant differences*

The consistent difference in the CPR and TPR values calculated for the total, adult and immature populations of these sites relative to Black Gate suggests the overall health of the inhabitants of Wearmouth, Jarrow, Ailcy Hill, Raunds Furnells, Wharram Percy, Addingham and North Elmham Park differed substantially from the Black Gate population. In contrast, the statistically homologous overall health profiles of Swinegate and St Andrew's Fishergate relative to Black Gate implies similar environmental stressors were experienced at these urban sites in York and the Black Gate. This may indicate that the Black Gate served an urban community.

In contrast, several sites exhibited contradictory relationships between the overall CPRs and TPRs calculated for the total, adult and immature populations:

- *The CPRs and TPRs calculated for the total and adult populations from Llandough were significantly different from the Black Gate population. In contrast the immature CPRs and TPRs were not significantly different between the two sites*

- *At York Minster the total CPR was not significantly different from Black Gate. In contrast the total TPR between the two sites did differ significantly*

- *The most contradictory was St Nicholas Shambles, where total CPR, adult TPR and immature TPR were not significantly different from Black Gate, whereas the total TPR, adult CPR and immature CPR were*

These observations highlight the inconsistent results sometimes acquired from calculations of crude and true prevalence rates. Overall, there were no clear relationships observed for the total, adult and immature prevalence of health indicators between Black Gate and the sites of Llandough, York Minster and St Nicholas Shambles. Each of the health indicators quantifies a different aspect of a person or population's lifestyle and environment. Consequently, the lack of a statistically significant difference between Black Gate and some of the comparative sites, when combining several stress indicators, implies similarities in several aspects of their lives. A statistically significant difference between the prevalence rates for Black Gate and the comparative health profile indicates differences in one or more aspects of their lives. For example, a settlement site could have experienced similar levels of childhood stress, and therefore exhibited similar CPRs and TPRs for cribra orbitalia and DEH, to the Black Gate population but consumed an adult diet rich in cariogenic foods. The subsequent elevated levels of dental caries and AMTL in the comparative site would result in a health profile that was significantly different to Black Gate. Comparisons of each health indicator between the Black Gate and urban, monastic and rural settlements explore the possible explanations for a lack of consistent prevalence patterns between the sites included within this study. This section considers which factors influenced health in the later Anglo-Saxon period, principally focussing on settlement type and the impact of increasing urbanisation. A summary of the results of this analysis is provided in Table 7.13

| TOTAL POPULATION: TPRs | | | | | | |
|---|---|---|---|---|---|---|
| | **Urban and Black Gate** | **Urban and Monastic** | **Urban and Rural** | **Monastic and Black Gate** | **Monastic and. Rural** | **Rural and Black Gate** |
| **Cribra orbitalia** | Black Gate > Urban | Monastic > Urban | >0.05 | >0.05 | Monastic > Rural | Black Gate > Rural |
| **DEH** | >0.05 | Urban >Monastic | Urban > Rural | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **TPNB** | >0.05 | - | >0.05 | - | - | Black Gate > Rural |
| **Maxillary sinusitis** | - | - | - | - | - | - |
| **Calculus** | Black Gate > Urban | - | >0.05 | - | - | Black Gate > Rural |
| **Caries** | >0.05 | Monastic > Urban | >0.05 | Black Gate > Monastic | Rural > Monastic | >0.05 |
| **Abscesses** | Black Gate > Urban | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| **AMTL** | >0.05 | >0.05 | >0.05 | >0.05 | Rural > Monastic | Rural > Black Gate |
| **DJD** | Black Gate > Urban | Urban > Monastic | >0.05 | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **ADJD** | Black Gate > Urban | Urban > Monastic | Rural > Urban | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **SDJD** | Black Gate > Urban | Urban > Monastic | Urban > Rural | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **ADULT POPULATION: TPRs** | | | | | | |
| | **Urban and Black Gate** | **Urban and Monastic** | **Urban and Rural** | **Monastic and Black Gate** | **Monastic and Rural** | **Rural and Black Gate** |
| **Cribra orbitalia** | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| **DEH** | - | - | - | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **TPNB** | Black Gate > Urban | >0.05 | >0.05 | >0.05 | Monastic > Rural | Black Gate > Rural |
| **Maxillary sinusitis** | - | - | - | - | - | Black Gate > Rural |
| **Calculus** | Black Gate > Urban | - | >0.05 | - | - | Black Gate > Rural |
| **Caries** | >0.05 | Urban > Monastic | Urban>Rural | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **Abscesses** | Black Gate > Urban | Monastic > Urban | Rural > Urban | >0.05 | Rural > Monastic | Rural > Black Gate |
| **AMTL** | >0.05 | >0.05 | Rural > Urban | >0.05 | Rural > Monastic | Rural > Black Gate |
| **DJD** | Black Gate > Urban | >0.05 | Rural > Urban | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **ADJD** | Black Gate > Urban | Monastic > Urban | Rural > Urban | Black Gate > Monastic | >0.05 | Black Gate > Rural |
| **SDJD** | Black Gate > Urban | Urban > Monastic | >0.05 | Black Gate > Monastic | Rural > Monastic | Black Gate > Rural |
| **IMMATURE POPULATION: TPRs** | | | | | | |
| | **Urban and Black Gate** | **Urban and Monastic** | **Urban and Rural** | **Monastic and Black Gate** | **Monastic and Rural** | **Rural and Black Gate** |
| **Cribra orbitalia** | >0.05 | Urban > Monastic | Urban > Rural | Black Gate > Monastic | >0.05 | Black Gate > Rural |
| **DEH** | - | - | - | Black Gate > Monastic | >0.05 | Black Gate > Rural |
| **TPNB** | Black Gate > Urban | Monastic > Urban | >0.05 | >0.05 | Monastic > Rural | Black Gate > Rural |
| **Maxillary sinusitis** | - | - | - | - | - | - |
| **Calculus** | - | - | - | - | >0.05 | Black Gate > Rural |
| **Caries** | Black Gate > Urban | >0.05 | >0.05 | Black Gate > Monastic | >0.05 | Black Gate > Rural |
| **Abscesses** | >0.05 | - | - | >0.05 | - | >0.05 |
| **AMTL** | Urban > Black Gate | Urban > Monastic | - | >0.05 | - | - |

Table 7.13 *Summary of the statistically significant relationships for the true prevalence of the health indicators between the Black Gate and Urban, rural and monastic settlement sites (>0.05 = no statistically significant difference; - no data available to enable statistical significance testing)*

Comparisons of TPRs between Black Gate, urban, rural and monastic settlements revealed the following:

- *All of the Black Gate TPRs were greater than observed for the urban, monastic and rural assemblages for the total population, adults and immatures*

- *Rural sites typically exhibited greater TPRs than monastic settlements (save for the total TPR for cribra orbitalia and adult and immature TPNB)*

- *No clear patterns in the frequencies of health indicators were seen between urban settlements relative to the rural and monastic assemblages*

- *There was no significant difference in the adult TPR values for cribra orbitalia between any of the settlement types*

When the sites were combined into settlement categories, – urban, monastic and rural settlement types – it was apparent that the Black Gate cemetery exhibited higher prevalences of the majority of health indicators than the three settlement categories. An absence of any cohesive pattern in health indicators between urban, monastic and rural sites was also observed.

The Black Gate total, immature and adult populations exhibit high levels of systemic, infectious, dental health and biomechanical stress relative to the comparative sites. The immatures in particular show levels greater than the other sites. In general, adults appear to be experiencing high levels of stress but this is not always greater than at other sites. However, it is apparent that although the prevalence rates are typically higher than the average they are still within the ranges expressed by the comparative sites and, therefore, within the norm for this period (Table 7.14).

| | TPRs | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Health Indicator | Black Gate | | | Urban | | | Monastic | | | Rural | | |
| | Total | Adult | Imm. | Total | Adult | Imm. | Total | Adult | Imm. | Total | Adult | Imm. |
| Cribra | 33.6 | 22.2 | 52.4 | 22.7 | 35.1 | 64.3 | 35.8 | 26.0 | 22.0 | 26.4 | 26.1 | 28.7 |
| DEH | 54.0 | 53.5 | 56.4 | 44.7 | - | - | 10.8 | 15.4 | 17.9 | 25.6 | 27.8 | 19.5 |
| TPNB | 29.2 | 17.9 | 13.9 | 18.4 | 11.4 | 1.99 | - | 15.1 | 15.5 | 9.1 | 17.9 | 4.4 |
| Max. Sin. | 11.5 | 12.7 | 8.9 | - | - | - | - | - | - | 5.6 | 8.2 | 0.0 |
| Calculus | 90.3 | 96.4 | 53.7 | 55.6 | 75.6 | 0 | - | - | - | 38.9 | 72.0 | 5.9 |
| Caries | 38.0 | 40.4 | 26.0 | 33.1 | 38.0 | 0 | 11.7 | 8.7 | 5.9 | 37.3 | 59.0 | 5.9 |
| Abscess | 20.0 | 23.6 | 1.9 | 10.6 | 77.8 | 0 | 16.0 | 19.2 | 0 | 18.3 | 40.8 | 0 |
| AMTL | 26.2 | 31.1 | 2.0 | 32.5 | 20.0 | 17.7 | 21.6 | 29.2 | 0 | 43.7 | 53.3 | - |
| DJD | 47.6 | 69.4 | n/a | 31.3 | 24.0 | n/a | 8.2 | 26.9 | n/a | 29.4 | 43.6 | n/a |
| ADJD | 51.6 | 32.2 | n/a | 3.8 | 5.0 | n/a | 10.9 | 15.6 | n/a | 27.3 | 17.0 | n/a |
| SDJD | 43.7 | 63.7 | n/a | 30.3 | 39.4 | n/a | 9.3 | 14.9 | n/a | 21.7 | 42.1 | n/a |

Table 7.14 *Summary statistics of true prevalence rate percentages for the total, adult and immature populations of Black Gate, urban, monastic and rural sites included in current study (Imm. = immatures)*

There are two possible explanations for the high levels of stress and dental health indicators recorded for the Black Gate assemblage relative to the early medieval period overall and the comparative sites included within the current study. Firstly, perhaps the population experienced higher levels of stress, from which they subsequently died. Alternatively, the Black Gate assemblage represents a healthy population, which was exposed to similar levels of stress to the comparative sites, but was strong enough to survive periods of stress long enough for them to manifest upon the skeleton. This second explanation is consistent with the osteological paradox (Wood *et al.* 1992) that healthier individuals manifest health indicators more often than less healthy individuals because they have the capacity to fight diseases for longer, enabling skeletal responses to the disease to manifest.

It is possible that the high levels of non-specific stress, non-specific infection, dental health indicators and biomechanical stress indicate Black Gate to have served an urban population. The relationship between cribra orbitalia and exposure to intestinal parasites make it probable that the high prevalence of cribra orbitalia for the total population indicates that the Black Gate population inhabited an area of dense population and the associated poor standards of sanitation and hygiene. The higher levels of DEH and dental diseases observed for Black Gate were consistent with the findings of Lewis (2002a: 56-7) that immatures in urban settlements exhibited greater levels of dental caries and abscesses than rural sites in the medieval period. Furthermore, the only two sites which shared prevalence rates for the total, adult and immature components with the Black Gate, which were not significantly different were the urban cemetery assemblages of Swinegate and St Andrew's, Fishergate in York.

The interpretation that these strands of evidence show the Black Gate cemetery to have served an urban population is extremely tenuous for several reasons. Firstly, the study by Lewis (2002a) was comparing early medieval rural sites (Raunds Furnells and Wharram Percy) with later medieval (St Helen-on-the-Walls) and post-medieval (Christ Church, Spitalfields) urban cemeteries. Therefore, the higher prevalence of stress and dental disease in Lewis' urban sample may simply reflect the aforementioned increase in stress and health indicators in the later medieval period in general, as identified by Roberts (2009). Secondly, stress and health indicators can be caused by a number of factors and there may be several aetiologies for a single pathology. Thus, a direct interpretation that a higher prevalence of a specific condition is a skeletal marker of a particular environment or activity is extremely problematic. For example, the high prevalence of maxillary sinusitis in the Black Gate sample may equally indicate a high exposure to pollutants associated with urban craft activities or to irritants such as pollen associated with rural agricultural activities (Wells 1977; Boocock *et al.* 1995; Lewis *et al.* 1995). Overall, the current study revealed no cohesive relationship between settlement type and the physiological manifestation of stress on the skeleton. The lack of an obvious correlation between health and settlement type can be explained in three ways. Firstly, urbanisation in the early medieval period was not sufficiently advanced for differences in health, hygiene, environment and sanitation to manifest skeletally on the skeleton enough to be visible. Secondly, the complex relationship between stress and skeletal health markers may make them an unreliable, or too insensitive, gauge of environmental stress and health (in other words, they are poor measures of environmental and cultural change). Thirdly, the methods used to record and quantify stress within this study were flawed, or hindered by issues such as different recording strategies in separate publications, methodological inaccuracies and problems with the use of crude and true prevalence rates. Each of these three indicators will now be considered in detail.

As detailed in Chapter 3, there was a gradual increase in the presence of urbanised settlements commencing in the 7th century and the number of people living in towns did increase somewhat from the 9th century. Nevertheless, this transition was nominal when considered in terms of real population numbers. It has been estimated that less than 10% of the population inhabited towns by the Norman Conquest and it has been predicted that half the urban population in the 9th-10th century were housed in small towns, not large-scale urban conurbations (Dyer 2000: 508; Astill 2009: 256). The urban settlements would have been populated by people who previously lived in the surrounding countryside. Indeed, at least a third of the urban population in the later Middle Ages comprised first- or second generation immigrants from local villages (Astill 2009: 266). Furthermore, urban and rural communities were not insular units. Therefore, it is possible that they would experience similar levels of stress and disease and the migration of people between urban and rural settlements would result in a two-way transmission of disease.

It is probable that inhabitants of rural and urban settlements were consuming similar foodstuffs. Rural communities would have probably depended upon locally derived produce. The farming practices were designed to enable a sufficient supply of food in a year of unpredictable weather and to provide a surplus for the state, the Church and landlords, and for the exchange of agricultural produce for other traded and manufactured goods and services available from the urban markets (Dyer 2002: 14, 67). Therefore, much of the urban diet was supplemented by rural surplus. Meat in the later Anglo-Saxon towns, *wics* and *burhs* would have been obtained from the countryside fresh 'on the hoof' (Sykes 2006: 63). Therefore, the variety of meat consumed in these early towns would have been comparable to that consumed in the countryside (Woolgar *et al.* 2006: 272). Meat would have been essentially available to all members of society, but is likely to have been consumed in much smaller quantities by labourers and peasants than the social elite, who would have also consumed higher quality cuts of meat (Müldner and Richards 2005: 41). It is probable that from the 7th century the inhabitants of trading centres such as *wics* would have had access to a wide variety of foods from the trade between rural regions and the urban centres (Hall and Kenward 2004: 401). However, the increased costs involved in the transportation of food to towns, and the requirement of an intermediary to facilitate the transfer of consumables from primary source to the town, meant the potential dietary advantages of urban life were essentially only available to the more wealthy members of society (Mays *et al.* 2008: 85). Even though the inhabitants of urban centres had access to a greater variety of food produce, they were reliant on foods that were, or could be, preserved and many of the nutritional features of such produce may have been lost in the process of preservation and transport. However, to ensure the availability of food throughout the year it is probable that those responsible for the cultivation of food at both rural settlements and monastic sites would have needed to preserve foodstuffs, resulting in a loss of nutrients, especially vitamins, from a number of perishable foods, such as vegetables and meats. The absence of very young sheep (i.e. 0-2 months of age) but a preponderance of older adults in the 7th-to 11th-century site of Flixborough (Lincolnshire) – an aristocratic estate centre which appears to become a monastic settlement in the 9th century – indicates sheep may have been provided as food rent[2] from rural communities (Dyer 2002: 27). Such animals would be the ewes that are no longer productive for dairying and are therefore surplus to the dairying herd (Dobney *et al.* 2007: 89). There is an increased presence of fish in the historical documents and archaeological contexts from the 10th century, which may represent developments in the fish trade to meet the demands of increasing urbanisation (Barrett *et al.* 2004: 619,

[2] Donations of regular supplies from the great estates to the kings, bishops, monasteries and nobles who controlled them.

621). The inhabitants of towns needed to be fed, and fish was an ideal source of food, readily preserved and transported (Serjeantson and Woolgar 2006: 130). It is likely that all settlement types and social status groups would have had similar access to fish as a source of protein. Fishing in rivers and streams on a small scale would have supplemented the diet of rural dwellers and those living in towns near to rivers. An abundance of fish bones was found within the human faecal deposits recovered from the Anglo-Scandinavian deposits at 16-22 Coppergate, York (Kenward and Hall 1995: 752). However, evidence for fish bones from other archaeological sites is rare. There is very little evidence for fish consumption by inhabitants of inland rural places, who would, like their urban peers, have needed to purchase marine fish, either fresh or preserved, the cheapest of which would have been herring, but even this is limited in the archaeozoological record (Woolgar *et al.* 2006: 271). It is probable that the process of preserving and preparing fish may have destroyed the fish bones, thus explaining their absence from the archaeological record, particularly if the fish was preserved as a paste or boiled into pottage or soup.

The lack of differentiation between different settlement types was also present between monasteries and high status settlements. The monastic estates were often run by secular elites such as royal or aristocratic families (Pestell 2004: 59), who may not have carefully adhered to a pious existence. Indeed, a letter composed by Bede in 747 to Archbishop Ecgbert questioned the extent to which secular run 'false monasteries' and minsters run by the 'sons of nobles or of veteran thegns' were adhering to religious observance. Bede states that inhabitants of such estates were 'devoted to loose living and fornication' (*EHD*,1: 170; Whitelock 1979: 741; Pestell 2004: 60) and that there were 'innumerable places ... allowed the name of monasteries ..., but having nothing at all of a monastic way of life' (*EHD*,1: 170; Whitelock 1979: 740).

Early studies of the Anglo-Saxon period from the mid-7th century, often referred to as the Benedictine centuries, assumed that the Rule of St Benedict was ubiquitous in the

European countries north and west of Italy (Knowles 2004: 3) and the only monastic code available. Indeed, documentary sources for England indicate that Wilfred introduced Benedictine Rule to Ripon in the 660's and it is apparent from Bede's writings that Bede himself was devoted to the Rule (Foot 2006: 50) and that it was followed at Wearmouth and Jarrow ( Brooke 2003: 156; Cramp 2005: 343; Foot 2006: 51). However, the current thinking, based on hagiographic evidence, is that although the Rule of St Benedict was widespread from the 7th century, it was by no means the only regulatory system followed. The later Anglo-Saxon period was one of *Regula Mixta* (mixed rules) (Pestell 2004: 22; Foot 2006: 52), whereby a composite mixture of guidelines for ensuring a holy existence were followed. Examples of alternative rules are the Gallic *Regula monachorum* and *Regula coenobialis* written by Columbanus to provide guidance for both individual monks and how monks should co-exist within their communities (Foot 2006: 53). It is probable that, due to secular involvements, the monastic communities did not adhere to a particularly limited diet. In actuality, the Rule of St Benedict itself was not unduly restrictive in its regulation of food and drink. A choice of one of two dishes was provided at each mealtime, young vegetables and fruit as available, one pound of bread (which was increased on days of hard labour, and half a bottle of wine or more if the weather was hot (*Regula S. Benedicti* 39,10; 40, 1-2; 40, 4). In contrast, the rule of Columbanus (a consolidated version of *Regula monachorum* and *Regula coenobialis*) decreed that the food of monks should be poor and drink limited and that they should 'fast daily', and provided no supplementary food and drink during periods of labour (Foot 2006: 234).

Neither the Rule of St Benedict nor the *Regularis Concordia,* a 'common rule of life to be observed by all monasteries' compiled by Aethelwold, the Bishop of Winchester (*c.* 975) (Tinti 2005: 7-8), provide specific instructions regarding the role of fish in the monastic diet (Barrett *et al.* 2004: 630). Even later documents such as Aelfric's letter to Wulfstan, the Archbishop of York (*c.* 1006), which clearly states that the clergy could consume fish, do not specifically address whether fish was the preferred alternative to meat during periods of fasting or simply permitted (Serjeantson and Woolgar 2006: 104). However, archaeological and documentary evidence show that early medieval monastic communities maintained fisheries. For example, the inland monastery of Glastonbury was granted a satellite fishery on the North Devon coast by King Ethelwilf in the mid-9th century (Barrett *et al.* 2004: 627). In such circumstances, monastic diets were likely to have included fish. The fasting practices of Christianity and monasticism were influential in the diet of the secular and religious communities of England. The practice of fasting formalised by the Rule of St Benedict and subsequent monastic regulations (Dembinska 1986) was also applied to the English secular community by 7th-century and later Anglo-Saxon law (Hagen 1992: 131). Therefore, the meat of quadrupeds would typically have been forbidden during 40 days of Lent, 40 days of advent before Christmas, possibly 40 days following Pentecost and on the eves of Christian celebrations throughout the year (Hagen 1992: 127-34; Barrett 2004: 629). This would have resulted in similarities in the lay and monastic diets. Monasteries could achieve a balance of available resources by possessing land dispersed over a region, including specialist woods and pastures and areas assigned for crop growing (Dyer 2002: 17). Monasteries may have had more cows' milk (and veal) available to them than lay establishments because young calves were killed to provide vellum. For example, the three Pandects or Bibles made for Ceolfrith at Wearmouth and Jarrow between 680 and 716 needed the skins of some 1,550 calves for their production, though such a large production was the exception rather than the rule. Nevertheless, smaller volumes, such as the *Lichfield Gospels,* were still made of the skins of 120 animals (Morris 1983: 113; Hagen 1992: 17). Documentary evidence for the consumption of beer in monastic institutions is provided by an excerpt in the 8th-century *The Life of Guthlac* (*Vita Guthlaci* 84, 20-1), which states that 'Guthlac was mocked by the other brothers at Repton for his refusal to drink beer, of which English monks seem to have been inordinately fond' (Foot 1990: 53). Overall, the monastic diet would have been quite similar to that of the secular elite, save for a closer observance of periods of fasting (Müldner and Richards 2005: 41). Differential diets between monks and the lay populace are evidenced at Wearmouth and Jarrow, where excavation of the monastic archaeological deposits recovered 'well-grown domestic fowl', wild birds, shellfish and riverine fish. In contrast, the early general occupation layers, associated with the lay populace, only yielded fish and bird bones (and evidence of a single sheep). However, the lay diet becomes more varied by the 10th to 12th centuries when the general occupation layers revealed an assemblage composed of cattle and small quantities of pig, sheep and horse bones (Cramp 2005: 343; 346). The later assemblage composition is what would be expected for rich, affluent members of society, as seen at Flixborough (Dobney *et al.* 2007: 89).

Feasting and drinking were central to both monastic and aristocratic life (Foot 2006: 236) in the late 7th and early 8th century, and this continued to be the case after the reforms of the 10th century, with documentary evidence describing feasts at Abingdon (Vita Aethwoldi. Ch. 12: 22-5), Ripon (VSW ch. 17: 36-7) and Whitby (Bede, VSCuth. Ch. 34: 262-3) (Foot 2006: 236-7). Indeed the *Regulars Concordia* written by St Aethelwold, the bishop of Winchester (*c.* 908-984), advised abbots to be 'most zealous' in providing hospitality for guests (Regularis *Concordia.* Ch. 63: 139; Symonds 1952). The rich diets associated with monks and the more affluent elite members of society have been linked to obesity, which in turn leads to conditions such as osteoarthritis (particularly of the hands and knee), diffuse idiopathic skeletal hyperostosis (DISH) (Rogers and Waldron 2001; Waldron 2006: 263-4) and gout (Roberts and Cox 2003: 137). However, it must be noted that these conditions are also present in individuals who are not obese and do not consume rich diets. It is only if there is a high prevalence of such conditions in a skeletal assemblage, that inferences about diet and status can be made (Waldron 2006: 265). Overall, it appears that the diets of high-status urban or rural settlements dating to the later period of use of the Black Gate cemetery, from the end of the 9th century, would be indistinguishable from monastic settlements.

Roberts (2009: 317) refers to Caffell's (2005) study that revealed an increase in caries frequency for both monastic and non-monastic populations from early to late medieval periods, suggesting parallels in their diets, whereby a change to a more cariogenic diet happens to both lay and monastic communities. It could also be argued that the consumption of carbohydrate foods may have been the preserve of secular elites that were often buried in monastic cemeteries, and therefore increasing the presence of burial containing individuals with caries in monastic cemeteries, even if the brethren were not partaking of cariogenic food stuffs.

Cemeteries, regardless of their urban or rural nature, can differ in status. For example, inconsistencies in the health profiles of the burial grounds from York may derive from differences in the status of the cemetery and those interred within it. The cemetery of York Minster would have been a highly desirable burial ground for elite members of society. The church cemeteries of St Andrews, Fishergate and would have contained the burials of less wealthy tradesmen, merchants, craftsmen and their families. The difference in status is evidenced by the wide variety of elaborate burial practices observed at the Minster (e.g. carved stone markers, stone cists, wooden biers and chest burials), whereas only plain and coffined burials were recovered from Swinegate. Monastic cemeteries were also highly desirable burial grounds for the secular elite, which would make them higher-status cemeteries than those associated with manorial complexes, such as Addingham, which only contained plain and coffined burials. The inclusion of elite secular burials in monastic cemeteries would make differentiation of the health status between them extremely difficult (Hadley 2002: 210; Loveluck 2007:187-8). The relationship between secular and ecclesiastical elements of society in the 7th to 9th century is complex, with members of the aristocratic elite playing secular and religious roles (Loveluck 2007: 187). The most notable manifestation of interaction is the evidence for procurement of burial spaces, presumably for secular aristocratic families, at monastic cemeteries, such as at Church Walk, Hartlepool (Loveluck 2007: 187-8).

The similarities and differences in health indicators between sites may be caused by differences in the location of settlements. York, Wearmouth and Jarrow and Wharram Percy are all closely located to Black Gate (Figure 2.13), therefore it is likely that they were affected by similar environmental conditions and resources, such as weather, seasonality and of the availability of produce. Whereas it can be hypothesised that higher status and larger settlement types could be buffered from weather, seasonality and crop failures etc., it must be remembered that much of their resources came from the surrounding locality. There were regional differences in the importance of specific livestock to the economy. For example, the assemblages of discarded animal bone recovered from York indicate that cattle were of primary importance whereas the assemblages recovered throughout Lincolnshire reveal a higher proportion of grazing sheep during the period between 850-1050 (Dyer 2002: 25).

There are several methodological problems, which may have influenced the results attained in this study for the comparative sites. Wherever possible the information included within this chapter has been extracted from catalogues of burials and appendixes within publications that list the skeletal elements and pathological lesions observed for each individual. However, as is admitted by Wells (1980: 247), the information included within the written text may not be solely derived from the data included within the catalogues and inventories provided. This results in discrepancies within the published data.

Often qualitative descriptions of dental palaeopathologies are included within the reports, which provide the reader with a picture of the health status but no hard numerical facts that can be used to make direct comparisons with other sites. For, example at North Elmham the following description of dental palaeopathology is provided:

*'most of the periodontal cavities are very small, often nothing more than a slight absorption of bone around a tooth root. A few of the jaws do have quite large abscess cavities and extensive alveolar infection with loss of the interdental septa. The stink of halitosis, if uncommon, must have been well enough known in the community.' (Wells 1980: 287)*

In most cases, the actual numbers could be determined from the burial catalogue. However, for some health indicators there were insufficient data within the text and the pathological lesion under consideration was not included within the burial catalogue meaning that the prevalence rates could not be determined. There was, in some cases, limited data available preventing the acquisition of prevalence rate data. For example, the true prevalence rates of skeletal health indicators within the immature population were only recordable for 3 of the thirteen sites (23.1%), two of which were monastic settlements. Consequently, the interpretation that the similarity in TPRs observed between Black Gate and Wearmouth and Jarrow indicates that the immature population is indicative of a monastic settlement is flawed. It may also be the case for urban sites such as York Minster, Swinegate, Fishergate and St Nicholas Shambles, but the data is just not available; that is, the sites for which data is not available may be equally homologous to Black Gate, but the evidence of such similarity is not available.

The discrepancies between total, adult and immature TPRs may be an artefact of the small sample sizes and small number of case studies. For example, the total population value for cribra orbitalia for monastic settlements derives from the Llandough cemetery alone. Furthermore, of all the comparative sites included within this text maxillary sinusitis is only addressed in the Barton-upon-Humber report, within which only the crude prevalence rate of 0.2% is recorded. The dearth of information prevents comparative analysis of maxillary sinusitis so no further insights into the prevalence and aetiology of this condition in the later Anglo-Saxon period can be made based on the comparative data. Such exclusion of specific health indicator data means that even if there were sufficiently large 'bodies' of published evidence from different funerary contexts, the relevant data would not be available to identify the specific funerary contexts. It is not necessarily a problem now of insufficient quantity of reports, more a case of insufficient comparability of data.

The results may also be biased by inconsistencies in recording criteria for identifying specific pathologies. Within this study, the presence of osteophytes was scored as indicating the presence of SDJD. However, other studies have only included osteophytes as an indicator of joint degeneration if it was accompanied by another lesion, such as eburnation (Bridges 1993: 291). As is addressed in Chapter 4, there are a number of terminological issues regarding the use of degenerative joint disease, osteoarthritis and other joint modifying conditions. Therefore, it is possible that in the sites with a comparatively low prevalence of SDJD, only osteoarthritis was recorded (that is, when the osteophytes were accompanied by eburnation).

A viable explanation for the high prevalence of health indicators within the Black Gate cemetery, relative to the comparative sites, is that the Black Gate cemetery experienced short periods of high environmental stress, such as droughts, famines or outbreaks of endemic disease resulting in sporadic periods of greater physiological stress. Comparisons of stress indicators are based on the mean prevalence for the entire period of use of each cemetery. Most of these sites span at least 200 years, thus a site with a greater number of episodes of physiological stress would create a profile with a greater prevalence of stress indicators than a population that experienced similar day-to-day environmental, nutritional and occupational stressors but had fewer periods of abnormal stress. Essentially, the long timespan represented by each cemetery has a 'smoothing' effect on any fluctuations in stress experienced by the contributing population (Waldron 1994: 21).

## 7.5 Summary

The demographic and mortality profiles of the Black Gate cemetery were within the range provided by the 13 comparative sites. The frequencies of all health indicators were either comparable or statistically greater for Black Gate than the early medieval period overall (Roberts and Cox 2003) and the comparative sites included within the current study. This, along with the fact that the only two sites which did not show a statistically significant difference to Black Gate for all the available health indicators were the urban sites of Swinegate and St Andrew's, Fishergate in York could tentatively be interpreted as suggesting an urban origin for the Black Gate population. However, comparisons of the prevalence of health indicators between Black Gate and the comparable sites revealed no consistent patterns. When the sites were combined into settlement categories i.e. urban, monastic and rural settlement types, the absence of any cohesive pattern was also observed. These results indicate that the overall health profile of a population cannot be used in this instance to identify the type of settlement that served a particular cemetery assemblage. Consequently, the overall health profile of the Black Gate cemetery cannot be used to identify the origins of the contributory population. It is apparent that even sites within the same settlement category were significantly different from each other. The lack of correlation between skeletal health indicators and settlement type suggest that the relationship between health and settlement in the later Anglo-Saxon period was extremely complex and influenced by factors such as the location of the site, overall population structure, status and underlying social relationships and economic structure. There are also a number of methodological issues, which further complicate the comparison of stress indicators between settlement types.

The period of use of the Black Gate Cemetery coincides with an increase in urbanisation in the sense that people were beginning to live in more dense concentrations and a range of settlements within which archaeological evidence for 'urban' activities were arising. However, the health differences between these and surrounding rural areas appear to have been minimal. These findings support those of Lewis (2002 a), who found no statistically significant differences in the prevalence of indicators of stress between the total immature populations of urban and rural sites in both the early and later medieval periods. It is probable that the lack of differentiation between the comparative sites observed in this study represents a lack of difference in the physical environments between urban, rural and monastic sites. However, the results presented here in their social and physical context indicate that the type of settlement was not the only factor influencing physical stress and overall levels of health.

# CHAPTER 8

# DISCUSSION AND CONCLUSIONS

The aim of this thesis was to explore the extent to which a bio-cultural investigation could inform about the health and social relationships within, and origins of, the contributory population of the later Anglo-Saxon Black Gate cemetery, Newcastle-upon-Tyne. This aim was achieved through the construction of mortality and morbidity profiles to characterise the overall assemblage. Skeletal indicators of non-specific stress, non-specific infection, dental health and the impact of biomechanical stress upon the skeleton were used to assess health status. All these health indicators are commonly used in the bio-cultural literature to assess and compare the health status of archaeological populations. To explore the impact of biological and cultural influences upon the health status of individuals within the Black Gate cemetery, comparisons were made of the prevalence of the health indicators between different age and sex categories, and socio-economic groups. Socio-economic status was inferred from preferential location of burial within the cemetery, interment of the body in plain and elaborate burial types and the disposition of the body within the grave. A further aim of the bio-cultural analysis was an investigation into the settlement context of the Black Gate cemetery through comparison of the health indicators with thirteen sites of known context.

The results of this study indicate that the Black Gate cemetery assemblage represents a lay population in a cemetery containing a focal building, in all likelihood a church. The osteological findings are consistent with the associated archaeological and documentary evidence that strongly suggests the cemetery was, at least for a period of its use, associated with a monastery. This investigation emphasises the multi-factorial nature of physiological stress and that age, diet, cultural practices and status had a greater impact upon the skeleton than settlement type in the later Anglo-Saxon period. This study has revealed that a bio-cultural study can help reduce the difficulties in distinguishing between the contribution of biological and cultural influences on the expression of skeletal health markers upon the skeleton.

Chapters 5, 6 and 7 contained detailed discussions of the results of the health indicator and bio-cultural studies undertaken on the Black Gate assemblage and the comparisons with settlement contexts. Each discussion contained a summary of the results, including a detailed interpretation of the data in terms of the current knowledge of stress and health indicators and Anglo-Saxon lifestyle and mortuary behaviour. A critique of the methodologies utilised and limitations of the study was also included in each discussion, which concluded those chapters. This chapter consolidates the main findings of the current study and considers the limitations, contribution to the current knowledge of Anglo-Saxon lifestyles and future potential of this research.

## 8.1 Evaluation of the Evidence for Monastic Settlement at Black Gate

The historical accounts of Simeon of Durham (Stevenson 1855: 559; Rollason 2000: xlii, xlviii, 200-3) specifically identify a monastery in Newcastle – which would at the time of his writing have been confined to the area immediately surrounding the castle, which stands within the Black Gate cemetery. These references make it highly probable that the Black Gate cemetery served a monastic community by the mid- 11$^{th}$ century, which had ceased to exist by 1074. The location of the Black Gate cemetery – on an escarpment overlooking the River Tyne, within the remains of an abandoned Roman fort – is characteristic of numerous early medieval monastic institutions, such as Wearmouth, Jarrow, and Tynemouth (Tyne and Wear) (Cramp 2005: 29, 348), Llandough (Glamorgan) (Loe 2003: 15), and Ailcy Hill, Ripon (North Yorkshire) (Hall and Whyman 1996: 65). These monasteries were typically established in promontory, riverside or coastal locations, or within abandoned Roman structures (Williams 1997, 2006; Bell 1998; Blair 2005: 249). Furthermore, there is substantial evidence that the building within the Black Gate cemetery constituting structures A, B and 68 represents an Anglo-Saxon church. Firstly, there was a high density of burials adjacent to the building suggesting a desire of people to be buried as close to the church as possible to increase their 'holiness' in death. Secondly, elaborate burial types were exclusively found within these areas, further indicating preferential burial and a desire to be buried next to the building. Thirdly, there was evidence for preferential burial of males in Areas C and D, with a higher frequency of prime and mature adults in Area C, closest to the building. There were also concentrations of infant burials close to the walls of this structure. All these characteristics are found adjacent to other late Anglo-Saxon churches such as at Raunds Furnells (Northamptonshire) (Boddington 1996: xii, 45), Whithorn (Galloway) (Hill 1997: 139) and Wharram Percy (North Yorkshire) (Mays 2007: 87). The distribution and composition of the burials can be interpreted as the lay community associated with a monastery. Certainly, the concentration of male and immature burials in Area C is analogous to a similar segregated area of male and immature burials, which was identified as a monastic burial ground, at Wearmouth.

However, while highly suggestive of the presence of a monastery, none of the evidence attesting a monastic link to the Black Gate cemetery is conclusive. Furthermore, it must be taken into consideration that the nature of the cemetery may have changed during the four centuries it was in use. The use of a pre-existing Roman settlement upon a steep escarpment with good defensive features, next to a river, which would provide good communication links would have made the location attractive for the establishment of any settlement type, particularly one associated with trade or defence. The large number of male burials on the south-eastern side of the church building, which is typically regarded as an area of preferential burial, may equally represent elite secular burials. Nonetheless, it is also highly possible that both secular and religious elites were accorded burial in this preferential location. Furthermore, the presence of a church building within the cemetery, although probably associated with a monastery, may indicate that the Black Gate cemetery represents a churchyard cemetery, which were a common feature of the later Anglo-Saxon landscape.

Monastic sites had emerged in the 7th and 8th centuries, which coincides with the earliest burials at Black Gate. Many declined or disappeared during the period of Viking raiding in the 9th and early 10th centuries, but many then saw a resurgence in the 10th and 11th centuries, with many developing into small towns. The Black Gate cemetery may have been established for monastic use, which declined and subsequently became a churchyard burial ground with the established church building and established burial ground attracting high-status individuals. This hypothesis is supported by the presence of green and yellow floor tiles characteristic of monastic and ecclesiastical buildings from the 13th century onwards (van Lemmen 2004: 7) and by the fact that the most elaborate burials were recovered from an area of the cemetery purported to be the latest. However, more extensive radiocarbon dating is necessary to attest or disprove this interpretation of the archaeological evidence. Overall, no specific burials within the cemetery can categorically be identified as monastic based on the archaeology alone. Furthermore, none of the burial types were distinctive to a specific settlement type. The pillow stones, earmuffs, head cists, rubble cists and stone cists are all found in urban rural and monastic cemeteries. A greater variability in grave form has been interpreted by previous researches as denoting different associated cemetery types, but in reality there are no consistent patterns observed in the thirteen comparative sites and, if anything, a greater number of elaborate grave types may be more associated with the social standing of the contributory population.

## 8.2 Black Gate Demography and Health

The presence of equal numbers of male and female burials and the inclusion of immature burials suggest that the Black Gate cemetery represents a burial ground of a lay community. The mortality profile, immature growth trajectories, and adult stature were all within the norm for the later Anglo-Saxon period, showing no distinction from any particular cemetery site. The demographic profile matches those of both monastic sites with lay cemeteries and non-monastic churchyard cemeteries and minsters. There was a noticeably high number of pre-infants and infants relative to the majority of other sites. However, this may result from the lack of excavation in the eastern side of the cemetery, which may have potentially contained a higher representation of adults. If the entire cemetery had been excavated this would have potentially increased the proportion of adult burials, thus lowering the percentage of the population represented by immatures aged less than one year at the time of death. Equally, if Area C had not been excavated, the percentage of pre-infants and infants would have been lower. The high prevalence of pre-infants and infants may also be due to preservation and methodological bias, such as a higher recovery of immature bones at Black Gate.

There was a comparatively high prevalence of non-severe childhood diseases, represented by cribra orbitalia and DEH, suggesting prolonged periods of chronic physiological stress caused by either nutritional deficiencies or long-lasting mild gastro-intestinal infections. The peak in mortality and high frequencies of cribra orbitalia and DEH in young children implies that this age group was experiencing the greatest levels of physiological stress, weaning, and accidents and greater pathogen exposure related to the increased mobility associated with crawling and walking.

It is apparent that many health indicators were most influenced by the accumulation of lesions and traumas during life, and the decreased immunological response capacity of the body as it degenerates with age. Alternatively, the increase in prevalence of health indicators with advancing age may relate to the 'osteological paradox' (Wood *et al.* 1992) whereby those who survive to an older age are those who have been strong enough to withstand and survive events that lead to a skeletal response long enough for the relevant bony lesions to manifest. In other words, those who survived to senior adulthood may have survived several episode of illness, physiological stress or exposure to trauma at specific stages earlier in their lives, but survived such episodes to reach old age and bore the skeletal scars to the grave. Maxillary sinusitis did not, in contrast, show any relationship with age and its presence was likely a consequence of extrinsic factors such as pollution and domestic or occupational irritants. The nature of maxillary sinusitis may mean that lesions remodel more effectively than lesions resulting from dental caries and abscesses which appear to be more or less permanent once they have formed. Thus, the frequencies of maxillary sinusitis truly represent the prevalences at the time of death, as once the infection or irritation had been removed the bony lesions may have remodelled and disappeared after a short period.

There were few differences in the frequencies of health indicators between males and females, and the few instances of such differences can often be explained by biological, not cultural, factors. This is because there are physical and genetic predispositions to certain conditions, which influence the prevalence of health indicators between the sexes. The most convincing evidence for this is the greater prevalence of AMTL in females, particularly in prime adult females. The high prevalence of prime adult female deaths seen at Black Gate and other sites confirm the relationship between pregnancy and health. These two features of the assemblage have been linked to hormonal activity associated with pregnancy. The higher prevalence of TPNB in senior adult males, may reflect either an increased susceptibility to infections and varicose veins, or a cultural activity (that is, senior adult males partook in some kind of activity that females did not, which subjected them to an increased risk of trauma to the shin), or it may even be a result of fashion. Indeed, it may reflect the wearing of stockings by monks (Owen-Crocker 2010: 328).

A number of researchers have advocated that general studies of health and mortuary behaviour are insufficient to understand past populations and that an analysis of various age and sex groups within the population provides a greater insight into the lives people lived (Goodman *et al.* 1980: 180; Gowland 2006). It is important not to see a skeleton as representing a static period of time, but as a narrative of the life that individual lived. Many of the palaeopathologies observed on the skeleton have accumulated throughout their life. Therefore, it is paramount to investigate the life course of that individual i.e. the duration of their life between their conception and inevitable death (Gowland 2006: 145). Furthermore, age and sex cannot be addressed as wholly independent factors, as an individual's biological age and sex are interlinked and both can affect their experience of the surrounding environment. Examination of the frequencies of heath indicators present in each age and sex category revealed that, aside from senior adults, young children and prime adults were the age groups most susceptible to mortality and specific health indicators. Young children exhibited the highest frequencies of cribra orbitalia for the entire population, which can perhaps be explained by both biological and cultural practices. Young children were biologically at a disadvantage relative to infants, because they no longer had access to the maternal supply of breast milk and its associated nutrients and antibodies. Culturally, weaning commenced in the young child phase of an immatures life, exposing this age group to unfamiliar pathogens, to which they had no natural immunity. However, there is no evidence for social transitions at any specific age or stage of physical development in the Black Gate assemblage. Gowland (2006: 144) states that social transitions are often identified for specific age groups, at specific stages of their physical development, giving the examples of learning to walk and puberty. Within the Black Gate cemetery there is no evidence to suggest either of these age categories are regarded any differently from everyone else buried in the cemetery. Indeed, adolescents are the only age group not buried in elaborate grave types. At least one individual in each of the other age categories is interred in an elaborate grave type. They also appear to be the only immature age category interred with head cists, but it is possible that some of the earmuff and pillow burials originally contained other stones forming a head cist, which have subsequently been removed or disturbed post-deposition. Furthermore, there appears to be no reason why head cists were the sole preserve of adults and transitional adolescents (an individual aged 13-15 years), when immatures are interred with other elaborate grave variations and grave types, which required an even greater investment of time and resources. What is suggested from the Black Gate evidence, in terms of the physical stages of development and health, is that the young adult age group, that undergoing weaning and learning to walk exposed themselves to the most risk. The osteological data show that they experienced greater levels of cribra orbitalia, but it is also possible that their increased mobility increased their mortality by increasing their exposure to risk. Due to the increased risks associated with their new found freedom, it is difficult to determine to what dangers young children succumbed. Orme (2001: 99) notes from the coroner's rolls, which published the results of investigations into unnatural deaths in the 13$^{th}$ and 14$^{th}$ century, that the same accidents occured in the medieval period as in modern times, making it reasonable to postulate that similar childhood domestic accidents happened in the later Anglo-Saxon period. Orme suggests that once children were able to crawl or walk they were exposed to a greater number of potential dangers than less mobile infants, particularly from the hearth, scalding, and falling into vessels of liquid. The accidental deaths recorded in the coroners rolls also included examples of being crushed by an opening door, falls from upstairs windows, choking, and dangers associated with water, such as, falling into the house well, neighbouring ditches, pits, ponds and rivers whilst playing, washing or fetching water (Orme 2001: 99-100).

The lack of differences in the majority of health indicators between males and females and adults and immatures, and lack of dietary deficiency disease reflects a population that consumed a diet sufficient in all the dietary requirements necessary for the normal growth and repair of the skeleton. There is no evidence of preferential access to food for any of the age or sex groups and the majority of differences that do occur appear to reflect the body's natural response to extrinsic factors. There were also no notable differences in the expression of biomechanical stress and trauma between the demographic groups. This indicates that there were no real differences in the physicality of the day-to-day lives of different age and sex groups or, alternatively, that frequencies of degenerative joint disease and trauma are not an accurate reflection of the day-to-day stresses imposed upon the skeleton.

## 8.3 Black Gate Burial as an Expression of Socio-cultural Relationships

There are no consistent statistically significant patterns in health between those afforded plain and elaborate burial practices, save for the fact that elaborate grave variations often exhibited the highest frequencies of health indicators. The higher frequency of health and stress indicators can be explained by a number of scenarios. First, the higher prevalence of health indicators implies that those interred with elaborate grave variations were exposed to more stresses and irritants than those buried in the elaborate grave types in Area C, but possibly experienced greater exposure to environmental, dietary and physiological stresses than those individuals buried in plain graves in the same zone and the Compound. Alternatively, in accordance to the 'osteological paradox' (Wood *et al.* 1992), those interred with elaborate grave variations experienced the same conditions but had better capabilities to survive onslaughts on their health than those interred in the plain burials in the Railway Arches and the Compound. This enhanced survival may be due to a slightly higher quality diet or access to medical resources or the fact that the individuals were able to rest up for longer and therefore survived chronic periods of infection and stress for longer, enabling skeletal modifications. Indeed, a number of the health indicators are age progressive and have been shown to accumulate with age. The majority of the elaborate burial types were accorded to senior individuals, therefore it is likely that the higher prevalence observed in these burials reflects the accumulation of health markers over time, by individual who had accrued the necessary wealth or social standing throughout their longer lives to be accorded such elaborate burial.

These people interred in elaborate grave variations may also have been involved in activities that were more physically strenuous. 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, which produced goods of high commercial and economic value. The high prevalence of sinusitis further indicates that they were involved in different employment tasks than the rest of the population, and this may be linked to their higher, but not highest, status burials. This hypothesis – that elaborate grave types and elaborate grave variations represent distinct groups of socio-economic status – is supported by the fact that these burials are found in clearly separate locations. The suggestion from this evidence is that status in later Anglo-Saxon Northumbria could have been acquired or inherited.

The burial practices included within the Black Gate cemetery are indicative of the social and cultural beliefs of those interred in the cemetery and those burying them, and can be interpreted in a number of ways, which can possibly enhance the current understanding of later Anglo-Saxon culture and lifestyle.

The east-west aligned supine burials, predominantly in plain graves, and high density of burials adjacent to a proposed church building, accompanied by the high number of infant burials immediately adjacent to the church in a practice proposed as having provided a pseudo-baptism of deceased children, strongly suggest Christian burial. However, the variability of burial practices, including right-sided burials and interments in elaborate cists and chests, suggests that the church or monastery did not dictate or standardise burial within the cemetery. Nonetheless, none of the elaborate burial practices contradict Christian doctrine and some, such as the increasing protection accorded to the body by the use of head cists and stone cist burials, correlate with changing Christian beliefs regarding corporeal resurrection and the after-life.

Prone burials may have held penitential significance (Thompson 2002: 239), symbolising the prostrate position that monks took to pray before the altar when a monk dies, although, as Thompson highlights, this hypothesis does not explain prone burials in non-monastic, lay contexts. Prone burials are not just confined to the proposed monastic burial ground of Area C, and they were also found in the Compound and Railway Arches, which is interpreted here as meaning that prone burials in the Black Gate cemetery were not simply a reflection of penitential mourning confined to monks. The fact that prone burials were included within the Black Gate amongst the other burials implies they were not the burials of criminals, a common explanation for prone interments, which would normally be segregated from the rest of the cemetery or buried in burial grounds elsewhere (Daniell 2002: 243; Reynolds 2002: 187; Hadley 2010). Nonetheless, the reason for prone interment within the Black Gate cemetery is unclear. Prone burials, as with all the other body positions, displayed no correlations with health. The lack of correlation between body position and health implies that either body position was not related to the status of the deceased, or that health indicators were not sensitive enough to detect differences in health between different social groups. Furthermore, the diet and general wellbeing of all social groups was to a minimum required standard that prevented manifestation of stress upon the skeleton. These are all factors that are considered by Robb *et al.* (2001) as viable explanations for a lack of correlation between biological and social status in the Pontecagnano cemetery (Italy). For example, the diet of individuals of low social status may not have been as rich or varied as those of higher status, but was sufficient in all the necessary vitamins and minerals to prevent afflictions such as scurvy and rickets to manifest in any social group. Indeed, there are very few cases of metabolic disease within the Black Gate assemblage. The only cases that did occur can be explained by cultural practices: the two cases of scurvy were in children of weaning age. The lack of definite cases of rickets and osteomalacia (adult rickets) also indicates a lack of dietary deficiency in the whole assemblage. The ubiquity of cribra orbitalia and its consistently higher prevalence amongst immatures in all burial locations and burial types (plain and elaborate), in association with the lack of any other metabolic disease, indicates that it did not result from a dietary deficiency. The high prevalence of cribra orbitalia most probably represents a childhood illness, from mal-nutrition, the inhibitory effects of cereal consumption on iron absorption from the diet or parasitic infections. The fact that immatures showed an almost equal presence or absence of cribra orbitalia implies that it resulted from something that was a threat to all immatures and they only had a 50/50 chance of survival. Such high susceptibility strongly suggests a parasitic aetiology, as the associated bouts of sickness diarrhoea and dehydration is a common killer in developing countries today. The low number of adults with cribra orbitalia implies a lowered exposure to parasitic infections or, more likely, that they had developed an immunological protective response to such infections. This does explain the ubiquity of cribra orbitalia in all burial practices.

Both males and females are interred in elaborate burials, denoting that status was not as focussed on males as in the early Anglo-Saxon period. Females and immatures were also interred in the most elaborate burial types, such as stone cists, but not as frequently as males. These observations correlate with the findings of Buckberry (2004) from her analysis of a range of later Anglo-Saxon cemeteries in Lincolnshire and Yorkshire. Buckberry and Hadley (Hadley and Buckberry 2005: 141-2; Buckberry 2007: 121-6, Hadley 2009: 145-6; 2011: 293) have observed that there was no correlation between either age or sex and burial provision in the later Anglo-Saxon period, but that, nevertheless, males were still more frequently accorded elaborate burial suggesting that males were still the main status holders. Even so, the predilection for senior adult females to be interred in elaborate grave types and grave variations suggests that this group was also highly regarded. The elaborate burials of females and immatures may indicate that these social groups were accorded high status in life, but it is most likely that the elaboration of their burial represents familial groupings, particularly the immature examples. The elaborate immature burials indicate that all family members were accorded equal status regardless of their economic contribution. The range of variation in female burials and the preponderance of elaborate burials of senior adult females may reflect acquired familial status through marriage. Alternatively, it may reflect the respect and accumulation of wealth and social standing of females in their own right, perhaps after the death of a husband or an increase in status of their children throughout their adulthood. It is, however, possible that the cist burials in Area C of males, females and immatures represent the burials of monks, nuns and oblates.

Elaborate burials are also found in the Railway Arches, although they are not as refined. No cist burials, but rubble cists, head cists, pillow stones and earmuffs are found there. The demographic of the Railway Arches is much more representative of a lay population than Area C, therefore the unique group of elaborate grave variations does strongly suggest a higher status lay burial group relative to the surrounding plain burials. Such close grouping of elaborate burials is often suggested to represent family groups (Kjølbye-Biddle 1995: 488-9; Phillips 1995: 83-4; Hadley 2004: 311-12) and there is no reason to discount this theory here.

There are few statistically significant patterns seen in the relationships between age, sex, stature, health and burial location and burial type. This may be an artefact of the small numbers of elaborate burial types, grave types and grave variations included within the Black Gate cemetery. For example, in a number of cases there are consistent trends in all burial categories or body positions but it is only the statistical tests involving categories of a large sample size that return a statistically significant result, even though the pattern is equally clear in the less common burial practices and body positions. The relationship between cribra orbitalia in adults and immatures in different burial practices is a case in point. It is evident that cribra orbitalia represents periods of childhood illness and that immatures consistently display greater prevalences of orbital porosity compared to adults, regardless of burial type or body position. This trend is clearly seen for all body positions, but the difference between immatures and adults is only significant for the two most common body positions, supine (n = 436) and right-sided (n = 132) burials, but not for the less common left-sided (n = 23), prone (n = 16) and flexed (n = 6) interments.

Several aspects of the Black Gate burials indicate the increased influence of concepts of family on the choice of burials. There were multiple burials containing adults and children indicating family relationships. The high number of infant burials is comparable to other later Anglo-Saxon cemeteries, but greater than earlier burial grounds, and this indicates an increase in family status enabling inclusion of the youngest family members in higher status cemeteries associated with churches and religious communities (Hadley 2010: 107; 2011: 294). Furthermore, the presence of immatures throughout the Black Gate cemetery agrees with the findings of Hadley (2010: 108), that family status, sex of the deceased child and their 'position within the family' contributed to the location within the cemetery chosen for their burial. The inclusion of immatures and senior adults – particularly females – in elaborate burials suggests that there was no exclusion of the young and old, which have been seen by researchers as 'non-active' members of the community (Bello and Andrews 2006: 9). It seems to the current author that to deem these members of the community as 'non-active' because they were not of working, fighting, marriageable, or of childbearing age is erroneous. Senior adults have invested a lot into the community throughout their lives and children have the potential to contribute greatly in the future. Senior adult females may be wealthy due to the death of a husband, were in a position to transfer skills on to younger members of community, and maybe help with childcare. Robb (1998: 165) suggests that a senior adult female (Catigano I), recovered from the Neolithic village of Catignano, Italy (Robb 1998; 162), had outlived the majority of people born at the same time as her and that it is likely that she acquired high status in social networks due to 'her increasing seniority and her accumulated knowledge becoming more exclusive and sought after in later life' (Robb 1998: 165).

The interment of children in elaborate burials probably is not a direct reflection of their status in life. Robb identifies a cultural equivalence to the osteological paradox by arguing that the deceased of any specific age or sex group may not have possessed the same social status as a living person of that age, sex or combination of both (Robb 1998: 161). It is often assumed that immatures interred in burials distinct from the norm are a medium for the display of a family's wealth and status. This may, indeed, be the case at Black Gate due to the aforementioned reasons suggesting a strong familial link between the individuals interred in elaborate grave types or variations.

## 8.4 The Black Gate Cemetery in Context

It was hoped that comparing the health prevalence of health indicators at the Black Gate cemetery with sites of known context it would be possible to identify the population that the Black Gate cemetery served. The Black Gate cemetery consistently displayed higher frequencies of pathologies than observed at other sites, albeit within the range of variation, indicating a possibly higher exposure to environmental stress and pollution which could be linked to an urban lifestyle, suggesting that Black Gate served an urban community. However, the high prevalence was always within the range of variation for the comparative sites, including both rural and monastic cemeteries, and there was no conclusive evidence from this study that there is any link between urban, rural or monastic living and the levels of non-specific stress, non-specific infection, dental health or biomechanical stress. Consequently, any interpretation of the high prevalence of health indicators in Black Gate in terms of settlement type would be highly questionable. It is likely that differences in the prevalence of these health indicators are greatly influenced by numerous extrinsic factors such as socio-economic status of the people interred within the cemetery, local environmental conditions, age structure and even biases and underestimations of osteological analysis.

When the whole population is addressed there appears to be high levels of most health indicators, especially in comparison to other early medieval cemeteries and specifically the thirteen sites included in this thesis, for both adults and immatures. However, the high frequencies of pathologies are typically within the range observed for the comparative sites and indicate they are not unusual for the period. Chapter 6 addressed the methodological issues, which may influence the high prevalence of pathologies relative to other sites. It was concluded, in light of precautions taken during analysis – such as utilising methods with diagrams and the exclusion of the youngest immatures when there may be confusion between physiological development and pathological lesions – that the high prevalence is most likely a true reflection of health in the Black Gate cemetery. The health indicators principally show that the Black Gate population experienced high levels of immature stress. This is indicated by a high prevalence of cribra orbitalia in children and high percentages of DEH throughout the assemblage, which form during childhood development of the teeth, possibly due to parasitic infections or periods of ill health. The high prevalence of dental calculus and caries indicates a varied diet containing protein, cereal and sugar based components. The high prevalence of calculus and caries, coupled with the high prevalence of abscesses and AMTL, may not necessarily reflect a diet any richer in these dietary constituents relative to contemporary sites. It is possible that this relationship is more a reflection of poor oral care and hygiene, allowing calculus deposits to establish themselves and encouraging the growth of bacteria to enable the fermentation of sucrose resulting in caries, the subsequent environment would encourage infection, inflammation and necrosis of the gums, causing abscesses and AMTL.

The lack of a consistent pattern of health indicators in each of the burial sites may result from a number of reasons. Firstly, the stress and health indicators may not be a sufficiently sensitive indicator of health status. Secondly, there may indeed be no true relationships between health and settlement type in the later Anglo-Saxon period, and thirdly, it is social status, not settlement type, which influences burial practices. Indeed, in a study focussing on immatures, Lewis (2002a, b) states that it is the impact of industrialisation, not urbanisation, that most influences health in the past, and therefore, it is not until the industrial revolution that we can see differences for health. This does not explain the differences observed between farming and hunter-gatherer societies in the past, and so maybe there has to be a substantial shift in lifestyle and actual stress as the body adapts to new situations to enable a noticeable difference in health to be observed. Buckberry (2010) argues that during the Anglo-Saxon period it is differences in status that most influenced health profiles.

## 8.5 Overall Conclusions

The overall demographic and health profile of the Black Gate cemetery and burial practices observed therein were consistent with later Anglo-Saxon burials in general. This study is the first study of later Anglo-Saxon burial to focus on the intra- and inter-cemetery relationship between several physiological stress indicators, mortuary behaviour and settlement type in Northumbria. As a bio-cultural study, it has explored the impact of biological, environmental and cultural factors upon the health status of the Black Gate population. This study has demonstrated the significant contribution that bio-cultural studies, that explore the relationship between the biological, archaeological and documentary data, can make to the current understanding of life and death in later Anglo-Saxon England.

The bio-cultural analysis of the Black Gate cemetery has determined that it is not possible to determine the origin of its contributing population utilising such an approach. Health in the later Anglo-Saxon period is influenced by several factors aside from settlement type, such as age and social status. The Black Gate population appears to represent a healthy population, which accorded care to all members of the community – as evidenced by the number of individuals who exhibited childhood diseases living to be senior adults, the similarities in health profiles observed between the sexes and the presence of elaborate burial provisioning to individuals of all age groups and each sex. The main factor influencing the prevalence and severity of most health indicators is the degeneration of the skeleton's immunological response systems and accumulations of palaeopathological lesions and deposits with advancing age. However, the high prevalence of low grade cribra orbitalia and dental enamel hypoplasia indicates some form of prolonged nutritional stress or dietary deficiency within this population throughout childhood, particularly during young childhood. The bio-cultural investigation revealed correlations between low levels of biological stress and preferential burial locations related to a building previously identified as an Anglo-Saxon church. It was also revealed through low levels of biological stress observed in individuals interred in rubble and stone cists that these burial types were possibly associated with high status, whereas chest burials and grave variations, such as pillow stones, earmuffs and head cists represent an intermediate 'status' category between the elaborate stone grave types and plain burials.

The homogenous health profiles within the Black Gate cemetery and relative to the comparative sites revealed that life in religious and secular environments was not vastly different and that urban and rural populations supplemented one another to enable a reasonable quality of life sustainable for everybody. It appears that the urban settlements of this period were of a suitable size to enable a sufficient diet and to control the levels of pollution and prevent overcrowded living conditions, which becomes unsustainable as urbanisation and industrialisation increase in later periods, resulting in poor provisioning for less wealthy members of society and pollution levels increase as they become overcrowded.

## 8.6 Limitations of the Present Study

The extent to which the dead population reflects the life and health of the corresponding surviving population is limited. As discussed throughout the present study, the skeletal sample is restricted by selective burial practices, taphonomic factors, recovery during excavation and the extent of the excavation. Preservation can greatly influence the visibility of palaeopathological conditions. For example, because the Black Gate assemblage has been extensively handled since its excavation the bones have become increasingly fragile and some elements have been lost or damaged. For example, 15 individuals possessed teeth with staining indicating the presence of calculus, which had long since been lost or broken off the tooth. Consequently, an estimate of the original severity of the calculus in such cases would be inaccurate, and these teeth were excluded from the severity analysis. Nevertheless, the staining was recorded as evidence for dental calculus, and the loss of the actual deposit, would not have had a significant impact on the prevalence rates.

Any interpretation of the demographic analysis, mortality and morbidity profiles presented in this study is limited by the fact that the demographic profile, prevalence and severity of health indicators within the Black Gate cemetery are representative of the people who died, and not necessarily of the living population. Waldron argues that it is not possible from such information to reconstruct the demography of the open and dynamic living population (Waldron 1994: 20) and frequencies of disease in a skeletal assemblage would be higher than for the surviving population from which they were derived (Wood *et al.* 1992). The Black Gate skeletal assemblage represents the total deaths of excavated individuals who were interred within the cemetery throughout its entire period of use. By grouping all of these burials together, any fluctuations in mortality, morbidity and longevity of life will have been lost (Waldron 1994: 21; Mays 1998: 71).

The lack of infectious diseases, such as tuberculosis and leprosy, in the Black Gate cemetery population may occur because the extremely ill and infectious were buried in an unexcavated area of the cemetery. Bell and Andrews have noted that people with infectious diseases are often excluded from the mortuary space of the rest of the community (Bello and Andrews 2006: 10). Alternatively, it is possible that such infectious diseases did not heavily affect the Black Gate population.

It is difficult to compare the data from the Black Gate, with the published data from other sites. There are a number of reasons for this, which were discussed in Chapter 7. However, the analytical methods used in this study were chosen so that the information acquired for Black Gate could be replicated for any site of any period and analysed by any person. To create a standardised recording system the well-established methods of several researchers and the guidelines produced by the Global History of Health project were utilised, and wherever possible recording criteria that provided pictorial or photographic representation were used as they would create the least scope for error. Nonetheless, this approach does have its problems. Even though the compartmentalisation of pathological lesions into arbitrary categories enables a clear, distinct and easily replicated and comparative data set, such designation forces what are continuous traits into nominal categories, which do not necessarily reflect more complex conditions. Even though the designation of spinal degenerative joint disease into Slight, Moderate and Severe enables inter- and intra- population comparisons, it over simplifies the nature of degenerative disease, which is a complex myriad of different features including osteophyte formation, porosity, eburnation, ankylosis of joints and inflammatory response of the periosteum. Consequently, if a greater understanding of specific palaeopathologies, such as degenerative joint disease, is desired a more complex and detailed recording system, such as that proposed by Buikstra and Ubelaker (1994: 122-3), should be employed. Dependent upon time available for research, a combination of site-comparable simplified recording and more detailed recording of specific palaeopathological lesions should be employed for each skeleton analysed during osteological analysis. Maybe for commercial ventures it should be agreed that 25% more time is added to the cost of each skeleton. If this was universally applied it could be a feasible proposition.

## *8.7 Recommendations for Future Work*

An extensive programme of radiocarbon dating would be able to determine if any differences observed in the biological or mortuary behaviour profile between the different burial areas (the Compound, Area C, the Railway Arches and Area D) represent chronological trends. It is apparent that a greater understanding of the Black Gate cemetery would be acquired from a detailed analysis of dietary carbon and nitrogen isotopes to determine the cause of the differences in health indicators observed between elaborate and plain burials Analysis of oxygen, strontium and lead stable isotopes could potentially identify if there is any evidence of migration. For example, do the taller males present in the Compound represent an immigrant population? This approach would help to determine if the Black Gate assemblage represents several local rural cemeteries or is linked to an, as yet unidentified, urban settlement which was attracting people from further afield.

# BIBLIOGRAPHY

## Primary Sources

*EHD* English Historical Documents

*VSCuth.* Vita S. Cuthberti: Colgrave, B. 1940 (Ed. and trans.) *Two Lives of Saint Cuthbert: A Life by an Anonymous Monk of Lindisfarne and Bede's Prose Life.* Cambridge: Cambridge University Press.

*VSW* Vita S. Wilfridi: Colgrave, B. 1927 (Ed. And trans) *The Life of Bishop Wilfred by Eddius Stephanus.* Cambridge: Cambridge University Press.

*Regularis Concordia: Anglicae Nationis Monachorum Sanctimonialiumque* trans. Symonds, T. 1952. (trans.) London: Thomas Nelson and Sons Ltd.

## Secondary Sources

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

Addyman, P.V. 1972 The Anglo-Saxon house: a new review. *Anglo-Saxon England* **1**: 273-307.

Addyman, P.V. 1989 The archaeology of public health at York, England. *World Archaeology* **21**(2): 244-64.

Allison, E., Hall, A., Jones, A., Kenward, H. and Robertson, A. 1996 Report on plant and invertebrate remains. In: Kemp, R.L. (Ed.) *Anglian Settlement at 46-54 Fishergate.* The Archaeology of York. Volume 7 Anglian York. York Archaeological Trust for Excavation and Research 1996. York: Council for British Archaeology. pp. 85-6.

Ambrosiani, B. 1988 The prehistory of towns in Sweden. In: Hodges, R. and Hobley, B. (Eds.) *The Rebirth of Towns in the West AD 700-1050.* Council for British Archaeology Research Report 68. London: Council for British Archaeology. pp. 63-8.

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.

Anderson, M.T., Messner, M.B. and Green, W.T. 1964 Distributions of lengths of the normal femur and tibia in children from one to eighteen years of age. *The Journal of Bone and Joint Surgery* **46**: 1197-202.

Anderson, S. 1988 *The Human Skeletal Remains from Blackgate, Newcastle 1977-8.* University of Durham. Unpublished report.

Anderson, S., Wells, C. and Birkett, D. 2006 The Human Skeletal Remains. In: Cramp, R. *Wearmouth and Jarrow Monastic Sites.* Swindon: English Heritage. pp. 481-91.

Anderson, T. and Carter, A.R. 1994 Periosteal reaction in a new born child from Sheppey, Kent. *International Journal of Osteoarchaeology* **4:** 47-8.

Angel, J.L. 1966 Porotic hyperostosis, anaemias, malarias and marshes in the prehistoric eastern Mediterranean. *Science* **153**: 760-63.

Astill, G.G. 1991 Towns and town hierarchies in Saxon England. *Oxford Journal of Archaeology* **10**(1): 95-117.

Astill, G.G. 2009 Medieval towns and urbanization. In: Gilchrist, R. and Reynolds, A. (Eds.) *Reflections: 50 years of Medieval Archaeology, 1957-2007*. Society for Medieval Archaeology Monograph 30. Leeds: Maney Publishing. pp. 255-70.

Ayers, B. 1985 *Excavations within the North-East Bailey of Norwich Castle 1979*. East Anglian Archaeological Report No. 28. Bury St Edmonds: East Anglian Archaeology.

Ayers, B. 2000 Anglo-Saxon, Medieval and Post-Medieval (Urban). In: Brown, N. and Glazenbrock, J. (Eds.) *Research and Archaeology: A Framework for the Eastern Counties 2, Research Agenda and Strategy.* East Anglian Archaeology Occasional Papers 8. Bury St Edmonds: East Anglian Archaeology. pp. 27-32.

Ayers, B. 2011 The growth of an urban landscape: recent research in early medieval Norwich. *Early Medieval Europe* **19**(1): 62-90.

Bagwell, T. and Tyers, I. 2001 *Dendrochronological analysis of a coffin assemblage from Swinegate, York, North Yorkshire.* Project Report 575p. Sheffield: ARCUS Dendrochronology. Unpublished report.

Bailey, R.N. 2010 Copper alloy pins. In: Nolan, J. The Early Medieval Cemetery at the Castle, Newcastle upon Tyne. *Archaeologia Aeliana* **39**: 262-4.

Baker, A.R.H. 1966 Evidence in the 'Nonarum Inquisitiones' of contracting arable lands in England during the early fourteenth century. *Economic History Review* **19**(3): 518-32.

Barrett, J.H., Locker, A.M. and Roberts, C.M. 2004 Dark Age economics revisited. *Antiquity* **78**: 618-36.

Bass, W.M. 1995 *Human Osteology: A Laboratory and Field Manual.* Columbia: Missouri Archaeological Society Special Publication 2. 3rd edition.

Bassett, S. 2006 Boundaries of knowledge: mapping the land-units of late Anglo-Saxon and Norman England. In: Davies, W., Halsall, G. and Reynolds, A. (Eds.) *People and Space in the Middle Ages, 300-1300.* Turnhout: Brepols Publishers. pp. 115-42.

Bassett, S. 2011 Anglo-Saxon Fortifications in Western Mercia. Midland History **36**(1): 1-23.

Bastow, M.E. 1996 Seeds. In: Adams, M. Excavations of a pre-conquest cemetery at Addingham, West Yorkshire. *Medieval Archaeology* **40**: 180.

Bayliss, A., Cook, G. and Heighway, C. 2008 Radiocarbon dating. In: Mays, S., Harding C. and Heighway, C. (Eds.) *Wharram: XI The Churchyard.* York: English Heritage. pp. 193-215.

Belcastro, G., Rastelli, E., Mariotti, V., Consiglio, C., Facchini, F. and Bonfiglioli, B. 2007 Continuity or discontinuity of the life-style in central Italy during the Roman Imperial Age – Early Middle Ages transition: diet, health and behaviour. *American Journal of Physical Anthropology* **132**: 381-94.

Bell, L.S., Skinner, M.F. and Jones, S.J. 1996 The speed of post mortem change to the human skeleton and its taphonomic significance. *Forensic Science International* **82**: 129-40.

Bell, R.D. 1987 General Introduction. In: Bell, R.D. and Beresford, M. (Eds.) *Wharram Percy: The Church of St. Martin*. London: Society for Medieval Archaeology. pp. 1-5.

Bell, R.D. and Beresford, M. 1987 *Wharram Percy: The Church of St. Martin*. London: Society for Medieval Archaeology.

Bell, T. 1998 Churches on Roman buildings: Christian associations and Roman masonry in Anglo-Saxon England. *Medieval Archaeology* **43**: 1-18.

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.

Biddle, M. 1976 Towns. In: Wilson, D. (Ed.) *The Archaeology of Anglo-Saxon England*. Cambridge: Cambridge University Press. pp. 99-150.

Blair, J. 2005 *The Church in Anglo-Saxon Society*. Cambridge: Cambridge University Press.

Boddington, A. 1987 Chaos, disturbance and decay in an Anglo-Saxon cemetery. In: Boddington, A., Garland, A.N. and Janaway, R.C. (Eds.) *Death, Decay and Reconstruction: Approaches to Archaeology and Forensic Science*. Manchester: Manchester University Press. pp. 27-42.

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.

Boulter, S. and Rega, E. 1993 *Report of Human Remains from Black Gate, Newcastle-upon-Tyne*. University of Sheffield. Unpublished report.

Boyle, A., Dodd, A., Miles, D. and Mudd, A. 1996 Two Oxfordshire Anglo-Saxon Cemetries: Berinsfield and Didcot. Thames Valley Landscapes Monograph 8. Oxford: Oxford Archaeological Unit.

Boylston, A. and Roberts, C. 1996 The human bone. In: Adams, M. Excavations of a pre-conquest cemetery at Addingham, West Yorkshire. *Medieval Archaeology* **40**: 173-84.

Brickley, M. and Ives, R. 2006 Skeletal manifestations of infantile scurvy. *American Journal of Physical Anthropology* **129**: 163-72.

Brickley, M. and McKinley, J. 2004 *Guidelines to the Standards for Recording Human Remains*. IFA Paper No. 7.

Bridges, P.S. 1993 The effect of variation in methodology on the outcome of osteoarthritic studies. *International Journal of Osteoarchaeology* **3**: 289-95.

Brone, M. 2001 *Gender and Health in Anglo-Saxon England.* University of Sheffield. Unpublished MSc. thesis.

Brooke, C. 2003 *The Age of the Cloister: the Story of Monastic Life in the Middle Ages.* Location: U.S: Paulist Press International.

Brooks, D.. 1988 The case for continuity in fifth century: Canterbury re-examined. *Oxford Journal of Archaeology* **7**(1): 99-114.

Brothwell, D.R. 1981 *Digging Up Bones.* New York: Cornell University Press. 3rd edition.

Brothwell, D.R. 1994 On the possibility of urban-rural contrasts in human population palaeobiology. In: Hall, A.R. and Kenwards, H.K. (Eds.) *Urban-Rural Connexions: Perspectives from Urban-Rural Archaeology.* Symposia of the Association of Environmental Archaeology No. 12. Oxbow Monograph 47. Oxford. Oxbow. pp. 129-36.

Brown, M.A. 1983 Orientation, a further view. *Archaeological Journal* **140**: 322-28.

Bruce-Mitford, R. 1997 *Mawgan Porth. A Settlement of the Late Saxon Period on the North Cornish Coast. Excavations 1949-52, 1954 and 1974.* English Heritage Archaeological Report 13. London: English Heritage.

Buckberry, J.L. 2000 Missing, presumed buried? Bone diagenesis and under-representation of Anglo-Saxon children. *Assemblage* **5**: 1-14.

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. 2008 Off with their heads: the Anglo-Saxon execution cemetery at Walkington Wold, East Yorkshire. In: Murphy, E. (Ed.) *Deviant Burial in the Archaeological Record.* Oxford: Oxbow. pp. 148-68.

Buckberry, J.L. 2010 Cemetery diversity in the mid to late Anglo-Saxon period in Lincolnshire and Yorkshire. In: Buckberry, J.L. and Cherryson, A.K. (Eds.) *Burial in Later Anglo-Saxon England c. 650-1100 A.D.* Oxford: Oxbow. pp. 1-25.

Buckberry, J.L. and Cherryson, A.K. (Eds.) 2010 *Burial in Later Anglo-Saxon England c. 650–1100 AD.* Oxford: Oxbow.

Buckberry, J.L. and Hadley, D.M. 2007 An Anglo-Saxon execution cemetery at Walkington Wold, Yorkshire. *Oxford Journal of Archaeology* **26**(3): 303-29.

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

Bullough, V. and Campbell, C. 1980 Female longevity and diet in the Middle Ages. *Speculum* **55**: 317-25.

Buzon, M.R and Judd, M.A. 2008 Investigating health at Kerma: sacrificial versus non-sacrificial individuals. *American Journal of Physical Anthropology* **136**: 93-9.

Caffell, A.C. 2005 Marking skeletons. University of Durham. Unpublished manuscript.

Cambridge, E. and Williams, A. 1995 Hexham Abbey: a review of recent work and its implications. *Archaeologia Aeliana* **29**: 33-94.

Campbell, B. 2000 *English Seigniorial Agriculture 1250-1450*. Cambridge Studies in Historical Geography. Cambridge: Cambridge University Press.

Cardoso, H.F.V. and Garcia, S. 2009 The not-so-dark ages: ecology for human growth in medieval and early twentieth century Portugal as inferred from skeletal growth profiles. *American Journal of Physical Anthropology* **138**: 136-47.

Carvalho, J.C., Ekstrand, K.R. and Thylstrup, A. 1989 Dental plaque and caries on occlusal surfaces of first premolars in relation to stage of eruption. *Journal of Dental Research* **68**: 773-9.

Carver, M.O.H. 1989 Kingship and material culture in early Anglo-Saxon East Anglia. In: Bassett, S. (Ed.) *The Origins of Anglo-Saxon Kingdoms*. Leicester: Leicester University Press. pp. 141-58.

Carver, M.O.H. 1998 *Sutton Hoo: Burial Ground of Kings?* London: British Museum Press.

Carver, M.O.H. 2003 *The Cross Goes North. Processes of Conversion in Northern Europe AD 300-1300*. York: York Medieval Press.

Carver, M.O.H. 2004 An Iona of the East: the early-medieval monastery at Portmahomak, Tarbat Ness. *Medieval Archaeology* **48**: 1-30.

Chamberlain, A.T. 2006 *Demography in Archaeology*. Cambridge Manuals in Archaeology. Cambridge: Cambridge University Press.

Chamberlain, A.T. 2009 Archaeological Demography. *Human Biology* **81**: 275-86.

Charles-Edwards, T. (Ed.) 2003 *After Rome*. Short Oxford Histories of the British Isles. Oxford: Oxford University Press.

Checkley, W., Gilman, R.H., Black, R.E., Epstein, L.D., Cabrera, L., Sterling, C.R. and Moulton, L.H. 2004 Effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. *Lancet* **363** (9403): 112-18.

Cherryson, A.K. 2005 *In the Shadow of the Church: Burial Practices in the Wessex Heartlands c. 600-1100 A.D.* University of Sheffield. Unpublished PhD thesis.

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.

Clarke, H. and Ambrosiani, B. 1991 *Towns in the Viking Age*. Leicester: Leicester University Press.

Clarke, N.G. and Hirsch, R.S. 1991 Tooth dislocation: the relationship with tooth wear and dental abscesses. *American Journal of Physical Anthropology* **85**: 293-8.

Colgrave, B. and Mynors, R.A.B. 1969 *Bede's Ecclesiastical History of the English People*. Oxford: Clarendon Press.

Collins, S. 2007 Treating severe acute malnutrition seriously. *Archives of Disease in Childhood* **92**: 453-61.

Connel, B. 2004 Compiling a dental inventory. In: Brickley, M. and McKinkey, J. (Eds.) *Guidelines to the Standards for Recording Human Remains*. IFA Paper No. 7. pp. 8.

Coppack, G. 1986 St Lawrence Church, Burnham, South Humberside: the excavation of a parochial chapel. *Lincolnshire History* **21**: 39-60.

Corėdon, C. 2004 *A Dictionary of Medieval Terms and Phrases*. Cambridge: Boydell and Brewer Ltd.

Craig, E. 2006 *An Osteological and Palaeopathological Assessment of Stress Indicators and Social Status at Raunds Furnells, Northamptonshire*. University of Bradford. Unpublished MSc. dissertation.

Craig, E. 2009 *Burial Practices in Northern England c. A.D. 650-850: A Biocultural Approach*. The University of Sheffield. Unpublished PhD thesis.

Craig, E. and Buckberry, J.L. 2010 Investigating social sttus 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.

Cramp, R. 2005 *Wearmouth and Jarrow Monastic Sites*. Swindon: English Heritage.

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.

Crawford, S. 2004 Votive deposition, religion and the Anglo-Saxon furnished burial ritual. *World Archaeology* **36**(1): 87-102.

Croft, P., Coggon, M., Cruddas, M. and Cooper, C. 1992 Osteoarthritis of the hip: an occupational disease in farmers. *British Medical Journal* **304**: 1269-72.

Cucina, A. and Tiesler, V. 2003 Dental caries and ante-mortem tooth loss in the northern Peten area, Mexico: a biocultural perspective on social status differences among the classic Maya. *American Journal of Physical Anthropology* **122**(1): 1-10.

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.

Daniell, C. and Thompson, V. 1999 Pagans and Christians 400-1150. In: Jupp, P.C. and Gittings, C. (Eds.) *Death in England: An Illustrated History*. Manchester: Manchester University Press. pp. 65-89.

Daniels, R. 1999 The Anglo-Saxon monastery at Hartlepool, England. In: Hawkes, J. and Mills, S. (Eds.) *Northumbria's Golden Age*. Stroud: Sutton Publishing. pp. 105-12.

Daniels, R. and Loveluck, C. 2007 *Anglo-Saxon Hartlepool and the Foundations of English Christianity: An Archaeology of the Anglo-Saxon Monastery*. Tees Archaeology Monograph Series. Volume 3. Tees Archaeology.

Darby, H.C. 2003 The geography of Domesday England. In: Erskine, R.W.H. and Williams, A. (Eds.) *The Story of the Domesday Book*. Chichester. England: Phillimore and Co. Ltd. pp. 25-36

Dark, P. 2000 *The Environment of Britain in the First Millennium AD*. London: Duckworth.

Davies, D. J. 1997 *Death, Ritual and Belief: The Rhetoric of Funerary Rites*. London: Cassell.

Davies, W. 2003 *From the Vikings to the Normans*. Short Oxford History of the British Isles. Oxford: Oxford University Press.

Dawes, J.D. and Magilton, J.R. 1980 *The Cemetery of St Helen-on-the-Walls, Aldwark*. The Archaeology of York 12/1. York Archaeological Trust. York: Council for British Archaeology.

De Silva, P., Evans-Jones, G., Wright, A. and Henderson, R. 2003 Physiological periostitits; a potential pitfall. *Archives of Disease in Childhood* **88**: 1124-5.

Delgado-Darias, T., Velasco-Vázquez, J., Arnay-de-la-Rosa, M., Martín-Rodríguez, E. and González-Reimers, E. 2006 Calculus, periodontal disease and tooth decay among the prehispanic population from Gran Canaria. *Journal of Archaeological Science* **33**(5): 663-70.

Dembinska, M. 1986 Fasting and working monks: regulations of the fifth to eleventh centuries. In: Fenton, A. and Kisban, E. (Eds.) *Food in Change: Eating Habits from the Middle Ages to the Present Day*. National Museums of Scotland. Edinburgh: John Donald Publishers. pp. 152-60.

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.

Dias, G.J., Prasad, K. and Santos, A.L. 2007 Pathogenesis of apical periodontal cysts: guidelines for diagnosis in palaeopathology. *International Journal of Osteoarchaeology* **17**: 619-26.

Dias, G. and Tayles, N. 1997 'Abscess cavity' – a misnomer. *International Journal of Osteoarchaeology* **7**: 548-54.

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.

Djuric, M., Milovanovic, P., Janovic, A., Draskovic, M., Djukic, K. and Milenkovic, P. 2008 Porotic lesions in immature skeletons from Stara Torina, late medieval Serbia. *International Journal of Osteoarchaeology* **18**(5): 458-75.

Dobney, K., Jaques, S.D., Barrett, J. and Johnstone, C. 2007 *Farmers, Monks and Aristocrats: The Environmental Archaeology of Anglo-Saxon Flixborough: Excavations at Flixborough Volume 3.* Oxford: Oxbow Books.

Draper, S. 2008 The significance of OE burh in Anglo-Saxon England. In: Crawford, S. and Hamerow, H. (Eds.) *Anglo-Saxon Studies in Archaeology and History No. 15.* Oxford: Oxbow. pp. 240-53.

Drinkall, G. and Foreman, M. 1998 *The Anglo-Saxon Cemetery at Castledyke South, Barton-upon-Humber.* Sheffield Excavation Reports No. 6. Sheffield: Sheffield Academic Press Ltd.

Duray, S.M. 1996 Dental indicators of stress in Native Americans. *American Journal of Physical Anthropology* **99**(2): 275-86.

Dyer, C.C. 1985 Towns and cottages in eleventh-century England. In: Mayr-Harting, H. and Moore, R.I. (Eds.) *Studies in Medieval History presented to R.H.C. Davies.* London: Hambledon Press. pp. 91-106.

Dyer, C.C. 1998 *Standards of Living in the Middle Ages: Social Change in England c. 1200-1520.* Cambridge: Cambridge University Press.

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

Dyer, C.C. 2002 *Making a Living in the Middle Ages.* London: Yale University Press.

Dyer, C.C. 2003 The archaeology of medieval small towns. *Medieval Archaeology* **47**: 85-114.

Dyer, C.C. 2006 Gardens and garden produce in the later Middle Ages. In: Woolgar, T., Sergeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition.* Oxford: Oxford University Press. pp. 27-40.

Eagan, R. 2006 *Biography of Sugar.* New York: Turtleback Books.

Effros, B. 2010 Death and burial. In: Bornstein, D. (Ed.) *Medieval Christianity.* A Peoples History of Christianity Volume 4. Minneapolis: Fortress Press. pp. 53-74.

Eliopoulis, C. 1998 *The problem of standardisation in palaeopathological lesion recording: an inter-observer variation study.* University of Sheffield. Unpublished MSc. dissertation.

Erskine, R.W.H. and Williams, A. (Eds.) 2003 *The Story of the Domesday Book.* Chichester. England: Phillimore and Co. Ltd.

Facchini, B.B. 2007 Continuity or discontinuity of the life-style in central Italy during the Roman imperial age-early middle ages transition: Diet, health, and behaviour. *American Journal of Physical Anthropology* **132**(3): 381-94.

Fazekas, I.G. and Kósa, F. 1978 *Forensic Fetal Osteology.* Budapest: Akadémiai Kiadó.

Feldesman, M.R. 1992 Femur/Stature ratio and estimates of stature in children. *American Journal of Physical Anthropology* **87**: 447-59.

Fell, C. 1986 *Women in Anglo-Saxon England.* Oxford: Blackwell.

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.

Fleming, R. 2010 *Britain After Rome: The Fall and Rise 400-1070.* London. Penguin Books.

Foot, S. 1990 What was an Anglo-Saxon monastery? In: Loades, J. (Ed.) *Monastic Studies.* Bangor: Headstart Archaeology. pp. 48-57.

Foot, S. 2006 *Monastic Life in Anglo-Saxon England, c. 600-900.* Cambridge: Cambridge University Press.

Freeth, C. 2000 Dental health in British antiquity. In: Cox, M. and Mays, S. (Eds.) *Human Osteology in Archaeology and Forensic Science.* Greenwich: Medical Media Ltd. pp. 227-37.

Geake, H. 1992 Burial practice in seventh and eighth century England. In: Carver, M. O. H. (Ed.) *The Age of Sutton Hoo: the 7th century in Western Europe.* Woodbridge: Boydell. pp. 83-94.

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.

Geake, H. 2002 Persistent problems in the study of conversion period burials in England. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales.* London: The Society for Medieval Archaeology. pp. 144-56.

Giannecchini, M. and Moggi-Cecchi, J. 2008 Stature in archaeological samples from central Italy: methodological issues and diachronic changes. *American Journal of Physical Anthropology* **135**: 284-92.

Gies, F. and Gies, J. 1990 *Marriage and the Family in the Middle Ages.* London: Harper and Row.

Gilchrist, R. and Sloane, B. 2005 *Requiem: the Medieval Monastic Cemetery in Britain.* London: Museum of London Archaeological Services.

Gilchrist, R. and Reynolds, A. (Eds.) 2009 *Reflections: Fifty Years of Medieval Archaeology.* London: Society for Medieval Archaeology.

Gilmour, B.J.J. and Stocker, D.A. 1986 *St Mark's Church and Cemetery*. The Archaeology of Lincoln xiii-i. London: Council for British Archaeology.

Gindhart, P. 1973 Growth standards for the tibia and radius in children aged one month through eighteen years. *American Journal of Physical Anthropology* **39**: 41-8.

Gittos, H. 2002 Creating the sacred: Anglo-Saxon rites for consecrating cemeteries. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales*. London: The Society for Medieval Archaeology. pp. 195-208.

Goodman, A.H. and Armelagos, G.J. 1984 Infant and childhood morbidity and mortality risks in archaeological populations. *World Archaeology* **21**(2): 225-43.

Goodman, A.H. and Armelagos, G.J. 1985 Factors affecting the distribution of enamel hypoplasias within the human permanent dentition. *American Journal of Physical Anthropology* **68**(4): 479-93.

Goodman, A.H., Brooke-Thomas, R., Swedlund, A.C. and Armelagos, G.J. 1988 Biocultural perspecitives 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.

Goodman, A.H. and Rose, J.C. 1990 Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. *Yearbook of Physical Anthropology* **33**: 59-110.

Goodman, A.H. and Rose, J.C. 1991 Dental enamel hypoplasias as indicators of nutritional status. In: Kelley, M.A. and Larsen, C.S. (Eds.) *Advances in Dental Anthropology*. New York: Wiley-Liss. pp. 279-93.

Gould, J.L. and Gould, G.F. 2002 *Biostats Basics: A Student Handbook*. New York: W.H. Freeman and Company.

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 Chamberlain, A.T. 2005 Detecting plague: palaeodemographic characterisation of a catastrophic death assemblage. *Antiquity* **79** (303): 146-57.

Gowland, R.L. and Knüsel, C. (Eds.) 2006 *Social Archaeology of Funerary Remains*. Oxford: Oxbow Books.

Graham, A.H and Davies, S. 1993 *Excavations in Trowbridge, Wiltshire, 1977 and 1986-1988: the Prehistoric, Saxon and Saxo-Norman Settlements and the Anarchy Period Castle*. Salisbury: Wessex Archaeology report No. 2.

Grauer, A.L. 1993 Patterns of anaemia and infection from medieval York, England. *American Journal of Physical Anthropology* **91**: 203-13.

Grey, W. 1649 *Chorographia: A Survey of Newcastle upon Tyne*. Newcastle upon Tyne: Antiquarian Society of Newcastle upon Tyne. S. Hodgson.

Griffiths, D. 2001 The North-West Frontier. In: Higham, N.J. and Hill, D.H. (Eds.) *Edward the Elder 899-924*. London: Routledge.

Griffiths, D. 2003 Exchange, trade and urbanization. In: Davies, W. (Ed.) *From the Vikings to the Normans*. Short Oxford History of the British Isles. Oxford: Oxford University Press. pp. 73-104.

Groves, S. 2010 The Bowl Hole Burial Ground: a late Anglian Cemetery in Northumberland. In: Buckberry, J.L. and Cherryson, A.K. (Eds.) *Burial in Later Anglo-Saxon England c. 650-1100 AD*. Oxford: Oxbow Books. pp. 116-27.

Guy, J.C. 1965 *Institutions Cénobitiques*. Sources Chrétiennes 109. Paris. du Cerf.

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

Hadley, D.M. 2000b Equality, humility and non-materialism?: Christianity and Anglo-Saxon burial practices. *Archaeological Review from Cambridge* **17**: 149-78.

Hadley, D.M. 2001 *Death in Medieval England: An Archaeology*. Stroud. Tempus Publishing.

Hadley, D.M. 2002 Burial practices in northern England in the later Anglo-Saxon period. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales*. London: The Society for Medieval Archaeology. pp. 209-28.

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. 2006 *The Vikings in England: Settlement, Society and Culture*. Manchester: Manchester University Press.

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. 2011 Later Anglo-Saxon Burial. In Hamerow, H., Hinton, D. and Crawford, S. (Eds.) *The Oxford Handbook of Anglo-Saxon Archaeology*. Oxford: Oxford University Press. pp. 288-314.

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.

Hagen, A. 1992 *A Handbook of Anglo-Saxon Food: Processing and Consumption.* Middlesex: Anglo-Saxon Books.

Halcrow, S.E. and Tayles, N. 2008 The bioarchaeological investigation of childhood and social age: problems and prospects. *Journal of Archaeological Method and Theory* **15**: 190-215.

Hall, A.R., Kenward, H.K., Williams, D. and Greig, J.R.A. 1983 *Environment and Living Conditions at Two Anglo-Scandinavian Sites.* The Archaeology of York. The Past Environment of York 14/4. York Archaeological Trust. London: Council for British Archaeology.

Hall, A.R. and Kenward, H.K. 2004 Setting people in their environment: plant and animal remains from Anglo-Scandinavian York. In Hall, R.A. (Ed.) *Aspects of Anglo-Scandinavian York.* The Archaeology of York, Volume 8: Anglo-Scandinavian York. York Archaeological Trust. London: Council for British Archaeology. pp. 372-426.

Hall, R.A. and Whyman, M. 1996 Settlement and monasticism at Ripon, North Yorkshire, from the 7th to 11th centuries AD. *Medieval Archaeology* **40**: 62-150.

Hamerow, H. 2002 *Early Medieval Settlements: The Archaeology of Rural Communities in North-West Europe 400-900 A.D.* Oxford: Oxford University Press.

Hamerow, H. 2006 Special deposits in Anglo-Saxon settlements. *Medieval Archaeology* **50**: 1-30.

Hamerow, H., Hinton, D. and Crawford, S. (Eds.) 2011*The Oxford Handbook of Anglo-Saxon Archaeology.* Oxford: Oxford University Press.

Hammond, P.W. 1998 *Food and Feast in Medieval England.* Wrens Park Publishing. W.J. Williams and Son Ltd. 2nd edition.

Harbottle, B. and Clack, P.A.G. 1976 Newcastle upon Tyne: archaeology and development. In: Clack, P.A.G. and Gosling, P.F. (Eds.) *Archaeology in the North: Report of the Northern Archaeological Survey.* Durham. pp. 111-31.

Harding, C. and Marlow-Mann, E. 2007 Excavations in the central graveyard area. In: Mays, S.; Harding, C. and Heighway, C. (Eds.) *Wharram: XI The Churchyard.* York: English Heritage. pp. 9-30.

Harding, C. and Wrathmell, S. 2007 Discussion. In: Mays, S.; Harding, C. and Heighway, C. (Eds.) *Wharram: XI The Churchyard.* York: English Heritage. pp. 327-36.

Hardy, K., Blakeney, T., Copeland, L., Kirkham, J., Wrangham, R. and Collins, M. 2009 Starch granules, dental calculus and new perspectives on ancient diet. *Journal of Archaeological Science* **36**(2): 248-55.

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.

Härke, H. 1997 Early Anglo-Saxon Social Structure. In: Hines, J. (Ed.) *The Anglo-Saxons: from the Migration Period to the Eighth Century*. Woodbridge: Boydell. pp 125-59.

Haslam, J. 1985 *Early Medieval Towns in Britain c. 700 to 1140*. Shire Archaeology Volume 45. Aylesbury: Shire Publishing.

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.

Heighway, C. and Bryant, R. 1999 *The Golden Minster: The Anglo-Saxon Minster and Later Medieval Priory of St Oswald at Gloucester*. Council for British Archaeology. Report 117. York: Council for British Archaeology.
Henisch, B.A. 1995 In due season: farm work in the medieval calendar. In: Sweeney, D. (Ed.) *Agriculture in the Middle Ages; Technology, Practice, and Representation*. Philadelphia: University of Pennsylvania Press. pp. 309-36.

Hercberg, S., Prezios, P. and Galen, P. 2001 Iron deficiency in Europe. *Public Health Nutrition* **4**(2B): 537-45.

Hill, P. 1997 Whithorn transformed. In: Hill, P. (Ed.) *Whithorn and St Ninian: The Excavation of a Monastic Town*. Stroud: Sutton Publishing. pp. 26-66.

Hills, C.M. 1989 Spong Hill Anglo-Saxon cemetery. In: Roberts, C.A., Lee, F. and Bintliff, J. (Eds.) *Burial Archaeology: Current Research, Methods and Developments*. British Archaeological Reports. British Series 211.Oxford: Tempus Repartum. pp. 247-8.

Hillson, S. 1991 Dental histology as an index of past community health. In Bush, H. and Zvelebil, M. (Eds.) *Health in Past Societies: Biocultural Interpretations of Human Skeletal Remains in Archaeological Contexts*. British Archaeological Reports. International Series 567. Oxford: Archaeopress. pp. 53-66.

Hillson, S. 1996 *Dental Anthropology*. Cambridge: Cambridge University Press. 3rd edition.

Hillson, S. 2000 Chapter 9: Dental pathology. In: Katzenberg, M.A. and Saunders, S.R. (Eds.) *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss. pp. 249-86.

Hindley, G. 2006 *A Brief History of the Anglo-Saxons: The Beginnings of the English Nation*. London: Robinson Publishing.

Hines, J. (Ed.) 1997 *The Anglo-Saxons: from the Migration Period to the Eighth Century*. Woodbridge: Boydell.

Hinton, D.A. 1990 *Archaeology, Economy and Society: England from the 5th to 15th century*. London: Sealby.

Hinton, D.A. 2000 The large towns 600-1300. In: Palliser. D.M (Ed.) *The Cambridge Urban History of Britain: Volume 1*. Cambridge: Cambridge University Press. pp. 217-44.

Hodgson Hinde, J. 1858 On the state of Newcastle and Gateshead during the Saxon period. In: Hartshorne, C.H. (Ed.) *Memoirs, Chiefly Illustrative, of the History and Antiquities of Northumberland*. Archaeological Institute of Great Britain and Ireland. Volume 1. Miscellaneous papers. Newcastle upon Tyne: Ball and Daldy Publishing.

Hoggett, R. 2007 Charting conversion: burial as a barometer of belief? In; Semple, S. and Williams, H. (Eds.) *Anglo-Saxon Studies in Archaeology and History No.14.* Oxford: Oxbow. pp. 28-37.

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

Holland, T.D. and O'Brien, M.J. 1997 Parasites, porotic hyperostosis and the implications of changing perspectives. *American Antiquity* **62**: 183-93.

Holloway, J. 2010 Material symbolism and death: charcoal burial and 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. 83-92.

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

Howe, G.M. 1997 *People, Environment, Disease and Death.* Cardiff: University of Wales Press.

Hubbard, A., Guatelli-Steinberg, D. and Sciulli, P. W. 2009 Under restrictive conditions, can the widths of linear enamel hypoplasias be used as relative indicators of stress episode duration? *American Journal of Physical Anthropology* **138**(2): 177-89.

Hudson-Edwards, K.A., Macklin, M.G., Finlayson, R. and Passmore, D.G. 1999 Medieval lead pollution in the River Ouse at York, England. *Journal of Archaeological Science* **26**: 809-19.

Hukuda, S., Inoue, K., Ushiyama, T., Saruhashi, Y., Iwasaki, A., Huang, J., Mayeda, A., Nakai, M., Xiang Li, F. and Quing Yang, Z. 2000 Spinal degenerative lesions and spinal ligamentous ossifications in ancient Chinese populations of the Yellow River civilization. *International Journal of Osteoarchaeology* **10**(2): 93-160.

Infante, P.F. and Gillespie, G.M. 1974 An epidemiologic study of linear enamel hypoplasia of deciduous anterior teeth in Guatemalan children. *Archives of Oral Biology* **19**: 1055-61.

Işcan, M.Y., Loth, S.R. and Wright, R.K. 1984 Metamorphosis at the sternal rib end: A new method to estimate age at death in white males. *American Journal of Physical Anthropology* **65**(2): 147-56.

Jacobi, K.P. and Danforth, M.E. 2002 Analysis of interobserver scoring patterns in porotic hyperostosis and cribra orbitalia. *International Journal of Osteoarchaeology* **12**(4): 248-58.

James, E. 1995 Part 2: The post-Roman period to 1069. 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. 9-13.

Jankauskas, R. 2003 The incidence of diffuse idiopathic skeletal hyperostosis and social status correlations in Lithuanian skeletal materials. *International Journal of Osteoarchaeology* **13**: 289-93.

Jenkins, V. 1993 Human Bone. In: Graham, A.H and Davies, S. *Excavations in Trowbridge, Wiltshire, 1977 and 1986-1988: the Prehistoric, Saxon and Saxo-Norman*

*Settlements and the Anarchy Period Castle*. Salisbury: Wessex Archaeology report No. 2. pp. 120-7.

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

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

Jurmain, R.D. 1990 Paleoepidemiology of a central California prehistoric population from CA-Ala 329. II. Degenerative disease. *American Journal of Physical Anthropology* **83**: 83-94.

Jurmain, R.D. 2000 Degenerative joint disease in African great apes: an evolutionary perspective. *Journal of Human Evolution* **39**: 185-203.

Jurmain, R.D. and Kilgore, L. 1995 Skeletal evidence of osteoarthritis: a palaeopathological perspective. *Annals of the Rheumatic Diseases* **54**: 443-50.

Kamp, K.A. 2001 Where have all the children gone? The archaeology of childhood. *Journal of Archaeological Method and Theory* **8**(1): 1-34.

Keenleyside, A. 2008 Dental pathology and diet at Apollonia, a Greek colony on the Black Sea. *International Journal of Osteoarchaeology* **18**(3): 262-79.

Kemp, R.L. 1993a The Archaeology of 46-54 Fishergate. In: Stroud, G. and Kemp, R. L. (Eds.) *Cemeteries of the Church and Priory of St Andrew's, Fishergate, York*. The Archaeology of York, 12/2. The Medieval Cemeteries. York. Council for British Archaeology. pp. 123-8.

Kemp, R.L. 1993b The Archaeology of the cemetery. In: Stroud, G. and Kemp, R. L. (Eds.) *The Medieval Cemeteries: Cemeteries of the Church and Priory of St Andrew's, Fishergate, York*. The Archaeology of York, 12/2. The Medieval Cemeteries. York. Council for British Archaeology. pp. 129-59.

Kemp, R.L. 2001 York. In: Cowie, R., Kemp, R.L., Morton, A. and Wade, K. Appendix 1: Gazeteer of Known English Wics. In: Hill, D. and Cowie, R. (Eds.) 2001 *Wics: The Early Medieval Trading Centres of Northern Europe*. Sheffield Archaeological Monographs. Sheffield: Sheffield Academic Press. pp. 92-4.

Kenward, H. 2001 Pubic lice in Roman and Medieval Britain. *Trends in Parasitology* **71**: 164-167.

Kenward, H.K. and Hall, A.R. 1995 *Biological Evidence from 16-22 Coppergate. The Archaeology of York: The Environment 14/7*. York Archaeological Trust. York: Council for British Archaeology.

Kermode, J. 2000 Northern Towns. In: Clark, P. (Ed.) *The Cambridge Urban History of Britain: Volume I 600-1540*. Cambridge: Cambridge University Press. pp. 657-79.

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 Post-medieval London. *American Journal of Physical Anthropology* **128**: 547-59.

Kjølbye-Biddle, B. 1975 A cathedral cemetery: problems in excavation and interpretation. *World Archaeology* **7**: 87-108.

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.

Knowles, W.H. 1926 The Castle, Newcastle Upon Tyne. *Archaeologia Aeliana* **4**(2): 1-51.

Knowles, D. 2004 *Monastic Order in England: A History of its Development from the Times of St Dunstan to the Fourth Lateran Council 940-1216.* Cambridge: Cambridge University Press.

Knüsel, C.J., Göggel, S. and Lucy, D.1997 Comparative degenerative joint disease of the vertebral column in the medieval monastic cemetery of the Gilbertine priory of St. Andrew, Fishergate, York, England. *American Journal of Physical Anthropology* **103**(4): 481-95.

Krogman, W.M. and Işcan, M.Y. 1986 *The Human Skeleton in Forensic Medicine.* Springfield. Illinois: Charles C Thomas.

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

Lake, D.A. 1977 *Preliminary Report on Skulls and Dentitions of Human Remains from Black Gate, Newcastle upon Tyne.* University of Newcastle. Unpublished report.

Lake, S. 2003 Knowledge of the writings of John Cassian in early Anglo-Saxon England. *Anglo-Saxon Archaeology* **32**: 27-41.

Lambert, P.M. and Walker, P.L. 1991 Physical anthropological evidence for the evolution of social complexity in coastal southern California. *Antiquity* **65**: 963-73.

Lang, J. 1995 Pre-Conquest sculpture. In Philips, D. and Heywood, B. *Excavations at York Minster Volume 1: from Roman Fortress to Norman Castle: Part 1: The Site.* London: HMSO. pp 433-67.

Langston, J. 1996 Analysis of human skeletal material. In: Hall, R.A. and Whyman, M. Settlement and monasticism at Ripon, North Yorkshire, from the 7th to 11th centuries AD. *Medieval Archaeology* **40**: 93-9.

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.

Lee, F. 1995 Palaeopathological report on selected skeletons from the pre-Norman cemetery. In: Carver, M. O. H *Excavations at York Minster Volume 1: Part 2 The Finds.* London: HMSO. pp. 559-73.

Leeds, E.T. 1936 *Early Anglo-Saxon Art and Archaeology.* Oxford: Clarendon Press.

Lester, G. 1976 *The Anglo-Saxons: How They Lived and Worked.* Newton Abbot. David and Charles Publishing.

Lewis, M.E. 2002a *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. 2002b Impact of industrialization: comparative study of child health in four sites from medieval and post medieval England (A.D. 850-1859). *American Journal of Physical Anthropology* **119**: 211-23.

Lewis, M.E. 2007 *The Bioarchaeology of Children: Perspectives from Biological and Forensic Anthropology*. Cambridge: Cambridge University Press.

Lewis, M.E. 2010 Life and death in a civitas capital: metabolic disease and trauma in the children from late Roman Dorchester, Dorset. *American Journal of Physical Anthropology* **142**(3): 405-16.

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.

Liebe-Harkort, C., Ástavaldsdóttir, Á. and Tranæus, S. 2010 Quantification of dental caries by osteologists and dentists. A validity and reliability study. *International Journal of Osteoarchaeology* **20**: 525-39.

Lieverse, A.R. 1999 Diet and the Aetiology of Dental Calculus. *International Journal of Osteoarchaeology* **9**: 219-32.

Lightowlers, M. 2010 Antibody responses to the host-protective *Taenia solium* oncosphere protein TSOL18 in pigs are directed against conformational epitopes. *Parasite Immunology* **32**(6): 399-405.

Lilley, K.A. 2002 *Urban Life in the Middle Ages 1000-1450*. European Culture and Society. Basingstoke: Plagrave.

Loe, L. 2003 *Health and Socio-Economic Status in Early Medieval Wales: An Analysis of Health Indicators and their Socio-Economic Implications in an Early Medieval Human Skeletal Population from the Cemetery Site at Llandough, Glamorgan*. University of Bristol. Unpublished PhD thesis.

Loe, L. and Robson-Brown, K. 2005 Summary report of the human skeletons. In: Holbrook, N. and Thomas, A. 2005 An early-medieval monastic cemetery at Llandough, Glamorgan: excavations in 1994. *Medieval Archaeology* **49**: 1-92.

Loseby, S. 2000 Power and towns in late Roman Britain and early Anglo-Saxon England. In: Ripoll, G. and Gurt, J.M. (Eds.). *Sedes Regiae (ann. 400-800)*. Barcelona. Institute of Classical Studies. pp. 319-70.

Loth, S.R. and Henneberg, M. 2001 Sexually dimorphic mandibular morphology in the first few years of life. *American Journal of Physical Anthropology* **115**: 179-86.

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

Loveluck, C. 2007 Changing Lifestyles: interpretation of settlement character and wider perspectives. In: Loveluck, C. *Rural Settlement, Lifestyles and Social Change in the Later First Millenium AD: Anglo-Saxon Flixborough in its Wider Context*. Excavations at Flixborough Volume 4. Oxford: Oxbow Books. pp. 144-64.

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.

Loveluck, C. 2007 Caedmon's world: secular and monastic lifestyles and estate organisation in northern England A.D. 650-900 in Frantzen, A. and Hines, J. (Eds.) Caedmon's Hymn and Material Culture in the World of Bede. Morgantown: West Virginia University Press. pp. 150-90.

Loveluck, C. and Rogers, P.W. 2007 Craft and Technology - non-agrarian activities underpinning everyday life In: Loveluck, C. *Rural Settlement, Lifestyles and Social Change in the Later First Millenium AD: Anglo-Saxon Flixborough in its Wider Context.* Excavations at Flixborough Volume 4. Oxford: Oxbow. pp. 99-110.

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.

Loyn, H.R. 2003 A General Introduction to Domesday Book. In: Erskine, R.W.H. and Williams, A. (Eds.) *The Story of Domesday Book.* Hampshire: Phillimore & Co. Ltd. pp. 1-28.

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.

Lucy, S. 1999 Changing burial rites in Northumbria A.D. 500-750. In: Hawkes, J. and Meaney, S. (Eds.) *Northumbria's Golden Age.* Stroud: Sutton Publishing. pp. 12-44.

Lucy, S. 2000 *The Anglo-Saxon Way of Death: Burial Rites in Early England.* Stroud: Sutton Publishing.

Lucy, S. and Reynolds, A. (Eds.) 2002 *Burial in Early Medieval England and Wales.* London: The Society for Medieval Archaeology.

Lukacs, J.R. 1989 Dental paleopathology: methods for reconstructing health status and dietary patterns in prehistory. In: Işcan, Y. and Kennedy, K.A.R. (Eds.) *Reconstructing Life from the Skeleton.* New York; Alan R. Liss. pp. 261-86.

Lukacs, J.R. 2007 Dental trauma and ante-mortem tooth loss in Prehistoric Canary Islanders: prevalence and contributing factors. *International Journal of Osteoarchaeology* **17**: 157-73.

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.

Lunn, P.G. 2000 The impact of infection and nutrition on gut function and growth in childhood. *Proceedings of the Nutrition Society* **59**: 147-54.

Maat, G.J.R. 2005 Two millennia of male stature development and population health and wealth in the Low Countries. *International Journal of Osteoarchaeology* **15**: 276-90.

MacPherson, P. 2005 *Tracing Change: An Isotopic Investigation of Anglo-Saxon Childhood Diet.* University of Sheffield. Unpublished PhD thesis.

MacPherson, P., Chenery, C.A. and Chamberlain, A.T. 2007 Tracing Change: Childhood diet at the Anglo-Saxon Black Gate cemetery, Newcastle upon Tyne, England. In Robson-Brown, K. and Roberts, A.M. (Eds.) *BABAO 2004: Proceedings of the 6th Annual Conference of the British Association for Biological Anthropology and Osteoarchaeology, University of Bristol.* British Archaeological Reports. International Series 1623. Oxford: Archaeopress. pp. 37-44.

Mainman, A. and Rogers, N. 2004 Craft and Economy in Anglo-Scandinavian York. In: Hall, R. A. *Aspects of Anglo-Scandinavian York.* The Archaeology of York, Volume 8: Anglo-Scandinavian York. York Archaeological Trust. York: Council for British Archaeology. pp. 459-87.

Manchester, K. 2001 Diseases. In: Lapidge, M., Blair, J., Keynes, S. and Scragg, D. (Eds.) *The Blackwell Encyclopedia of Anglo-Saxon England.* Oxford: Blackwell Publishing Ltd. pp. 141-3.

Mann, R.W. and Hunt, D.R. 2005 *Photographic Regional Atlas of Bone Disease: A Guide to Pathology and Normal Variation in the Human Skeleton.* Springfield: Charles C Thomas Ltd.

Maresh, M.M. 1970 Measurements from roentgenograms. In: McCammon, R.W. (Ed.) *Human Growth and Development.* Springfield Illinois: C.C. Thomas. pp. 157-200.

Marsh, P.D. and Martin, M.V. 1999 *Oral Microbiology.* Edinburgh: Elsevier Limited. 5th edition.

Martin, G.H. 2002 Introduction. In: Williams, A. and Martin, G.H. (Eds.) *Domesday Book: A Complete Translation.* London: Penguin Books Ltd. pp. vii-viii.

Mason, K. 1996 The documentary evidence. In: Adams, M. 1996 Excavations of a pre-conquest cemetery at Addingham, West Yorkshire. *Medieval Archaeology* **40**: 153-5.

Mays, S. 1998 *The Archaeology of Human Bones.* London: Routledge.

Mays, S. 1999 Linear and appositional long bone growth in earlier human populations: a case study from Medieval England. In Hoppa, R.D. and FitzGerald, C.M. (Eds.) *Human Growth in the Past: Studies from Bones and Teeth.* Cambridge: Cambridge University Press. pp. 290-312.

Mays, S. 2006 The Osteology of Monasticism in Medieval England. In Gowland, R.L. and Knüsel, C. *Social Archaeology of Funerary Remains.* pp. 179-89.

Mays, S. 2007 The human remains. In: Mays, S., Harding, C. and Heighway, C. (Eds.) *Wharram: XI The churchyard.* York: English Heritage. pp. 77-192.

Mays, S. and Cox, M. 2000 Sex determination in skeletal remains. In: Cox, M. and Mays, S. (Eds.) *Human Osteology in Archaeology and Forensic Science.* London: Greenwich Medical Media Ltd. pp. 117-130.

Mays ,S., Turner-Walker, G. and Syversen, U. 2006 Osteoporosis in a population from Medieval Norway. *American Journal of Physical Anthropology* **131**: 343-51.

Mays, S., Harding, C. and Heighway, C. 2007 (Eds.) *Wharram XI The Churchyard.* York: English Heritage.

Mays, S., Brickley, M. and Ives, R. 2008 Growth in an English population from the Industrial Revolution. *American Journal of Physical Anthropology* **136**(1): 85-92.

Mays, S., Ives, R. and Brickley, M. 2009 The effects of socioeconomic status on endochondral and appositional bone growth, and acquisition of cortical bone in children from 19th century Birmingham, England. *American Journal of Physical Anthropology* **140**(3): 410-16.

McCreanor, M. 1998 *The Mystery of the Malady of Periodontal Disease*. University of Sheffield. Unpublished MSc. thesis.

McDonald, J.H. 2008 *Handbook of Biological Statistics*. Baltimore: Sparky House Publishing.

McEvedy, C. and Jones, R. 1978 *Atlas of World Population History*. London: Penguin.

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*. IFA 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.

Meaney, A.L. and Hawkes, S.C. 1970 *Two Anglo-Saxon cemeteries at Winnall, Hampshire*. Society for Medieval Archaeology Monograph Series No.4. London: Society for Medieval Archaeology.

Melikian, M. and Waldron, T. 2003 An examination of skulls from two British sites for possible evidence of scurvy. *International Journal of Osteoarchaeology* **13**: 207-12.

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.

Merbs, C.F. 1989 Trauma. In: Işcan, M.Y. and Kennedy, K.A.R (Eds.) *Reconstruction of Life from the Skeleton*. New York: Wiley-Liss. pp. 161-89.

Merrett, D. and Pfeiffer, S. 2000 Maxillary sinusitis as an indicator of respiratory health in past populations. *American Journal of Physical Anthropology* **111**: 301-18.

Merrony, C., Boulter, S. and Rega, E. 1996 *Male Migration into Medieval Monkchester: Mobility and Social role*. University of Sheffield. Unpublished manuscript.

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.

Moffett, L. 1994 Charred cereals from some ovens/kilns in late Saxon Stafford and the botanical evidence for the pre-burh economy. In: Rackham, J. (Ed.) *Environment and Economy in Anglo-Saxon England*. Council for British Archaeology Research Report 89. York: Council for British Archaeology. pp. 55-64.

Molleson, T., Cruse, K. and Mays, S. 1998 Some sexually dimorphic features of the human immature skull and their value in sex determination in immature skeletal remains. *Journal of Archaeological Science* **25**: 719-28.

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.

Morris, R. 1983 *The Church in British Archaeology*. Council for British Archaeology Research Report 47. London: Council for British Archaeology.
Morris, R. 1989 *Churches in the Landscape*. London: Dent and Sons.

Morton, A. 2001 Southampton. In: Cowie, R., Kemp, R.L., Morton, A. and Wade, K. Appendix 1: Gazetteer of Known English Wics. In: Hill, D. and Cowie, R. (Eds.) *Wics: The Early Medieval Trading Centres of Northern Europe*. Sheffield Archaeological Monographs. Sheffield Academic Press. pp. 89-91.

Müldner, G. and Richards, M.P. 2005 Fast or feast: reconstructing diet in later Medieval England by stable isotope analysis. *Journal of Archaeological Science* **32**: 39-48.

Müldner, G. and Richards, M.P. 2007a Stable isotope evidence for 1500 years of human diet at the city of York. *American Journal of Physical Anthropology* **133**: 682-97.

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

Nenk, B.S., Margeson, S. and Hurley, M. 1991 Medieval Britain and Ireland in 1990. *Medieval Archaeology* **35**: 126-238.

Nenk, B.S., Margeson, S. and Hurley, M. 1993 Medieval Britain and Ireland in 1992. *Medieval Archaeology* **37**: 285-86.

Niinimäki, S. 2012a The relationship between musculoskeletal stress markers and biomechanical properties of the humeral diaphysis. *American Journal of Physical Anthropology* **147**: 618-28.

Nolan, J. 1998 *Provisional notes on the cemetery at the castle, Newcastle-upon- Tyne*. Unpublished manuscript.

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

Nolan, J. and Harbottle, B. unpublished. *The early medieval cemetery at the Castle, Newcastle-upon-Tyne*. Unpublished manuscript.

Ogden, A.R. 2008a Advances in the palaeopathology of teeth and jaws. In: Pinhasi, R. and Mays, S. (Eds.) *Advances in Palaeopathology*. Sussex: Wiley and Sons. pp. 283-308.

Ogden, A.R. 2008b Periapical voids in jaw bones. In: Smith, M. and Brickley, M. (Eds.) *Proceedings of the 7th British Association of Biological Anthropology and Human Osteoarchaeology (BABAO) Meeting*. British Archaeological Reports. International Series: 1743. Oxford: Archaeopress. pp. 51-6.

Ogilvie, M.D., Curran, B.K. and Trinkhaus, E. 1989 Incidence of dental enamel hypoplasia among the Neanderthals. *American Journal of Physical Anthropology* **79**: 25-41.

Orme, N. 2001 *Medieval Children*. London: Yale University Press.

Ortner, D.J. 2003 *Identification of Pathological Conditions in Human Skeletal Remains*. New York: Academic Press. 2nd edition.

Ortner, D.J. and Theobald, G. 1993 Diseases in the pre-Roman world. In Kiple, K.F. (Ed.) *The Cambridge World History of Disease*. Cambridge: Cambridge University Press. pp. 247-61.

Ortner, D. J. and Mays, S. 1998 Dry-bone manifestations of rickets in infancy and early childhood. *International Journal of Osteoarchaeology* **8**: 45-55.

Ortner, D.J., Butler, W., Cafarella, J. and Milligan, L. 2001 Evidence of probable scurvy in sub-adults from archaeological sites in North America. *American Journal of Physical Anthropology* **114**: 343-351.

Ottaway, P. 1992 *Archaeology in British Towns: From the Emperor Claudius to the Black Death.* London: Routledge.

Owen-Crocker, G. 1986 *Dress in Anglo-Saxon England.* Manchester: Manchester University Press.

Palkovitch, A. M. 1987 Endemic disease patterns in palaeopathology: porotic hyperostosis. *American Journal of Physical Anthropology* **74**: 527-37.

Pallister, D.M. (Ed.) 2003 *The Cambridge Urban History of Britain: Volume 1 600-1540.* Cambridge: Cambridge University Press.

Pallister, D.M., Slater, T.R. and Dennison, E.P. 2000 The topography of towns 600-1300. In: Pallister, D.M. (Ed.). *The Cambridge Urban History of Britain: Volume 1 600-1540.* Cambridge: Cambridge University Press. pp. 153-86.

Palubeckaite, Z., Jankauskas, R. and Bolsden, J. 2002 Enamel hypoplasia in Danish and Lithuanian Late Medieval/early Modern samples: a possible reflection of child morbidity and mortality patterns. *International Journal of Osteoarchaeology* **12**: 189-201.

Pantzer, D.K. 2004 *Paget's Disease: An Archaeological Survey in England.* University of Sheffield. Unpublished MSc thesis.

Papadimitriou, L. 2003 *Sex determination based on long bone circumference. The Anglo-Saxon population of Black Gate.* University of Sheffield. Unpublished MSc thesis.

Papadopoulou, A. 2009 *Age changes in adult cranial sutures: investigating a sample of unknown age.* University of Sheffield. Unpublished MSc thesis.

Parker-Pearson, M. 1999 *The Archaeology of Death and Burial.* Stroud: Sutton Publishing.

Pearson, K. 1899 Mathematical contributions to the theory of evolution. V. On the reconstruction of the stature of prehistoric races. *Philosophical Transactions of the Royal Society* **192**: 169-244.

Pearson, K.L. 1997 Nutrition and the early-medieval diet. *Speculum* **72**: 1-32.

Pearson, N.F. 1989 Swinegate excavation. *Interim* **14**: 2-9.

Pearson, N.F. 1990 Swinegate excavation. *Interim* **15**: 2-10.

Pechenkina, E.A. and Delgado, M. 2006 Dimensions of health and social structure in the early intermediate period cemetery at Villa El Salvador, Peru. *American Journal of Physical Anthropology* **131**(2): 218-35.

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. p. 82-92.

Phillips, D. and Heywood, B. 1995 *Excavations at York Minster Volume 1: from Roman Fortress to Norman Castle: Part 1: The Site*. HMSO. London.

Pinhasi, R. and Mays, S. 2008 *Advances in Human Palaeopathology*. Chichester: John Wiley and Sons Ltd.

Piontek, J. and Kozlowski, T. 2002 Frequency of cribra orbitalia in the sub-adult medieval population from Gruczno, Poland. *International Journal of Osteoarchaeology* **12**: 202-8.

Plummer, C. 1896 *Venerabilis Bedae, opera historica* 2 vols. Oxford: Clarendon Press. pp. 364-87.

Powell, F. 1996 The human remains. In: Boddington, A. *Raunds Furnells: The Anglo-Saxon Church and Churchyard*. London: English Heritage. pp. 113-24.

Proudfoot, E. 1996 Excavations at the long cist cemetery on the Hallow Hill, St. Andrews, Sife 1975-7. *Proceedings of the Society of Antiquaries of Scotland* **126**: 387-454.

Pryce, H. 2003 The Christianization of society. In: Davies, W. (Ed.) *From the Vikings to the Normans*. Short Oxford History of the British Isles. Oxford: Oxford University Press. pp. 138-67.

Rackham, J. (Ed.) 1994 *Environment and Economy in Anglo-Saxon England: A Review of Recent Work on the Environmental Archaeology of Rural and Urban Anglo-Saxon Settlements in England: Proceedings of a Conference Held at the Museum of London, 9-10 April 1990*. York: Council for British Archaeology.

Rackham, O. 1994 Trees and Woodland in Anglo-Saxon England: the documentary evidence. In: Rackham, J. (Ed.) *Environment and Economy in Anglo-Saxon England: a Review of Recent Work on the Environmental Archaeology of Rural and Urban Anglo-Saxon Settlements in England: Proceedings of a Conference Held at the Museum of London, 9-10 April 1990*. York: Council for British Archaeology. York. pp. 7-11.

Rahtz, P. 1978 Grave orientation. *Archaeological Journal* **135**: 1-14.

Raine, J. 1838 *Vita Oswini Regis*. In: Raine, J. (Ed.) *Miscellanea Biographica*. Surtees Society. Volume 8. London: Boydell and Brewer Ltd. pp. 1-59.

Raoult, D. and Roux, V. 1999 The body louse as a vector of re-emerging human diseases. *Clinical Infectious Diseases* **29**: 888-911.

Reid, D.J. and Dean, M.C. 2000 Timing of linear enamel hypoplasias on human anterior teeth. *American Journal of Physical Anthropology* **113**: 135-9.

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

Reynolds, A. 2002 Burials, boundaries and charters in Anglo-Saxon England: a reassessment. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales*. London: The Society for Medieval Archaeology. pp. 171-95.

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

Reynolds, S. 1977 *An Introduction to the History of English Medieval Towns*. 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.

Richards, J. 2000 *Viking Age England*. 2nd Edition. Stroud: Tempus.

Robb, J. 2000 Analysing human skeletal data. In: Cox, M. and Mays, S. (Eds.) *Human Osteology in Archaeology and Forensic Science*. Greenwich: Medical Media. pp. 475-89.

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.

Roberts, C. 2000 Trauma in biocultural perspective: past, present and future work in Britain. In: Cox, M. and Mays, S. (Eds.) *Human Osteology in Archaeology and Forensic Science*. Greenwich: Medical Media. pp. 337-56.

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

Roberts, C.A. 2009 *Human Remains in Archaeology: A Handbook*. York: Council for British Archaeology.

Roberts, C.A and Manchester, K. 1995 *The Archaeology of Disease*. Stroud: The History Press.

Roberts, C.A., Lewis, M.E., Boocock, P. and Manchester, K. 1998 Infectious disease, sex and gender: the complexity of it all. In: Grauer, A. and Stuart-Macadam, P. (Eds.) *Sex and Gender in Paleopathological Perspective*. Cambridge: Cambridge University Press. pp. 93-113.

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

Roberts, C. and Buikstra, J.E. 2008 *The Bioarchaeology of Tuberculosis: A Global View on a Re-emerging Disease*. Gainsville. Florida: University Press of Florida.

Roberts, N. 1998 *The Holocene: An Environmental History*. Oxford: Blackwell Publishers Ltd. 2nd edition.

Rodwell, W. 2001 *The Archaeology of Wells Cathedral: Excavations and Structural studies, 1978–93*. Volumes 1 and 2. London: English Heritage.

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.

Rodwell, W and Rodwell, K. 1982 St Peter's Church, Barton-upon-Humber: excavation and structural study, 1978-81. *Antiquaries Journal* **62**: 284-315.

Rogers, J. and Waldron, T. 1995 *A Field Guide to Joint Disease in Archaeology*. New York: John Wiley Publishing.

Rogers, J. and Waldron, T. 2001 DISH and the monastic way of life. *International Journal of Osteoarchaeology* **11**: 357-65.

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. 1998 *Symeon of Durham: Historian of Durham and the North*. Stamford: Paul Watkins.

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.

Rollason, D. 2003 *Northumbria 500-1100: Creation and Destruction of a Kingdom*. Cambridge: Cambridge University Press.

Roux, V. and Raoult, D. 1999 Body lice as tools for the diagnosis and surveillance of re-emerging diseases. *Journal of Clinical Microbiology* **37**: 596-9.

Ruiz, F. 2003 *Musculo-Skeletal Stress Markers of the Upper Limb: Skeletons from the Anglo-Saxon and Norman Cemetery of Black Gate, Newcastle-upon-Tyne*. University of Sheffield. Unpublished MSc thesis.

Samuels, J. 1998 Newark Castle. *Current Archaeology* **156**: 458-61.

Saunders, S.R. and Barrans, L. 1999 What can be done about the infant category in skeletal samples? In: Hoppa, R.D. and Fitzgerald, C.M. (Eds.) *Human Growth in the Past: Studies from Bones and Teeth*. Cambridge: Cambridge University Press. pp.183-209.

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.

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.

Scheuer, L. and Black, S. 2000 *Developmental Immature Osteology*. London: Elsevier Inc.

Schofield, J. 1988 The Cemetery of St Nicholas Shambles: burial types and burial practices. In: White, W. *The Cemetery of St Nicholas Shambles*. London: London and Middlesex Archaeological Society. pp. 18-27.

Schultz, M. 1988 Paläopathologische Diagnostik. In: Knußmann, R. (Ed.) *Anthropologie Handbuch der vergleichenden Biologie des Menschen*. Stuttgart: Gustav Fischer Verlag. pp. 480-96.

Schutowski, H. 1993 Sex determination of infant and immature skeletons I. Morphognostic features. *American Journal of Physical Anthropology* **90**: 199-205.

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

Scull, C. 1997 Urban centres in pre-Viking England? In: Hines, J. (Ed.) *The Anglo-Saxons from the Migration Period to the Eighth Century: An Ethnographic Perspective. Woodbridge:* Boydell. pp. 269-310.

Scull, C.F. and Harding, A.F. 1990 Two early medieval cemeteries at Milfield, Northumberland. *Durham Archaeological Journal* **6**: 1-29.

Selye, H. 1973 The evolution of the stress concept. *American Scientist* **61**: 692-9.

Serjeantson, D. and Woolgar, C. M. 2006 Fish consumption in Medieval England. In: Woolgar, T., Serjeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition.* Oxford: Oxford University Press. pp. 102-30.

Slaus, M. 2008 Osteological and dental markers of health in the transition from the Late Antique to the Early Medieval period in Croatia. *American Journal of Physical Anthropology* **136**(4): 455-69.

Smith, B.H. 1991 Standards of human tooth formation and dental age assessment. In: Kelley, M.A. and Larsen, C.S. (Eds.) *Advances in Dental Anthropology.* New York. Chichester: Wiley-Liss. pp. 143-68.

Snape, M., Bidwell, P. and Fern, R. 2002 The Roman fort at Newcastle Upon Tyne. *Archaeologia Aeliana* **31**: 1-52.

Sofaer-Derevenski, J. (Ed.) *Children in Material Culture.* London: Routledge.

Stamper, P.A. and Croft, R.A. 2000 *The South Manor Area.* Wharram: A study of settlement in the Yorkshire Wolds Volume 8. York: York University Archaeological Publications.

Steckel, R.H. and Rose, J.C. (Eds.) 2002 *The Backbone of History: Health and Nutrition in the Western Hemisphere.* Cambridge: Cambridge University Press.

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

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

Steckel, R.H., Rose, J.C. and Sciulli, P.W. 2002b A health index 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. 61-93.

Stevenson, J. 1855 *The Church Historians of England* Volume 3, Part 2: *The Historical Works of Simeon of Durham.* London: Seeley Publications Ltd.

Stewart, T.D. 1979 *Essentials of Forensic Anthropology.* Springfield. Illinois. Charles C. Thomas.

Stini, W.A. 1990 Osteoporosis: etiologies, prevention, and treatment. *Yearbook of Physical Anthropology* **33**: 151-94.

Stocker, D. 2000 Monuments and merchants: irregularities in the distribution of stone sculpture in Lincolnshire and Yorkshire in the tenth century. In: Hadley, D. and Richards, J.D. (Eds.) *Cultures in Contact: Scandinavian Settlement in England in the Ninth and Tenth Centuries.* Studies in the Early Middle Ages Volume 2. Turnhout: Brepols. pp. 179-212.

Stone, D.J. 2006 The consumption of field crops in late Medieval England. In Woolgar, T., Serjeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition.* Oxford: Oxford University Press. pp. 11-26.

Stoodley, N. 1999a *The Spindle and the Spear: a Critical Enquiry into the Construction and Meaning of Gender in the early Anglo-Saxon Burial Rite.* British Archaeological Reports. British Series 288. Oxford: Tempus Repartum.

Stoodley, N. 1999b 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.

Stoodley, N. 2002 Multiple burials, multiple meanings? Interpreting the early Anglo-Saxon multiple interment. In: Lucy, S. and Reynolds, A. (Eds.) *Burial in Early Medieval England and Wales.* London: The Society for Medieval Archaeology. pp. 103-121.

Stoodley, N. 2007 New perspectives on cemetery relocation in the seventh century AD: The example of Portway, Andover. In: Semple, S. and Williams, H. (Eds.). *Anglo-Saxon Studies in Archaeology and History No.14.* Oxford: Oxbow. pp. 154-162.

Stroud, G. 1993a The human bones. In: Stroud, G. and Kemp, R.L. (Eds.) *Cemeteries of St Andrew, Fishergate. The Archaeology of York, 12/2. The Medieval Cemeteries.* York: Council for British Archaeology. pp. 160-241.

Stroud, G. 1993 Discussion. In: Stroud, G. and Kemp, R. L. (Eds.) *Cemeteries of St Andrew, Fishergate. The Archaeology of York, 12/2. The Medieval Cemeteries.* York: Council for British Archaeology. pp. 251-260.

Stroud, G. and Kemp, R.L. 1993 Cemeteries of the Church and priory of St Andrew, Fishergate, York. In: Stroud, G. and Kemp, R.L. (Eds.) *Cemeteries of St Andrew, Fishergate.* The Archaeology of York, 12/2. The Medieval Cemeteries. York: Council for British Archaeology. pp. 121-3.

Stuart-Macadam, P. 1985 Porotic hyperostosis: representative of a childhood condition. *American Journal of Physical Anthropology* **66**: 391-8.

Stuart-Macadam, P. 1987a Porotic hyperostosis: new evidence to support the anaemia theory. *American Journal of Physical Anthropology* **74**: 521-6.

Stuart-Macadam, P. 1987b A radiographic study of porotic hyperostosis. *American Journal of Physical Anthropology* **74:** 511-20.

Stuart-Macadam, P. 1989 Porotic hyperostosis: relationship between orbital and vault lesions. *American Journal of Physical Anthropology* **80**: 187-93.

Stuart-Macadam, P. 1991 Anaemia in Roman Britain: Poundbury Camp. In: Bush, H and Zvelebil, M. (Eds.) *Health in Past Societies: Biocultural Interpretations of Human Skeletal*

*Remains in Archaeological Contexts.* British Archaeological Reports International Series 567. Oxford Tempus Repartum. pp. 101-13.

Stuart-Macadam, P. 1992 Porotic hyperostosis: a new perspective. *American Journal of Physical Anthropology* **87**: 39-47.

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

Suckling, G., Elliot, D.C. and Thurley, D.C. 1986 The macroscopic appearance and associated histological changes in the enamel organ of hypoplastic lesions of sheep incisor teeth resulting from increased parasitism. *Archives of Oral Biology* **31**: 427-39.

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.

Sullivan, A. 2005 Prevalence and etiology of acquired anaemia in medieval York. *American Journal of Physical Anthropology* 128: 252-72.

Sykes, J. 1833 *Local Records, or Historical Register, of Remarkable Events in Two Volumes.* Newcastle: John Sykes.

Sykes, N. 2006 From *Cu* and *Sceap* to *Beffe* and *Motton.* In: Woolgar, T., Serjeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition.* Oxford: Oxford University Press. pp. 56-71.

Tainter, J.R. 1978 Mortuary practices and the study of prehistoric social systems. *Archaeological Method and Theory* 1: 105-41.

Taylor, A. 2001 *Burial Practice in Early England.* Stroud: Tempus Publishing Ltd.

Temple, D. and Larsen, C.S. 2007 Dental caries prevalence as evidence for agriculture and subsistence variation during the Yayoi period in prehistoric Japan: Biocultural interpretations of an economy in transition. *American Journal of Physical Anthropology* **134**(4): 501-12.

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.

Tinti, F. 2005 Introduction. In: Tinti, F. (Ed.) *Pastoral Care in Late Anglo-Saxon England.* Anglo-Saxon Studies 6. Suffolk: Woodbridge. pp. 7-8.

Tinti, F. 2005 (Ed.) *Pastoral Care in Late Anglo-Saxon England.* Anglo-Saxon Studies 6. Woodbridge: Boydell.

Tipper, J. 2004 *The Grubenhaus in Anglo-Saxon England.* London: English Heritage.

Todd, T.W. 1921 Age changes in the pubic bone, I: the male white pubis, *American Journal of Physical Anthropology* **3**: 285-335.

Trotter, M. 1970 Estimation of stature from intact limb bones. In: Stewart, T.D. (Ed.) *Personal Identification in Mass Disasters.* Washington: Smithonian Institution. pp.71-83.

Trotter, M. and Gleser, G.C. 1952 Estimation of stature from long bones of American whites and negroes. *American Journal of Physical Anthropology* **10**: 463-514.

Van de Vijver, K. 2007 *The Study of Immature Skeletal Trauma in Archaeological Populations.* University of Sheffield. Unpublished MSc thesis.

Van der Merwe, A.E., Işcan, M.Y. and Abbè, E.N. 2006 The pattern of vertebral osteophyte development in a South African Population. *International Journal of Osteoarchaeology* **16**: 459-64.

Van Lemmen, H. 2004 *Medieval Tiles.* Riseborough. Buckinghamshire. Shire Publications Ltd.

Varley, W J. 1950 Excavations of the Castle Ditch, Eddisbury 1953-8. *Transactions of the Historic Society of Lancashire and Cheshire* **102**: 1-68.

Vince, A. 1994 Saxon urban economies: an archaeological perspective. In: Rackham, J. (Ed.) *Environment and Economy in Anglo-Saxon England.* Council for British Archaeology Research Report 89. York: Council for British Archaeology. pp. 108-19.

Vlak, D., Roksandic, M. and Schillaci, A. 2008 Greater sciatic notch as a sex indicator in immatures. *American Journal of Physical Anthropology* **137**: 309-15.

Wade, K. 2001 Ipswich. In: Hill, D. and Cowie, R. (Eds.) *Wics: The Early Medieval Trading Centres of Northern Europe.* Sheffield Archaeological Monographs. Sheffield Academic Press. pp. 86-7.

Wade-Martins, P. 1980 *Excavations in North Elmham Park 1967-1972.* Volumes 1 and 2. East Anglian Archaeology Report No. 9. Norfolk. Norfolk Archaeological Unit.

Waldron, T. 1989 The effects of urbanisation on human health: the evidence from skeletal remains. In: Serjeantson, D. and Waldron, T. (Eds.) *Diet and Crafts in Towns: The Evidence of Animal Remains from the Roman to the Post-Medieval Periods.* British Archaeological Reports British Series 199. Oxford: Tempus Repartum. pp. 55-73.

Waldron, T. 1994 *Counting the Dead: The Epidemiology of Skeletal Populations.* Chichester: John Wiley and Sons Ltd.

Waldron, T. 2006 Nutrition and the Skeleton. In: Woolgar, T., Serjeantson, D. and Waldron, T. (Eds.) *Food in Medieval England: Diet and Nutrition.* Oxford: Oxford University Press. pp. 254-66.

Waldron T. 2007 *St Peter's, Barton-upon-Humber, Lincolnshire: A Parish Church and its Community. Volume 2. The Human Remains.* Oxford: Oxbow.

Waldron, T. 2009. *Palaeopathlogy.* Cambridge: Cambridge University Press.

Walker, P.L. 2001 A bioarchaeological perspective on the history of violence. *Annual Review of Anthropology* **30**: 573-96.

Walker, P.L. 1995 Problems of preservation and sexism in sexing: some lessons from historical collections for paleodemographers. In: Herring, A. and Saunders, S.

(Eds.) *Grave Reflections: Portraying the Past Through Skeletal Studies*. Toronto: Canadian Scholars' Press. pp. 31-47.

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.

Wapler, U., Crubez, E. and Schultz, M. 2004 Is cribra orbitalia synonymous with anemia? Analysis and interpretation of cranial pathology in Sudan. *American Journal of Physical Anthropology* **123**: 333-9.

Watson, P. 1993 Dental findings. In: Stroud, G. and Kemp, R.L. (Eds.) *Cemeteries of St Andrew, Fishergate.* The Archaeology of York, 12/2. The Medieval Cemeteries. York: Council for British Archaeology. pp. 242-50.

Weber, J., Czarnetzki, A., Spring, A., Hukuda,S., Inoue, K. and Ushiyama, T. 2003 Paleopathological features of the cervical spine in the Early Middle Ages: natural history of degenerative diseases. *Neurosurgery* **53**(6): 1418-24.

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

Welch, M. 1992 *Anglo-Saxon England.* London: English Heritage.

Wells, C. 1964 *Bones, Bodies and Disease.* London: Thames and Hudson.

Wells, C. 1977 Disease of the maxillary sinus in antiquity. *Medical and Biological Illustration* **27**: 173-8.

Wells, C. and Cayton, H. 1980 The human bones. In: Wade-Martins, P. *Excavations in North Elmham Park 1967-1972.* East Anglian Archaeology Report No. 9. Norfolk Archaeological Unit. Norfolk. East Anglian Archaeology. pp. 247-302.

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

White, W. 1988 *The Cemetery of St Nicholas Shambles, London.* London and Middlesex Archaeological Society. London: London and Middlesex Archaeological Society.

Whitelock, D. 1979 *English Historical Documents c. 500-1042.* Cambridge: Eyre and Spottiswoode.

Williams, H. 1997 Ancient landscapes and the dead: the re-use of Prehistoric and Roman monuments as Early Anglo-Saxon burial sites. *Medieval Archaeology* **41**: 1-31.

Williams, H. 2002 Cemeteries as central places: landscape and identity in early Anglo-Saxon England. In: Hardh, B. and Larsson, L. (Eds.) *Central Places in the Migration and Merovingian Periods.* Papers from the 52nd Sachsensymposium. Lund: Almqvist. pp. 341-62.

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.

Wood, J.W., Holman, D.J., O'Connor, K.A. and Ferrell, R.J. 2002 Mortality models in paleodemography. In: Hoppa, A. and Vaupel, J.W. (Eds.) *Paleodemography: Age Distributions from Skeletal Samples*. Cambridge Studies in Biological and Evolutionary Anthropology. Cambridge: Cambridge University Press. pp. 129-68.

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.

Wrathmell, S. 1996 The development of settlement on the gravel ridge. In: Adams, M. Excavations of a pre-conquest cemetery at Addingham, West Yorkshire. *Medieval Archaeology* **40**: 184-8.

Yoder, C., Ubelaker, D.H. and Powell, J.F. 2001 Examination of variation in sternal rib end morphology relevant to age assessment. *Journal of Forensic Sciences* **46**(2): 223-7.

Young, S.M. and Clark, J. 1982 Medieval Britain in 1981. *Medieval Archaeology* **26**: 164-5.

Zuckerman, M.K. and Armelagos, G.J. 2011 The origins of biocultural dimensions in bioarchaeology. In: Agarwal, S.C. and Glencross, B.A. (Eds.) *Social Bioarchaeology*. Chichester: John Wiley and Sons, Ltd. pp. 15-43.

## APPENDIX A: BLACK GATE CEMETERY PLANS


Figure A.1 *Plan of the Black Gate Cemetery: burials and buildings*


Figure A.2 Distribution of foetal, neonate and infant burials


Figure A.3 Distribution of male and female adult burials within the Black Gate cemetery


Figure A.4 Distribution of elaborate burial practices (grave types and grave variations)