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**Unearthing Late Medieval Children:
Health, status and burial practice in southern England
Volume One**

**by
Heidi Suzanne Dawson**

**A dissertation submitted to the University of Bristol in accordance with the
requirements for award of the degree of PhD in the Faculty of Arts.**

**Department of Archaeology and Anthropology, School of Arts
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Abstract

This thesis presents an exploration of the status of children in the late medieval period (AD1066-1539) and involves two concepts of the child; biological and cultural. The biological evidence is explored by an osteoarchaeological analysis of sub-adult skeletal remains, and concentrates on markers related to status, such as, age, rates of growth, the presence of stress indicators, and rates of dental wear. The cultural aspect involves an analysis of the funerary context, such as, location of burial, position of the body, and grave inclusions.

Two hundred and sixty-two sub-adult skeletons were analysed from three skeletal samples from southern England: the priory of SS Peter and Paul, Taunton (AD 1158-1539), where 93 sub-adults were analysed; the priory of St Oswald, Gloucester (AD 1120-1539), where 65 sub-adults were analysed; and the priory of St Gregory, Canterbury (AD 1086-1539), where 104 sub-adults were analysed. Ninety-seven adults were also analysed and used as a comparison at Taunton. All sites were located on the edge of towns and had child burials present in both the church and cemetery. Location of burial was assigned to each individual as position around the church, and proximity to the church.

Some differences in burial practice and prevalence of stress indicators were seen between the sub-adults and adults at Taunton. The analysis of the sub-adult data for all three sites indicates that a higher prevalence of stress indicators was related to higher status burials. This is in contrast to expected results; however, these indicators may be more likely to appear on high status individuals due to their greater potential for survival during times of stress, allowing time for these lesions to manifest on the skeleton. Higher status individuals appear to have a less coarse diet as reflected by dental wear in the church burials. The use of deciduous dental wear as a method to aid in ageing young children was also explored with encouraging results, suggesting this method may be of use as a standard for recording dental wear on young children.

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Authors Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED..... ..... DATE 4 Feb 2011.....

Table of Contents

Chapter 1 : Introduction	1
1.1 Aims	1
1.1.1 Demography.....	1
1.1.2 Funerary context.....	2
1.1.3 Preservation.....	3
1.1.4 Dental wear	4
1.1.5 Episodes of stress	4
1.1.6 Growth and development	5
1.2 Interpretation of status and stress	6
1.3 Skeletal collections analysed.....	9
1.4 Thesis structure	9
Chapter 2 : Defining the child: a biocultural approach.....	13
2.1 Introduction.....	13
2.2 Addressing the “invisibility” of children in archaeology.....	14
2.2.1 Previous research on child burial and the exploration of status.....	16
2.3 Cultural concepts of the child	19
2.3.1 Childhood Stages	22
2.4 Biological concepts	26
2.4.1 Development and growth of the bones of the human skeleton	26
2.4.2 Development of the human dentition.....	31
2.4.3 Previous developmental studies on archaeological human remains	32
2.5 Summary	34
Chapter 3 : The Medieval Child.....	37
3.1 Introduction.....	37
3.2 Assessing the medieval concept of a child.....	38
3.2.1 Childhood stages	40

3.3 Representations of children.....	47
3.3.1 Burial monuments	47
3.3.2 Other artistic representations.....	51
3.4 Childhood accidents, diseases and death	53
3.5 Children's artefacts, games and toys.....	59
3.6 Summary	62
Chapter 4 : Medieval populations, burial practice and taphonomic bias	65
4.1 Introduction.....	65
4.2 Palaeodemography	65
4.2.1 Infant mortality.....	67
4.2.2 Historic evidence for demography	69
4.2.3 Family size and child mortality.....	71
4.3 Burial Practice	73
4.3.1 Burial location within the church or cemetery	74
4.3.2 Grave furnishing and goods	76
4.3.3 Body Positioning.....	79
4.4 Taphonomy	81
4.4.1 Preservation of infants and children.....	82
4.5 Summary	86
Chapter 5 : Childhood health and the interpretation of stress indicators	89
5.1 Introduction.....	89
5.2 The Dentition	91
5.2.1 Enamel Hypoplasia	91
5.2.2 Caries	95
5.2.3 Deciduous dental wear	96
5.3 Metabolic Disease	97
5.3.1 Cribra orbitalia and porotic hyperostosis	97

5.3.2 Transverse lines of arrested growth or Harris Lines	101
5.3.3 Scurvy	103
5.3.4 Rickets.....	103
5.4 Infectious Disease	105
5.4.1 Non-specific Infection.....	105
5.4.2 Endocranial Lesions.....	106
5.4.3 Tuberculosis	107
5.5 Summary	108
Chapter 6 : Sites and skeletal collections.....	111
6.1 Introduction	111
6.2 The Priory of St Peter and St Paul, Taunton, Somerset.	112
6.2.1 History of the priory.....	112
6.2.2 Socioeconomics of the town	116
6.2.3 Excavation in 2005.....	117
6.2.4 Discussion	121
6.3 The Priory of St Oswald, Gloucester	133
6.3.1 History of the priory.....	133
6.3.2 Socioeconomics of the town	135
6.3.3 Excavation methods	136
6.4 The Priory of St Gregory, Canterbury.....	139
6.4.1 History of the priory.....	139
6.4.2 Socioeconomics of the town	141
6.4.3 Excavation methods	141
6.5 Summary	147
Chapter 7 : Methodology	149
7.1 Burial inventory	149
7.2 Skeletal inventory.....	150

7.3 Dental inventory.....	151
7.3.1 Dental pathology and non-metric traits.....	152
7.4 Ageing.....	153
7.4.1 A Comparison of ageing methods.....	156
7.4.2 Intra and Inter Observer error tests	157
7.5 Dental wear	158
7.5.1 Intra and Inter Observer error tests	160
7.5.2 Dental wear stages.....	161
7.5.3 Permanent teeth dental wear	166
7.6 Metrical and Non-metrical data	167
7.6.1 Stature	169
7.7 Pathology.....	172
7.8 Data analysis	176
7.9 Questions and hypotheses	177
7.9.1 Demography.....	177
7.9.2 Funerary Context.....	180
7.9.3 Preservation.....	181
7.9.4 Dental Wear	183
7.9.5 Episodes of stress	184
7.9.6 Growth and development	185
7.10 Summary	187
Chapter 8 : Results	189
8.1 Demography.....	189
8.1.1 Taunton population	190
8.1.2 The Gloucester population.....	192
8.1.3 The Canterbury population	193
8.1.4 Sub-adult mortality: comparison of all sites	194

8.1.5 Infant mortality: comparison of all sites	197
8.1.6 Age range by location and proximity.....	198
8.2 Funerary Context.....	205
8.2.1 Taunton population	205
8.2.2 Comparison sites	212
8.3 Preservation.....	215
8.3.1 Taunton adults and sub-adults.....	215
8.3.2 All sites (sub-adults)	215
8.4 Dental wear	229
8.4.1 Taunton	229
8.4.2 Gloucester	230
8.4.3 Canterbury.....	231
8.4.4 All sites comparison.....	232
8.4.5 Dental wear by burial location	235
8.4.6 Dental wear and the potential for use in ageing sub-adult dentitions	236
8.5 Episodes of Stress	239
8.5.1 Cribra Orbitalia	239
8.5.2 Non-specific infection - periostitis.....	242
8.5.3 Endocranial lesions	247
8.5.4 Porotic hyperostosis	248
8.5.5 Enamel defects	249
8.5.6 Stress indicators compared with each other.....	252
8.5.7 Dental disease.....	253
8.6 Growth and Development	255
8.6.1 Long bone lengths.....	255
8.6.2 Stature	259
8.6.3 Burial location and stature	263

8.6.4 Stature and stress.....	264
8.6.5 Development	269
8.6.6 Non-metric traits	273
8.7 Other pathologies	277
8.7.1 Congenital conditions	277
8.7.2 Trauma	278
8.7.3 Long bone deformities (possible rickets).....	278
8.7.4 Possible cases of tuberculosis	279
8.7.5 Activity related lesions.....	282
8.8 Summary	283
Chapter 9 : Discussion	285
9.1 Introduction	285
9.2 Chapter Review	285
9.3 Interpretation of results	289
9.3.1 Demography	289
9.3.2 Funerary Context.....	295
9.3.3 Preservation.....	298
9.3.4 Dental Wear	301
9.3.5 Episodes of Stress	303
9.3.6 Growth and development	307
Chapter 10 : Conclusions	309
10.1 Research Aims	309
10.2 Summary of findings.....	310
10.3 Limitations	313
10.4 Future Research.....	314
References Cited	317
Appendices	Volume Two

List of figures

Figure 2.1: Development of a typical long bone.....	27
Figure 2.2: Fusion of the vertebrae over time.	29
Figure 2.3: Development of the tibia.	30
Figure 3.1: Memorial brass of John (died c. 1480) and Joan Jaye.....	48
Figure 3.2: Close-up of the children depicted on the brass of John and Joan Jaye.....	48
Figure 3.3: Fifteenth century tomb in the crypt of St John the Baptist, Bristol.....	49
Figure 3.4: Close up of the boys situated on the left base of the tomb.	49
Figure 3.5: Woodcut depicting the seven ages of man.	52
Figure 3.6: Kinderspiele – Children’s Games by Pieter Bruegel 1525-1569.	60
Figure 4.1: Burial of a shrouded body.	77
Figure 4.2: Sewing up the shroud.	78
Figure 4.3: A widow kneels in prayer whilst another woman sews the shroud.....	78
Figure 4.4: Crossed long bones over SK 851.....	79
Figure 4.5: Shrouded burial of SK 1646, aged ten years.	80
Figure 5.1: Enamel hypoplasia (EH) on SK 2028.....	92
Figure 5.2: Localised hypoplasia of the deciduous canine on SK 398.	92
Figure 6.1: Map of Taunton.	112
Figure 6.2: The site of Taunton Priory as seen in the nineteenth century.....	115
Figure 6.3: The priory barn, Taunton.....	115
Figure 6.4: Reconstruction drawing of the priory complex.	116
Figure 6.5: Excavation plan of the priory and cemetery of SS Peter and Paul, Taunton.	118
Figure 6.6: Map of Taunton, with excavation areas marked.....	122
Figure 6.7: SK327 needed to be removed to allow full excavation of SK320.....	123
Figure 6.8: Plan of sub-adult skeletons from area 1, Priory Avenue, Taunton.....	125
Figure 6.9: Plan of inhumations from area 2 and 5, Priory Avenue, Taunton.	126

Figure 6.10: Plan of all inhumations from area 3, Priory Avenue, Taunton.....	128
Figure 6.11: Plan of all inhumations from area 4, Priory Avenue Taunton.....	130
Figure 6.12: Plan of the Canon street excavations of 1977.....	132
Figure 6.13: The internal standing wall that remains of St Oswald's priory.	134
Figure 6.14: View of the external wall of St Oswald's priory.	134
Figure 6.15: John Speed's map of Gloucester, 1610.	135
Figure 6.16: Plan of the location of excavated trenches at St Oswald's priory.	138
Figure 6.17: John Speed's map of Canterbury.....	140
Figure 6.18: Plan of the cemetery area to the south of St Gregory's priory.	142
Figure 6.19: Modified plan of the south cemetery with sub-adults analysed shown....	144
Figure 6.20: Plan of the priory church and buildings.....	146
Figure 7.1: Dental wear stages.....	162
Figure 7.2: Dental wear stage 1 (molar 1) SK 104 Gloucester	163
Figure 7.3: Dental wear stage 2 (molar 1 and molar 2) SK 434 Gloucester.....	163
Figure 7.4: Dental wear stage 3 (molar 2) and stage 4 (molar 1) SK 914 Taunton.....	163
Figure 7.5: Dental wear stage 4 (molar 2) SK 1637 Taunton	164
Figure 7.6: Dental wear stage 5 (left) and 6 (right) (molar 2) SK 2023 Taunton	164
Figure 7.7: Dental wear stage 7 (molar 1 and 2) SK 118 Taunton	164
Figure 7.8: Dental wear stage 8 (molar 1 and 2) SK 349 Gloucester	165
Figure 7.9: Dental wear stage 9 (molar 2) and 8 (molar 1) SK 716 Canterbury.....	165
Figure 7.10: Renumbering of Brothwell's dental wear stages.....	166
Figure 7.11: Photographs of cribra orbitalia grades.....	173
Figure 7.12: Photographs of endocranial lesion grades.	174
Figure 7.13: Photographs of different levels of periostitis recorded.....	175
Figure 7.14: Logical data model.	176
Figure 8.1: Demographic profile of the Taunton population.	190
Figure 8.2: Excavations areas, children versus adults.....	191

Figure 8.3: Demography of the complete Taunton population, including 1977 data. ..	192
Figure 8.4: Demographic profile of the Gloucester population.	193
Figure 8.5: Demographic profile of the Canterbury population.	193
Figure 8.6: Sub adult mortality (Taunton).	195
Figure 8.7: Sub adult mortality (Gloucester).	195
Figure 8.8: Sub adult mortality (Canterbury).	195
Figure 8.9: Cumulative age distributions of the three sites.	196
Figure 8.10: Infant mortality (preterm and neonate burials).	197
Figure 8.11: All sites (location of age ranges).	202
Figure 8.12: All sites (proximity to church by age range).	203
Figure 8.13: SK 308 lower legs slightly flexed inwards (neonate).....	206
Figure 8.14: SK 2108 legs flexed to the right (9 months).....	206
Figure 8.15: Double burial of SK 2080 & SK 2089	209
Figure 8.16: Double burial of SK 1205 & SK 1206	209
Figure 8.17: SK914 child buried in nave, the white markers indicate coffin nails.....	210
Figure 8.18: Elements present, skull and axial.	219
Figure 8.19: Elements present, upper body.....	220
Figure 8.20: Elements present, lower body.....	221
Figure 8.21: Taunton age range preservation.....	223
Figure 8.22: Gloucester age range preservation.....	223
Figure 8.23: Canterbury age range preservation.....	223
Figure 8.24: Skeletal completeness by age range for Taunton	224
Figure 8.25: Skeletal completeness by age range for Gloucester	224
Figure 8.26: Skeletal completeness by age range for Canterbury.....	224
Figure 8.27: Taunton dental wear mean stages.....	230
Figure 8.28: Gloucester dental wear mean stages.....	231
Figure 8.29: Canterbury dental wear mean stages.	232

Figure 8.30: All sites dental wear mean stages.	234
Figure 8.31: Mean wear stages for each population (dm1).....	237
Figure 8.32: Mean wear stages for each population (dm2).....	238
Figure 8.33: Number of bones affected by periostitis across the skeleton (all sites)....	244
Figure 8.34: Femoral lengths plotted against age for each site.....	256
Figure 8.35: Tibia lengths plotted against age for each site.....	256
Figure 8.36: Humeral lengths plotted against age for each site.	257
Figure 8.37: Radius lengths plotted against age for each site.	257
Figure 8.38: Ulna lengths plotted against age for each site.	258
Figure 8.39: Fibula lengths plotted against age for each site.....	258
Figure 8.40: Stature plotted against age for each site.	260
Figure 8.41: Estimated stature for all sites.....	261
Figure 8.42: Medieval stature plotted in comparison to modern stature.....	262
Figure 8.43: Medieval stature plotted in comparison to modern stature.....	262
Figure 8.44: Estimated stature by age and stress indicators present.	264
Figure 8.45: Fusion of pars lateralis to squama of the occipital	269
Figure 8.46: Fusion of the pars basilaris	270
Figure 8.47: Fusion of the atlas.....	271
Figure 8.48: Fusion of the cervical vertebrae.....	272
Figure 8.49: Fusion of the thoracic vertebrae.	272
Figure 8.50: Fusion of the lumbar vertebrae.....	272
Figure 8.51: SK 2077 lytic lesion on parietal.	280
Figure 8.52: SK 2077 lesion on occipital.....	280
Figure 8.53: SK 2077 pathology on ribs.	281
Figure 8.54: SK 1620 lesion on frontal bone.	281

List of Tables

Table 3-1: Medieval stages of childhood.....	41
Table 3-2: Childhood stages in years used in different disciplines.....	44
Table 3-3: Percentage of accidents or deaths recorded for children, by age.....	59
Table 6-1: Number of burials for each site.	148
Table 7-1: Dental non-metrics recorded.	153
Table 7-2: Postcranial measurements taken for sub-adults.....	167
Table 7-3: Cranial measurements taken for infants and older sub-adults*.....	167
Table 7-4: Additional cranial measurements taken for older sub-adults.	168
Table 7-5: Mandibular measurements taken for older sub-adults.....	168
Table 7-6: Cranial non-metric traits.....	169
Table 7-7: Postcranial non-metric traits.....	169
Table 8-1: Number and percentage of individuals in each age range for all sites.	194
Table 8-2: Results for age range tested by site (Kolmogorov-Smirnov).	196
Table 8-3: Number of preterm/neonate individuals for each site	197
Table 8-4: Location and proximity data for the sub-adults and adults from Taunton. .	198
Table 8-5: Taunton ages by location.....	199
Table 8-6: Proximity to the church Taunton.....	199
Table 8-7: Gloucester ages by location.....	199
Table 8-8: Gloucester ages by proximity to the church.	200
Table 8-9: Canterbury ages by location.	200
Table 8-10: Proximity to church by age ranges.	201
Table 8-11: Location of age ranges.....	202
Table 8-12: Proximity of age ranges.....	202
Table 8-13: Mean ranks of the four locations.	203
Table 8-14: Mean ranks of the three proximity groups.....	204
Table 8-15: Body Position of Taunton sub-adults and adults.....	206

Table 8-16: Skull position of Taunton sub-adults and adults.	208
Table 8-17: Descriptive statistics of depth of burial for each skeleton.....	212
Table 8-18: Body position of Gloucester skeletons	213
Table 8-19: Skull position of Gloucester skeletons	213
Table 8-20: Preservation of Taunton individuals.....	215
Table 8-21: Completeness of Taunton individuals.	215
Table 8-22: Preservation.	216
Table 8-23: Completeness.....	216
Table 8-24: Surface erosion.	218
Table 8-25: Mean ranks for preservation by age range.....	222
Table 8-26: Kruskal Wallis mean ranks for all sites.....	225
Table 8-27: Preservation by burial location.....	226
Table 8-28: Preservation by proximity.	226
Table 8-29: Mean ranks for burial locations.	227
Table 8-30: Completeness by burial location.....	227
Table 8-31: Completeness by proximity to church.....	228
Table 8-32: Mean ranks of proximity to the church.	228
Table 8-33: dm1 all sites.....	233
Table 8-34: dm2 all sites.....	233
Table 8-35: Dental wear scores by age and burial location.	235
Table 8-36: Numbers of teeth scored by location and distance from the church.....	236
Table 8-37: Suggested dental wear stages for age.	238
Table 8-38: Cribra orbitalia presence in the Taunton population (by grade).....	240
Table 8-39: Cribra orbitalia presence on sub-adults by grade and site.....	240
Table 8-40: Cribra orbitalia presence by grade and location.	240
Table 8-41: Cribra orbitalia presence by grade and proximity.	240
Table 8-42: Cribra orbitalia presence by age and grade.	241

Table 8-43: Number of bones affected by periostitis.....	243
Table 8-44: Number of individuals with periostitis by location.	245
Table 8-45: Number of individuals with periostitis by proximity.	246
Table 8-46: Number of individuals with periostitis by age group.	246
Table 8-47: Endocranial lesions by site and grade.....	247
Table 8-48: Endocranial lesions by location and grade.	247
Table 8-49: Endocranial lesions by proximity and grade.	247
Table 8-50: Endocranial lesions by age and grade.....	248
Table 8-51: Porotic hyperostosis by site and grade.	248
Table 8-52: Porotic hyperostosis by location and grade.	248
Table 8-53: Porotic hyperostosis by proximity and grade.	249
Table 8-54: Porotic hyperostosis by age and grade.	249
Table 8-55: All enamel defects by number of teeth.....	250
Table 8-56: Enamel defects by number of teeth (clear defects only).	250
Table 8-57: Types of defects present on the deciduous teeth.	251
Table 8-58: Types of defects present on the permanent teeth.....	251
Table 8-59: Types of defects (clear only) present on permanent teeth.	251
Table 8-60: Enamel hypoplasia prevalence by individual and site.....	252
Table 8-61: Enamel hypoplasia prevalence by individual and location.	252
Table 8-62: Enamel hypoplasia prevalence by individual and proximity.....	252
Table 8-63: Caries rates by individual for each site.....	253
Table 8-64: Presence of caries by tooth for each site.....	254
Table 8-65: Position of caries by tooth (all sites).	255
Table 8-66: Significant values of age 7 and 8 years for stature by burial location.....	264
Table 8-67: Cranial non-metric traits (midline).....	273
Table 8-68: Cranial non-metric traits (sided).....	274
Table 8-69: Postcranial non-metric traits.....	275

Chapter 1 : Introduction

1.1 Aims

The aim of this thesis is to explore the status of children buried in three cemetery sites from the late medieval period (AD 1066-1539). Several strands of evidence need to be examined to enable a complete picture of how children lived in the period, and how they were treated by society after death. The main form of evidence to be explored is the skeletal remains of late medieval children. By analysing human remains we can gain information about individual children who lived and died in the past. When the information collected at a population level is collated these data can be analysed for trends, such as rates of growth, or the presence of disease in children of certain ages. When more than one population is studied similarities and differences between children from the separate sites can be determined. By looking at the skeletal remains in conjunction with the evidence for burial practice the different markers that may reflect status can be compared. Throughout this thesis several terms have been used by the author, and in reference to the work of other authors, such as, “infant”, “child”, “sub-adult”, and “non-adult”. The term “infant” is used for individuals under two years of age, before they have acquired the skills of walking and talking. The terms “child”, “sub-adult” and “non-adult” have been used in the context of this research to define any individual who is not yet biologically mature, and as discussed in Chapter Two has been taken to be those under 20 years of age (although the majority of the individuals analysed for this study are twelve years of less).

There are several research questions on which this study will focus, presented here under separate headings, each designed to try and determine if the status of children shows any causal relationship between the osteological analysis and the evidence for the funerary context, gleaned from the burial archaeology.

1.1.1 Demography

This section will explore the relationship between burial location and age of the individual to determine if any differences are seen between children and adults, or for differently aged children.

Question 1: Is there a difference between the distribution of sub-adult and adult burials by site?

H_0 : The number and distribution of sub-adult and adult individuals are equal across sites.

H_1 : The number and distribution of sub-adult and adult individuals are not equal across sites.

Question 2: Is there a difference between the distribution of sub-adult age ranges by site?

H_0 : The number and distribution of sub-adult age groups are equal across sites.

H_1 : The number and distribution of sub-adult age groups are not equal across sites.

Question 3: Is there a difference between the distribution of preterm and neonate burials by site?

H_0 : The number and distribution of preterm/neonate individuals are equal across sites.

H_1 : The number and distribution of preterm/neonate individuals are not equal across sites.

Question 4: Is there a difference between the distribution of sub-adult and adult burials by burial location?

H_0 : The number and distribution of sub-adult and adult individuals are equal by burial location.

H_1 : The number and distribution of sub-adult and adult individuals are not equal by burial location.

Question 5: Is there a difference between the distributions of sub-adult age ranges by burial location?

H_0 : The number and distribution of sub-adult age groups are equal by burial location.

H_1 : The number and distribution of sub-adult age groups are not equal by burial location.

1.1.2 Funerary context

The relationships between grave furnishings and inclusions, and method of placement of the body within the grave will be explored, in association with age of the child, and differences between adult and child burials will be considered.

Question 6: Is the placement of the body for burial similar for sub-adults and adults?

H_0 : There is no difference in the placement of the body for burial between sub-adults and adults.

H_1 : There is a difference in the placement of the body for burial between sub-adults and adults.

Question 7: Is the presence of evidence for coffins similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for coffins between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for coffins between sub-adults and adults.

Question 8: Is the presence of evidence for grave goods similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for grave goods between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for grave goods between sub-adults and adults.

Question 9: Does depth of burial differ for sub-adults and adults?

H_0 : There is no difference in the depth of burial between sub-adults and adults.

H_1 : There is a difference in the depth of burial between sub-adults and adults.

1.1.3 Preservation

The state of preservation of the skeletal remains will be explored to determine if age at death is a factor, both between adults and children, and between children of different age groups. Whether any difference is seen in preservation by burial location will also be considered.

Question 10: Is there a difference in preservation and completeness of the skeleton between sub-adult and adult skeletons?

H_0 : The preservation of the remains are equal for sub-adults and adults.

H_1 : The preservation of the remains are not equal for sub-adults and adults.

Question 11: Is there a difference in preservation and completeness of the skeleton by site?

H_0 : The preservation of the remains are equal across sites.

H_1 : The preservation of the remains are not equal across sites.

Question 12: Is there a difference in the percentage of elements recovered from each skeleton by site or burial location?

H_0 : The percentage of elements recovered are equal across sites, and by burial location.

H_1 : The percentage of elements recovered are not equal across sites, and by burial location.

Question 13: Is there a difference in surface erosion on the skeleton by site or burial location?

H_0 : The surface erosion recorded on each skeleton is equal across sites, and by burial location.

H_1 : The surface erosion recorded on each skeleton is not equal across sites, and by burial location.

Question 14: Is there a difference in preservation and completeness of the skeleton by age?

H_0 : The preservation of each skeleton is equal across age ranges.

H_1 : The preservation of each skeleton is not equal across age ranges.

Question 15: Is there a difference in preservation and completeness of the skeleton by burial location?

H_0 : The preservation of the remains are equal by burial location.

H_1 : The preservation of the remains are not equal by burial location.

1.1.4 Dental wear

Dental wear of the deciduous teeth will be analysed to see if any relationship is present between the rate of dental wear and the location of burial, as well as with a view to creating a standard that may be a useful aid in assigning age to the dentitions of young children.

Question 16: Is there a difference between dental wear scores recorded and burial location?

H_0 : The dental wear score of same age children is equal across burial locations.

H_1 : The dental wear score of same age children is not equal across burial locations.

Question 17: Is there a difference between dental wear scores recorded and site?

H_0 : The dental wear score of same age children is equal across sites.

H_1 : The dental wear score of same age children is not equal across sites.

1.1.5 Episodes of stress

The presence of stress indicators on the skeleton and their relationship to age or burial location will be explored, as well as any link between the different stress indicators.

Question 18: Is there a difference between the presence of stress indicators, or caries, between sub-adults and adults?

H_0 : The presence of stress indicators, or caries, recorded is equal between sub-adults and adults.

H_1 : The presence of stress indicators, or caries, recorded is not equal between sub-adults and adults.

Question 19: Is there a difference between the presence of stress indicators recorded by site?

H_0 : The presence of stress indicators recorded is equal across sites.

H_1 : The presence of stress indicators recorded is not equal across sites.

Question 20: Is there a difference between the presence of stress indicators recorded by burial location?

H_0 : The presence of stress indicators recorded is equal by burial location.

H_1 : The presence of stress indicators recorded is not equal by burial location.

Question 21: Is there a difference between the presence of stress indicators recorded by sub-adult age grouping?

H_0 : The presence of stress indicators recorded is equal by age group.

H_1 : The presence of stress indicators recorded is not equal by age group.

Question 22: Is there any relationship between the presence of two different stress indicators?

H_0 : There is no relationship between the presence of two different stress indicators.

H_1 : There is a relationship between the presence of two different stress indicators.

1.1.6 Growth and development

This section will explore if similar bone lengths, and stature, are seen for individuals of the same age from the different burial locations, and whether the presence of stress indicators has any effect on long bone length or stature. Information gathered on fusion times for the individual elements of the skull and vertebrae, and the presence of non-metric (epigenetic) traits, which may inform us of the developmental timings of these different traits, will also be explored.

Question 23: Do the remains of similar age individuals from the three different sites have a similar stature?

H_0 : There is no difference between stature for similar age individuals for the three sites.

H_1 : There is a difference between stature for similar age individuals for the three sites.

Question 24: Does burial location have any effect on stature in similar age individuals?

H_0 : There is no difference between stature for similar age individuals and burial location.

H_1 : There is a difference between stature for similar age individuals and burial location.

Question 25: Does the presence of stress indicators have any effect on stature in similar age individuals?

H_0 : There is no difference between the presence of stress indicators and stature for similar age individuals.

H_1 : There is a difference between the presence of stress indicators and stature for similar age individuals.

Each specific question is outlined again in Chapter Seven, section 7.9, alongside a review of the statistical tests employed.

1.2 Interpretation of status and stress

The status of children can be defined in three different ways; the social status of children in general within a society, the status they achieve through the wealth or standing of their parents (or possibly themselves if they are workers), and their health status, which we can attribute to them from the analysis of their skeletal remains. Firstly, to determine the general status of children within society, evidence for burial practice will be used, including both location of burial within a burial ground, positioning of the body, and any grave furnishings or inclusions present. This evidence indicates how children were prepared for burial and will specifically relate to the worth of the children as seen by their parents (who probably would have prepared them for burial), and by the Church (who would have decided how and where they may be buried) (Gilchrist & Sloane 2005). Their status within society may have been partly dictated by what they could contribute and therefore possibly be determined by their age. Looking for patterning according to age group individuals in burial grounds may suggest a change in status as children progress on their way towards adulthood. Secondly, status can be defined for individual children by the material wealth of the

child, or more specifically their parents or guardians. This may be reflected in burial practice by enabling the purchase of a more favoured burial spot, or the presence of grave furnishings, such as coffins, or other inclusions.

Thirdly, and perhaps most importantly to the osteoarchaeologist, is the child's health status which can be defined through evidence from their skeletal remains for episodes of stress or disease from which they had suffered during life. Stress in a medical context is defined as '*an organism's total response to environmental demands or pressures*' (Farlex 2011). For the purpose of this thesis "stress" is defined by Buikstra and Cook (1980, 444) as '*any extrinsic variable or combination of variables which causes the organism to react. Reaction is mediated by the physiological state of the individual and can be completely buffered, leaving no osseous record*'. Selye invented the idea of the "stress concept" and he defined stress as '*the non-specific response of the body to any demand*' (Selye 1956, 55). This concept stated that whatever agent affects the body, such as bacteria or a lack of food, will have its own characteristics, but it will also cause stress which is a non-specific demand for adaptation (Selye 1976, 54). He noted three phases of response in relation to stress: the alarm reaction, the stage of resistance, and the stage of exhaustion (Selye 1956, 38). Therefore, evidence of stress to the developing child will show, in some cases, as diagnostic markers on the skeleton. These markers are commonly termed "stress indicators" and appear on the skeleton due to the ability of an individual to recover from the causal insult (Bush 1991, 11).

Both cultural and biological (skeletal) evidence can inform us about the status of children in the past; they are intrinsically linked and need to be studied in juxtaposition. This type of investigation which integrates the archaeological evidence with the interpretation of disease processes in the skeleton is termed a "biocultural" approach (Buikstra & Cook 1980, 443), and rather than focusing on the individual the aim is to elucidate information at the population level (Bush & Zvelebil 1991, 4). The biological evidence, as assessed by osteological study, will inform us about each individual from the population under study. The evidence that can be derived from the skeletons of deceased children such as age at death, growth, development and health provides primary data for each member of the population. The cultural evidence provides information about the identity of the individual within the group or culture to which they belong, and therefore gives evidence about the type of environment in which they

lived and the social status that was conferred on them by the group. The information derived from the method of burial, including grave construction and location, placement of the body within the grave, and the presence of any inclusions such as grave goods or linings, will reflect cultural practices within the child's community.

This focus on health, growth and status among sub-adults in the late medieval period is a neglected topic with only a few osteological papers published, mainly on skeletal samples from the north of England (Grauer 1991; 1993; Lewis 2002a; 2002b; Mays 1995; 2003; 2007). In the south-west of England no research has been performed in this area, whilst little research has been carried out on sub-adult remains from the south of England (Ribot & Roberts 1996; Lewis 2008). This thesis aims to address this, as well as adopting a fully-integrated approach in which the osteological and archaeological data are treated as mutually dependent; a perspective which appears to be lacking in previous studies.

Although both the osteological and archaeological data are important in establishing a more complete narrative on the individual children discovered in archaeological contexts, it is often the case, in both archaeological site monographs and academic research, that these two types of evidence tend to be studied by different specialists. Burial archaeologists tend to interpret burial archaeology, whilst osteoarchaeologists analyse human skeletal remains. This research will focus on both of these aspects with the aim of gaining information on both the health and developmental status of the late medieval children analysed, as well as information on the status they were afforded in death, from the archaeological evidence for burial practice. This will enable a fuller understanding on how these different aspects of status can be linked and what implications they may have had for the life of a child living in late medieval England.

Information will be recorded from each individual skeleton to determine their age at death, stage of development, rate of growth, and evidence for any pathology and correlate this with information recovered on excavation about the burial practices afforded to each child. It is hoped that these data will provide results that can support interpretations of the status of children in the late medieval period. A new method for recording deciduous dental wear will be presented in Chapter Seven. This was devised because there appears to be no standard method for collecting information on the dental wear of young children and, as dental wear is related to diet (Powell 1985), it was felt

that this may also provide information on the status of the children analysed. The collection of these data also led the author to test if there was any relationship with dental wear scores and age, with a view to determine if the recording of deciduous wear may aid with ageing the dentitions of young children.

1.3 Skeletal collections analysed

The data used for this thesis derives from excavations carried out on three priory church and cemetery sites from the south of England. The main skeletal collection used for this analysis came from the excavation of the cemetery of the priory of St Peter and St Paul, Taunton, Somerset. The author was present as a member of the team that conducted the excavation, which took place over six months in 2005 under the direction of Context One Archaeological Services. The skeletons of both the sub-adults and adults have been analysed and number ninety-three and ninety-seven individuals respectively. Comparative data for the sub-adult population was collected from two other cemetery sites; the remains of sixty-five children from the cemetery of the priory of St Oswald, Gloucester, and one hundred and four sub-adults from the priory of St Gregory, Canterbury. Throughout this thesis the skeletons will be referred to as coming from Taunton, Gloucester or Canterbury.

1.4 Thesis structure

Chapter Two will explore the definition of the term “child” and will discuss this in terms of cultural and biological concepts. The past invisibility of children within archaeological research will be discussed, and some of the work that has focused on addressing this imbalance will be reviewed. How children at different stages of childhood are viewed in the modern world, both within western culture and more traditional cultures, will be reviewed. This chapter will also outline the process of growth and development across the human skeleton and how this can aid with ageing skeletal remains and in determining whether children are developing at a different rate than modern norms.

Chapter Three will focus on the evidence for the life and status of the child within late medieval English society. The late medieval period has a wealth of historical records that can be explored for information on children. Research by historians will be reviewed to determine the ideas present within medieval society relating to the concept of childhood and how children were viewed in the period. These will include a review

of the stages that were assigned to childhood in the period by doctors and philosophers. Representations of children on burial monuments and other mediums will be discussed, and historical accounts of disease and accidental deaths involving children will be reviewed. The recovery of artefacts and excavated features thought to be associated with children playing will also be mentioned.

Chapter Four will look at how we can reconstruct demographic profiles for populations from their remains excavated from cemeteries, along with a discussion of demographic data from the late medieval period researched by historians. Burial practice within the late medieval period will be discussed, in relation to children, to determine any patterns that are apparent from the many archaeological excavation reports that are available. Taphonomic processes, both natural and cultural, which can affect the recovery of human remains, will be discussed as well as the possibility of specific causes of child deaths, such as infanticide.

Chapter Five will focus on the description and interpretations of the different skeletal and dental lesions which are indicative of stress in the growing child, as well as some diseases from which children would have suffered which can be recognised from their skeletal remains. Previous osteoarchaeological studies of these indicators will also be reviewed.

Information about the three sites, from which the collections of skeletal remains analysed for this study were excavated, will be detailed in **Chapter Six**. This will include information on the history of the three priory sites, the socio-economic status of the towns, and details on how the excavations were carried out. Plans of the sites will be included along with the numbers of skeletons excavated from each site and the location of trenches.

The methods chosen for the osteological analysis of the human remains will be discussed in **Chapter Seven**, alongside explanations as to why certain methods have been selected, and how these were used to interpret the data collected. The method for recording dental wear was devised by the author specifically for recording wear on the deciduous teeth of these collections, but also with a view to creating a method for other researchers to use in the future; this will be discussed in detail. This chapter will also include a section on how the data was stored by the creation of a database, and how it

was explored during the analysis. The final section of this chapter will define each of the research questions to be asked of the data, alongside a review of the statistical tests that were chosen.

Chapter Eight will present the results, structured to match the hypotheses defined as individual questions presented in Chapter Seven. These results are presented under the following headings as defined above: Demography, Funerary context, Preservation, Dental wear, Episodes of stress, Growth and development, and Other pathologies.

Chapter Nine will consist of a discussion of these results and how they can inform us about the lives of children in the late medieval period. The data on growth, stress, dental wear, and burial practice will be compared to see how each dataset relates to the other. Interpretations of the data will be given with the aim of answering the questions posed in Chapter Seven. A final summary and conclusions will be drawn together in **Chapter Ten** along with a note on the limitations of this research and recommendations for further research.

To summarise, the aim of this research is to shed new light onto the lives of children in the late medieval period by exploring the cultural and biological evidence for the status of children within medieval society. The cultural evidence will help to answer the question of how children were treated in death, by their families and the church, by exploring the burial rites afforded to them. The biological evidence will be used when analysing their remains for evidence of stress and disease that they would have suffered from in life. It is the comparison of these two types of evidence that the author hopes will lead to new interpretations of the status of children within medieval society.

Chapter 2 : Defining the child: a biocultural approach

'Exploring the complex conundrum of the relationship between culture and biology lies at the heart of the study of children' (Sofaer Derevenski 2000, 9).

2.1 Introduction

Archaeology can provide us with primary evidence about how children were treated after death as well as enabling the study of the physical remains of these children. This involves two different concepts of a child, biological and cultural. While osteological analysis can inform us about biological concepts such as age, growth, development and health, archaeological evidence, from the act of burial, will inform us about cultural concepts. Biological definitions of a child may be seen as fixed, as all humans that develop from infancy to adulthood follow the same process. Although this is in many ways true, it needs to be taken into account that females and males will develop in slightly different ways and at different rates (Hughes 1998), and as all humans are individuals, variations in timing of biological events within the sexes will also be present (Scheuer & Black 2000a). In contrast, cultural definitions may vary widely depending on the prominent vision of childhood and the worth of children within specific societies.

Another aspect of defining the child (as discussed in the Introduction to this thesis) is by looking at their status, both in terms of social status within the group as children, and by the status they receive through the wealth or social standing of their parents or family members; these forms of status are linked to cultural evidence. Defined by the biological evidence is the child's health status and this will be determined by analysis of the evidence on their skeletal remains for episodes of stress or disease from which they had suffered during life.

This chapter will introduce some of the theoretical background to the archaeology of children and childhood, as well as discussing how previous studies of children have been approached. Biological and cultural definitions of a child will be discussed by exploring the question of what is a child, how many stages are there on the journey to adulthood, and when in their life does the child make the transformation into an adult? It is clear that biology will dictate some of the ways in which children are cared for and conceptualised, but each society will have its own culturally constructed notions of childhood and parent-child relationships.

2.2 Addressing the “invisibility” of children in archaeology

‘The child cannot be imagined except in relation to a conception of the adult, but essentially it becomes impossible to generate a well-defined sense of the adult, and indeed adult society, without first positing the child’ Jenks (1996, 3).

Children form a significant proportion of the population of all societies, both those from the past and from the present. Modern population statistics indicate that in the industrialised world the population of children is around 22-30% of the total population whereas in Africa it is nearer 40-45% (under 15 years) (Department of Economic and Social Affairs 2007). In spite of this, and the fact that all adult individuals were once children, their presence has often been neglected in archaeological studies. Partly this is due to the fact that when we are dealing with material culture we cannot tell whether it was children or adults who used or even made the objects. In landscape studies it may be assumed that it was adults that decided how and where to build houses and religious monuments, or where to grow crops but this may not always be the case; we only need to look to modern Africa to see children living independently and working as providers, as well as bringing up their younger siblings, after the death of their parents, often associated with the spread of HIV. Even in societies where children may not have created landscapes, they would have lived in them and possibly viewed them in a different way to adults.

Without doubt the major obstacle to an archaeology which includes children was the androcentric view that dominated the discipline for so long. Feminist theories grew up in the 1960’s and 1970’s with the aim of reforming society as a whole from its biases against women. These theories were being explored in the social sciences, history and anthropology by the 1970’s but lagged behind as a new theoretical approach within the discipline of archaeology (Conkey & Spector 1998). This lag was due to the theoretical climate of the discipline at the time. Both the culture history approach (popular until the 1960’s and beyond), and the “new archaeology” of the 1960’s and 1970’s, had little interest in the actual people of the past. The former was concerned with artefacts and typologies and explanations of change due to diffusion. The latter was interested in the structures of different cultures, primarily with regard to long term processes and general laws or how different processes acting within societies could lead to changes observed in the archaeological record. Therefore, in both approaches people as individual agents seemed to be excluded. In the 1980’s a backlash against the “new archaeology” came in

the form of postprocessual theories. This created new interest in cognitive and symbolic aspects of societies and became a search for real people in the past and not just general processes. Here was the opening that was needed for feminist theories and archaeologies of gender to make an appearance on the scene. Feminist theories showed that gender is an important factor in understanding the dynamics of societies and have found some acceptance within the framework of postprocessual theory (Hodder, 1991: 168-172). There is a difference in how the terms sex and gender are defined. The sex of a person is determined biologically by observing the physical differences between females and males. Gender is a cultural construction and defines aspects of feminine or masculine traits as perceived by society (Sofaer Derevenski 1997, 192), therefore it is possible for an individual of the male biological sex to be gendered female. The exposure of androcentric biases that were inherent in most archaeological writings also led to the realisation of other biases within the discipline including race, where the current 'histories' and beliefs of indigenous populations, such as in the Americas, were overlooked in archaeological interpretations (Spector 1991, 361), and age, where the agents of the past were always assumed to be adult (Scott 1997).

Exploring the role of children and their visibility within the archaeological record has recently become recognised as an important area of research due to the emphasis that feminist theory had in creating "gender archaeology". In the past children have often only been referred to in archaeology in relation to women and domesticity, but children are worthy of study in their own right as a major part of society, both as dependents and contributors to their communities (Levison 2000). Our views about children in our own culture, and how we experienced our own personal childhood, will obviously bias our opinion about what it means to be a child today or in the very recent past. We need to become aware that, for other cultures both today and in the past, the experience of childhood will be very different, as will the attitudes of the adults within those societies to their children. Of course it is also fundamental that children (if they survive) will become the future adults in society and therefore either perpetuate or change the views inherent within their society. How a child is brought up and nurtured and what they are taught will be reflected in the adult that they become.

Although gender archaeologies became popular and widespread, a lack of focus has tended to be seen regarding archaeologies of children. Sofaer Derevenski (1997) cites

two main reasons for this, the first being the under-representation of children within cemeteries, (which will be discussed in Chapter Four), and the second being our assumption that children are dependent on adults and therefore non-contributors to society. However the contribution made to the community in economic terms is only one form of status. In some societies, such as those of the !Kung San, children are held in high regard by their community, yet they are not expected to contribute economically until they reach near adult status (Draper 1976; Lee 1979). Several authors have tried to address this lack of focus on the study of archaeologies of children by offering suggestions about how children can be “found”, and their lives explored, by archaeologists working in all periods and on all different types of sites (Scott 1999; Baxter 2005; Wileman 2005).

2.2.1 Previous research on child burial and the exploration of status

In the 1990's researchers in Britain began to explore the status of children through burial practice. This focus was mainly on the early medieval or Anglo-Saxon period (AD 410-1066) where the presence of grave goods, as forms of material wealth, were used to directly infer status (Crawford 1993; 1999; Stoodley 1999; 2000). This period was undoubtedly a popular starting point as fairly large cemeteries had been excavated and a high proportion of those buried, including children, had some form of burial artefacts. Both Crawford (1993; 1999) and Stoodley (1999; 2000) used the human remains reports to provide them with the age at death for each skeleton. Inferences about the gender and status of the children of different ages were determined by the artefacts present within their graves; it is not yet possible from routine macroscopic study of human remains to accurately determine biological sex in children (Scheuer & Black 2000b, 15). Stoodley (2000) equated these with the acquisition of more goods as individuals grew older.

Gowland (2006) has more recently revisited five skeletal collections from Anglo-Saxon cemeteries using a “life course” approach. Infants before the age of four years had few grave goods present, whilst for females a marked increase in goods occurred from the age of eight, with all burials of females aged as thirteen years or older containing adult grave assemblages. These findings confirmed that grave goods changed in both style and number as individuals grew older, with the association of adult styles of grave goods uncommon for females until they had reached at least eight years of age. A complete absence of saucer brooches was noted before the age of eighteen years which

may signify marital status (Gowland 2006, 148). For males whilst some young individuals were buried with spearheads, shields were only associated with individuals from sixteen years of age, and swords from eighteen (*ibid.* 151).

Published research on child burial in the Roman period (AD 43-410) in England includes Gowland's (2001) study on the number and type of grave goods present in Lankhills cemetery, Scott's (1991) study of infant burials in the Roman period, and Mays' (1993; 2000) research into whether the evidence for these infant burials suggests infanticide. Gowland (2001, 158) found that although fewer children were buried with grave goods than adults, they had a higher proportion of the overall quantity of artefacts. A peak in the average quantity of grave goods was seen during the ages of eight and twelve years of age (Gowland 2001, 159) rather than an increase in goods with age. Scott (1991) looked at the evidence for newborn infants being found buried within settlement areas, such as under the floors of houses or farm buildings, rather than in cemeteries. Mays (1993) explored the osteological evidence for age at death of these children and decided that the peak age at death, of full term infants, indicated that infanticide was practiced. However, care must be taken when interpreting high numbers of burials of new born infants as infanticide, because selective burial practice of infants who died naturally at birth may be a factor.

These examples look at different types of status afforded to children by society; in terms of burial wealth associated with the age of the child, and in terms of infanticide and differential burial treatment of infants (of possibly not yet full human status). Within the late medieval period, for the majority of the population, burials would not have included grave goods designed to symbolise wealth or goods required for a journey to the afterlife, as seen in the Roman and early medieval (Anglo-Saxon) periods. For members of the Christian church possessions were not needed in the afterlife (Daniell 1997, 150) and all were supposed to be equal in the eyes of God. However, it may be possible to infer wealth status by more subtle means such as burial location within a cemetery or church and the inclusion of grave fittings other than personal possessions or ornaments. The section on late medieval burial practice in Chapter Four will discuss this theme further. It is also possible to examine differential burial treatment for infants and children which may imply that the age of a person reflected how they were viewed by society. The Christian church dictates that all Christians, whatever age, should receive

burial within consecrated ground and therefore all members of these communities should be present in the burial record, with the possible exception of unbaptised infants, people who committed suicide and the excommunicated (Orme 2001, 118).

None of the studies mentioned above have looked at the dual aspects of the cultural evidence for social status alongside the biological evidence for health status. One of the initial studies that attempted to look at the biological evidence for episodes of stress to the growing skeleton, and relate this to changes in population status over time focused on prehistoric American populations (Goodman *et al.* 1984a). This study looked at both adults and sub-adults from the populations (AD 950-1300) buried at Dickson Mounds, Illinois. An increase in the prevalence rates of stress indicators (cribra orbitalia, enamel hypoplasia, and non-specific infection) was observed over time, relating to the shift from a hunter-gatherer subsistence strategy to an agricultural one.

A further study by Robb *et al.* (2001), on an Italian population from the seventh-third centuries BC, focused on the relationship of stress indicators and stature, as well as activity related lesions, to see if any groupings in the cemetery would become clear suggesting higher or lower status groups. They chose to only look at the adults of the population for this study, although a good number of sub-adult remains were present. They found no link between location of burial and stress indicators or stature, but did distinguish a group of men with activity related lesions which they interpreted as a division of labour within the population. Another study, which analysed the burial archaeology, in relation to the osteological analysis is that of Pechenkina & Delgado (2006); they chose to look at only the adult population¹ from a prehistoric cemetery in Peru. They concluded that the cemetery was used by two different social groups, recognised by differences in cranial deformity, and skeletal markers of stress. One study that does focus on children and status is that of Bennike *et al.* (2005), which compared Danish sub-adult skeletons from the medieval period from two sites, one associated with a low status group and the other a privileged one. They found a higher prevalence of stress indicators in the lower status group.

¹ they state this was due to inferior preservation of sub-adult remains (Pechenkina & Delgado 2006, 221).

A very recent study (Craig & Buckberry 2010) on the late Anglo-Saxon cemetery at Raunds Furnells, Northamptonshire, has integrated the approach of looking at the funerary context alongside the osteological evidence for skeletal markers of episodes of stress and disease; it involved the analysis of both the adults and sub-adults. Craig & Buckberry (2010) concluded that the south-east area of the cemetery was of lower status, both in terms of grave furnishings and in a higher presence of stress indicators recorded.

2.3 Cultural concepts of the child

Before embarking on a study of children questions have to be asked about how to define “child” and “childhood”. The Oxford Dictionary defines the word “child” as *‘a young human being below the age of puberty or below the legal age of majority’* (OD 2010). Definitions in the Oxford English Dictionary from the medieval world refer to the “child” as *‘the unborn or newly born human being’* (OED c950), indicating a change in the meaning of the word from this time, and one that still resides in words such as “child-birth” and “to be with child”. The word child can, however, have different meanings to different cultures today. A child may be an individual who is not yet fully adult, or alternatively a child may be defined as belonging to a specific age group, an individual older than an infant but not yet a “teenager” or adolescent. Using the terminology of “child” for all non-adult individuals may be misleading as a “child” of three years will have very different experiences and have a different role in society than a child of twelve years. “Childhood” is defined by the Oxford Dictionary (2010) as *‘the state of period of being a child’*. However, “childhood” is something that is associated with, but fundamentally different to the term “child”; it is seen as a social construction and can never be entirely separated from other variables such as class or gender (James & Prout 1997, 3). Therefore “childhood” is something that will vary dramatically depending on the society in which a child lives and the other definitions that are associated with them, such as class and gender. Jenks (1996, 9) refers to *‘childhood as a stage, a structured process of becoming’*. It is the adult world that is seen as complete and adulthood the desired stage to be attained.

In modern western culture childhood is thought of as a time of play and learning, with few responsibilities. However, not all children will experience such a childhood. In some cultures, both present and in the past, childhood may not have lasted for long, with children having to work and take on adult responsibilities at a young age.

Conversely in modern western culture "childhood" may be prolonged for certain individuals who are maintained by their parents after they have reached the age of adulthood. If these individuals have no responsibilities and still maintain a lifestyle of leisure, they may in some way still be experiencing "childhood".

All societies have to invest economically and emotionally in their children, otherwise those societies would not survive. Without the nurturing of infants by their mothers, they would probably die, and toddlers would find themselves at risk if they are not closely supervised. Each society will have its own specific concept of the stages from birth to adulthood, and each society will also have its own ways of raising children depending on its culturally constructed notions of parent child relationships.

Children are seen as dependent on their parents and other adults to protect and instruct them but they do not seem to have the right to social or personal autonomy (Sofaer Derevenski 2000, 5). To be a child outside supervision is to be a '*child out of place*' (Connolly & Ennew 1996). We see this today with gangs of youths where the media seem to portray them as getting younger and younger, causing trouble, or in some cases serious violence, and leaving their communities in fear to walk the streets. These are out of place children that no one is prepared to supervise or guide. If these children are living outside of society and are not seen as part of a community then they only have their own rules to follow. From accounts from children themselves, if they are removed from all the things that define childhood in their society they no longer view themselves as children (Sofaer Derevenski 2000, 5). This suggests that children and childhood are different concepts that are not mutually exclusive.

Levine & New (2008) suggest that any cross-cultural framework for anthropological studies on children need to rely on several basic assumptions;

- that every human society recognises a distinction between children and adults and the link between age and certain developments,
- schooling for the majority of children is a recent twentieth century development and therefore most children in the past would have spent more of their time participating in domestic tasks and economic activities,
- childhood environments vary across human societies in material, social, and cultural dimensions,

- the ideas and actions of parents will be strongly influenced by culturally specific norms,
- children are not passive receivers of cultural practices but can be active in social interactions and cultural learning.

To establish a relationship between status and childhood we first have to approach the question of who to include within the definition of the word “child”. The United Nations Convention on the Rights of the Child (1989) states that ‘*for the purposes of the convention a child means every human below the age of eighteen years*’. However, a caveat is inserted ‘*unless under the law applicable to the child, majority is attained earlier*’. This implies that different countries and cultures around the world will have a different age when their children become adults. In modern Britain we tend to think of people as children until they have reached the age when they leave school, at sixteen or eighteen. This group termed children is therefore obviously of a diverse range of individuals at very differing stages in their lives. “Child” and “adult” are not symmetrical dichotomies but may consist of many different life stages or thresholds in both groups.

Not all cultures will have a clear distinction between adult and child. Within Inuit culture the individual is both child and adult at the same time (Park 1998; Brody 2001). Brody (2001) explains how a new baby will have an *atiq*, which is the spirit of an ancestor after whom the child is named. He gives the example of a new baby girl who is both called “daughter” and “mother” by her mother as she has the *atiq* of her dead grandmother. Her grandfather who is still alive calls the child both “granddaughter” and “wife”. This belief that the spirit of an ancestor resides within the child means that they are doubly loved and must be treated with respect (Brody 2001, 12). The material culture of children in these communities is also shown to reflect the view that they are miniature adults (Park 1998, 280). Many of the “toys” used and games played by Inuit children involve either miniature versions of adult material culture, or the copying through play of adult tasks, such as house building, cooking, and hunting (Park 1998).

In Meads research, originally published in 1928, she referred to the Samoan culture of Polynesia as having the attitude of children as “little adults” but noticed that the types of role play toys such as dolls, household implements and toy boats were missing. Real

babies were carried around by young children, they helped for real in the home, and if boys wanted to “play boats” they used the real thing (Mead 2008, 23). She did however observe that they often played ball games, making flower necklaces and improvising songs. In this culture the smallest toddler performed tasks such as carrying water, and at about six years of age, until their late teens, the child would become a member of the children’s world and join the groups of boys working the fields and tending cattle, or of girls working on more domestic tasks (Mead 2008, 26).

2.3.1 Childhood Stages

In Chapter Three the concept of a child in the late medieval period will be discussed along with reference to the stages of childhood written about in documents and writings of the time. As mentioned earlier, it can be difficult to define exactly who we are referring to when we use the term child. A very young child, say of three years, will have a different role and social status in society than one of around twelve years of age. For the statistical analysis of skeletal remains it is convenient to place each individual recorded into an age group, but how to determine which ages should be grouped together is not something that has been standardised across archaeological reports or research articles (see Appendix A). This section will therefore explore some of the tasks and responsibilities that children of different ages are given both in the modern west and in some cross cultural examples from the anthropological literature.

2.3.1.1 Anthropological examples of childhood stages

Age categories, like gender, are culturally variable although they are closely linked to physiological development (Sofaer 2006, 119). We may therefore expect that different cultures will have differing terms for, and possibly attitudes to, children at certain chronological ages. In the first few years of life infants need to rely on their mothers, especially in cultures where breastfeeding is still the only adequate source of nutrition. In the United Kingdom recommended guidelines for the breastfeeding of infants suggest they should be exclusively breastfed until six months of age (Department of Health 2008). Although breastfeeding of infants is steadily becoming more popular in the United Kingdom, with a plethora of infant formulas to choose from, and many mothers having to return to work whilst their infants are still young, longer periods of breastfeeding are less likely to be practiced. In contrast, within some hunter-gatherer societies, such as the !Kung of the Kalahari, infants are rarely separated from their

mothers during the first few years of life (Lee 1979, 310), and breastfeeding usually only stops due to the mother falling pregnant, birth spacing averaging 3.8 years in !Kung populations (Draper 1976, 215). Cross cultural studies have shown that infants who live in nuclear households tend to be weaned at an earlier age (median 2 years) than those from extended or mother-child households (Werner 1979, 276). The first stage of infancy is then related to breastfeeding and it is roughly with this cessation of breastfeeding and the completion of the deciduous dentition that the infant moves to the next stage of life.

In Europe the start of formal education (school) begins between the ages of four² and seven³, involving the beginning of a life of learning away from the home, and social interactions with a wider group of both children and adults. However, as many mothers now tend to work, the age when children are left in the care of an adult which is not their parent is becoming progressively younger, and many small children spend much of their day in nurseries, possibly making the transition to full-time education less of a threshold. Among the Ngoni of Malawi in Central Africa the social status of children was perceived to progress when they shed their first teeth (Rogoff *et al.* 2008, 251). They were also regarded as ready for a new kind of life around seven years of age which coincided with the eruption of their second teeth (*ibid.*); this was when childish games ceased and “training” in tasks required for the adult world began.

Cross-cultural studies have shown that, from around the ages of five to seven years, children begin to assume new social roles and that sex differentiation in chores and social relationships become formalised: where school is not the norm girls tend to be introduced to work roles earlier than boys (Werner 1979, 278). Rogoff *et al.* (2008) explored data from thirteen different cultures. They found a shift in responsibilities appearing between the ages of five and seven years in sixteen of twenty-seven categories of tasks. It therefore appears that it is common in varying cultures to assign more responsibility, such as childcare, tending animals, and household chores, to a child once they have reached the age of between five and seven years old. The Ijaw in the Niger Delta of Africa believe children reach the age of knowing right from wrong at

² United Kingdom

³ Sweden, Denmark, and Poland among others

around five years of age, whilst the pre-five year old is believed to be on the border between the worlds of the living and the dead (Rogoff *et al.* 2008, 252). This evidence does suggest a change seen in the capacity of the child to learn and carry out tasks from around the age of five to seven years.

The Ijaw view the period from five to eight years of age as a time of transition until the age of responsibility at nine years (Rogoff *et al.* 2008, 252), and during this time the sexes would be segregated with the girls working with their mothers, and the boys farming or hunting with the men. Research on children from the Giriama people of Kenya indicates the percentage of time spent in work is not very high until they reach the eight to eleven year age category (38%), although it is higher for girls on average than boys (Wenger 2008, 295).

In the western world a major change coincides with the move to senior or high school at eleven or twelve years of age, often coinciding with more independence. In hunter-gatherer societies at the age of adolescence individuals still do not appear to have acquired full adult status. Lee (1979) records two fourteen year old girls being involved in gathering mongongos for a total of seven out of forty-seven days, during the time they were observed; '*The rest of the children were footloose and fancy-free*' (Lee 1979, 265). Draper (1976, 210) also records fourteen years of age as the time when girls begin to gather food, wood, and water as part of their work routine. Learning to hunt begins as young as three but only as a play activity in which both boys and girls are involved. Formal training for males starts around the age of twelve when a boy will begin to accompany his father or other relatives on hunts (Lee 1979, 236).

In biological terms puberty is seen as a brief stage (Bogin 2001, 66) but, once it is passed, adolescents do not necessarily acquire a new or adult status. In Britain it is not until the completion of compulsory schooling at around sixteen years of age that the legal step into adulthood begins. At sixteen years of age individuals become legally able to participate in certain activities, including sexual relationships and marriage (although only with consent of their parents in England in the case of the latter). In England it is not until eighteen years of age that people are seen as truly independent; the age of majority (HMRC 2011). At this age they no longer need parental consent for marriage, they can vote in elections, purchase alcohol and gain a drivers licence (currently available at seventeen years although there are discussions underway to raise the age to

eighteen). However, although in British society adult status is not conferred until an individual reaches their eighteenth birthday, children are responsible under the law from the age of ten years, when they can be charged with a criminal offence (DirectGov 2011). Other cultures around the world, and also in the past, undoubtedly would have associated maturity with an earlier milestone than a set chronological age, as in Britain. This could be associated with cognitive or physical development, ensuring that individuals could carry out the necessary tasks and roles associated with adulthood or possibly something more associated with the step into adulthood, such as sexual maturity.

The data analysed by Rogoff *et al.* (2008) indicated a shift around puberty for only four out of twenty-seven variables. These were associated with sexual attractiveness, initiation ceremonies, and wearing of adult modes of dress (Rogoff *et al.*, 2008, 262). In !Kung society the onset of puberty in girls is usually between 15-17 years of age and girls are not expected to start regular subsistence work until they are married (Lee 1979, 265). For females the link with adult status appears to be more closely aligned with puberty and marriage, although girls may be married before they have reached menarche (Shostak 1976, 249). The assumption of adult status for the boy comes with his first successful killing of an adult antelope which is marked by the first buck ceremony (Lee 1979, 238). The age of first buck will vary depending on the skill of the individual, between fifteen to twenty-two years for those boys that work hard on their hunting skills. However, the employment of some !Kung boys at the Bantu cattle posts have meant that some men will not have their first buck ceremony until they are as old as thirty years (*ibid*). For males, therefore, adult status seems to be linked to the acquisition of skills rather than age, and whilst adolescence is the bridge into the adult world in many cultures individuals at this stage are often still not quite adult.

Different cultures will tend to have different roles and responsibilities for children at different ages. However, development in both physical and psychological terms will play a part in the types of tasks that children are able to perform at different stages in their lives. Examples from the modern world indicate that the age of a child does have an influence on how they are treated and the types of tasks that they can become involved in, especially from the age of around five to seven years. Thus, as development in both the physiological and cognitive sense are probably fairly closely aligned for

most children, it seems a fair assumption that the level of role and responsibility within their separate cultures will also to some extent conform to a similar pattern, even if the types of roles are very different.

2.4 Biological concepts

For the purpose of this thesis the information that informs us about the biological concept of a child will be gathered from sub-adult skeletal remains. The development of the skeleton from the newborn infant to a mature individual is spread over two decades. The processes that can be observed on the skeleton will involve the growth, maturation and fusion of skeletal elements, and the formation and eruption of the dentition.

2.4.1 Development and growth of the bones of the human skeleton

During childhood the development and growth of bones and teeth requires a great deal of energy. Adequate nutrition is therefore needed for any child to reach their full growth potential. Although bone is a hard tissue it is certainly not a static one. Bone is constantly in the process of remodelling, involving bone formation and resorption. Bone formation begins early in foetal life with ossification commencing at about the fifth week after fertilisation (Mays 1998a, 8). There are two main ways in which bone growth takes place, endochondral (from a cartilaginous model) and intra-membranous (from within a membrane) ossification (White & Folkens 2000, 28). The former is most common throughout the body and can be illustrated in the long-bones. Initially the long-bone consists of a cartilaginous structure surrounded by a membrane (the perichondrium). Ossification begins on the outer edge of this model and osteoblasts and osteoclasts are transmitted into this bony sleeve to allow the calcified cartilage to be converted into bone (see Figure 2.1). This initial centre is the primary ossification centre. At birth the shaft (diaphysis) of the long-bone is present and during the first few years of life the secondary centres of ossification appear, such as the proximal and distal epiphyses. Bone growth takes place at the cartilaginous plate which is situated between the end of the diaphysis (metaphysis) and the epiphysis.

This type of growth ceases once the epiphyses of the bone fuse to the shaft, around adolescence (Scheuer & Black, 2000b). Growth in diameter occurs as osteoblasts deposit new bone on the outer surface beneath the periosteum. The interior of the shaft is hollowed out by the osteoclasts, as growth continues, to form the medullary cavity. Intra-membranous ossification is seen in the bones of the skull and the clavicle. No

cartilaginous model is involved; instead the osteoblasts lay down bone within a membrane which will eventually form the periosteum. Bone growth occurs at the surface allowing growth in diameter from a single centre of ossification, or multiple centres, which will subsequently fuse together (Mays 1998a, 8).

Figure 2.1: Development of a typical long bone.

a) epiphysis, b) diaphysis, c) metaphysis; cartilage is clear, calcified cartilage is stippled, bone is black, adapted from Mays (1998a, 9).

2.4.1.1 Age and development

The bones of the human skeleton develop gradually over time for up to three decades. The timing of these developments in maturation is known, although not all individuals will develop at the same rate. Growth and age are related but also fundamentally different. Growth relates to progressive incremental changes in both size and morphology, whilst age can be measured in a variety of ways (Scheuer & Black 2000b 4-5). Chronological age is the actual age of a child, something that is not possible to

deduce from human skeletal remains. Biological age is something that can be deduced from the human skeleton by studying the development of the dentition and the skeletal elements. To assign a biological age analytical methods developed from modern radiographic data or skeletal samples of known age individuals have to be used. The documented skeletal collections used for creating ageing methods in sub-adults include Coimbra and Lisbon, Portugal⁴ (Coqueugniot & Weaver 2007; Cardoso 2008), and for older sub-adults, collections of young male casualties of war from Korea (US soldiers 1951-1957) (McKern & Stewart 1957 as cited in Buikstra & Ubelaker 1994, 43) and Bosnia (year of death 1995) (Schaefer 2008). Radiographic data has also been utilised, for example that of the Fels growth study (begun in 1929) on living children in the US (Schaefer *et al.* 2009). This involves the assumption that children in the past developed at the same trajectory as children in the modern world. However due to the variability of both environmental and genetic factors, there will be differences in the timing of development both within and between populations (Clegg 2007, 45). Chapter Five will discuss some of the effects that malnutrition and dietary deficiencies may have on the developing skeleton, but for the present it is important to be aware that *'the only consistent characteristic of growth is its variability'* (Scheuer & Black 2000b, 4). Differences also occur between the sexes, with skeletal maturation tending to be more precocious in girls than boys (Hughes 1998). The adolescent growth spurt occurs later in boys and therefore tends to result in a greater adult size (Alexander, 1969).

Skeletal age is determined by establishing the age phase of each skeletal element. Initially, the bone will form from an ossification centre. The primary centres of ossification will have occurred in-utero and most skeletal elements will be recognisable at birth, although not yet morphologically mature. The next stage will consist of the fusion of elements and the appearance of secondary centres of ossification. Elements of the sub-adult skeleton important for ageing are the base of the skull, the vertebrae, and the long bones. These bones are important as they are initially made up of several different elements which fuse at different ages. The occipital bone consists of four parts in the newborn infant, the squamous part, the pars basilaris, and the left and right pars

⁴ The Coimbra and Lisbon collections both consist of individuals (sub-adult and adult) who died in the 20th century.

lateralis. The partes laterales fuse to the squama between the years of one and three. The pars basilaris fuses to the partes laterales between the ages of five and seven. As well as the fusion of these portions of the occipital being useful in ageing infants and young children, measurements on the basilar part can also aid in ageing (Scheuer and MacLaughlin-Black 1994; Scheuer and Black 2000b). The vertebrae consist of three separate bones at birth, the body (centrum) and the left and right neural arches. These three elements fuse between one to four years, starting with the neural arches fusing together at the spinous process and later fusing to the centrum (Figure 2.2). Later in life, further secondary ossification centres appear, the highest number being seven for the lumbar vertebrae, such as those for the processes and the annular rings of the centrum; most of these appear around puberty and fuse during later adolescence (Scheuer & Black 2000b, 218).

SK 308 neonate vertebrae

SK 1646 Age 9-10 years old

SK 2048 Age 1-2 years old

Figure 2.2: Fusion of the vertebrae over time.

Photos by H. Dawson, Taunton collection

At birth all the long-bones consist of a diaphysis and a metaphysis. At varying ages, secondary centres of ossification appear which will become the proximal and distal epiphyses for each of the long-bones (Figure 2.3). Some of the long-bones also have

further epiphyses such as the greater and lesser trochanter of the femur, or the tibial tuberosity of the tibia. These epiphyses will eventually fuse in later childhood (adolescence) from around twelve to twenty years of age, depending on the bone and epiphysis. The development and epiphyseal fusion of the hand and wrist bones, from radiographs, is also widely used by paediatricians to determine the skeletal maturation of living children (Tanner *et al.* 1975). This method is not so useful for determining the skeletal maturation of archaeological human remains due to the developing wrist bones and epiphyses being very small and having a stone-like appearance, meaning that they are often missed during excavation, unless soil sieving has been put in place. The final epiphysis to fuse is that of the medial clavicle which may fuse as late as twenty-nine years (Scheuer & Black 2000b, 251). Therefore, the development of the skeleton is ongoing from birth until three decades later.

SK 308 neonate tibia

SK 1646 Age 9-10 years

SK 2048 Age 1-2 years

Figure 2.3: Development of the tibia.

Photos by H. Dawson, Taunton collection

It is not yet possible from routine macroscopic study of human remains to accurately determine biological sex in children (Scheuer & Black 2000b, 15). Sexually dimorphic changes do not begin to develop until the time of puberty, the onset of which occurs

around eleven years in girls and twelve years in boys (Hughes 1998, 50), and therefore male and female skeletal morphology is similar until this time. Assigning sex to foetal remains has been attempted by measuring the slight differences in morphology of the pelvis (Mays 1998a, 39), but these disappear soon after birth. Molleson *et al.* (1998) developed a technique to sex children using craniofacial morphology, correctly sexing 78% of the named individuals from the Christchurch Spitalfields, London (post-medieval) collection. Mays (2007) tried the technique on fifty-six of the sub-adults from the medieval cemetery of Wharram Percy, Yorkshire and assigned each sex in roughly equal numbers (31 males, 25 females). However, he suggests that this technique needs to be tested on other collections of sub-adults of known sex before it can be used with confidence on archaeological material (Mays 2007, 92).

2.4.2 Development of the human dentition

Dental age is established by the state of formation and eruption of each tooth within the dental arcade. The timing of dental development has been shown to have less variation than the development of the skeleton, and therefore the age ranges involved for each stage tend to be narrower (Scheuer & Black 2000a, 13). In turn, the suggested age is probably closer to the true age of the child. If all the teeth are present within the jaw only a limited amount of information can be gleaned as teeth can only be recorded as unerupted, erupting or erupted; the roots of the teeth not being visible. Where the teeth are loose or the jaw is broken, it can be possible to record the formation stage of the tooth as well as the eruption stage. When only a loose tooth is present, the formation stage can be recorded, and whether the tooth was erupted in the jaw at the time of death may be deduced by looking for wear patterns on the tooth. Radiographs can be taken of complete jaws to gain information on the formation stage of each tooth but, where this is not possible, fragmented mandibles may be more useful for ageing children than intact ones. Dental ageing tends to be preferred over skeletal ageing (Mays 1998a, 44; Scheuer & Black 2000a, 12). As well as both sexes having a more similar rate of dental development, it is thought that environmental influences will also be less on the timing of dental development compared to skeletal development (Demirjian 1978, 418; Humphrey 2000, 29).

A third way of assigning age to sub-adult skeletal remains is to actually measure longitudinal growth of the long-bones. This method may be open to the most variation, due to the effects of environmental factors such as diet, disease and genetic influences.

However, as a way of ageing foetuses it can give results accurate to within a few weeks (Scheuer *et al.* 1980).

2.4.3 Previous developmental studies on archaeological human remains

Johnston's (1962) research, on the Indian Knoll skeletal sample from Kentucky, was one of the first studies to explore growth through the measurement of the long bone lengths of sub-adults. Since then a range of growth studies on skeletal remains from around the world have been carried out and lists of these appear in Humphrey (2000), Lewis (2007) and Saunders (2008). Of the nine British sites listed, only two are dated firmly to the late medieval period, Wharram Percy (Mays *et al.* 2007) and St Helen-on-the-Walls (Dawes & Magilton 1980), both within Yorkshire. The cemetery of the hospital of St James and St Mary Magdalene, Chichester, West Sussex (Magilton *et al.* 2008) has burials from the late medieval period, but burial continues into the seventeenth century and the dating of the later area containing the majority of sub-adult burials is uncertain (Magilton 2008). The other sites listed include one Roman, Poundbury, Dorset (Farwell & Molleson 1993), one early medieval, Raunds, Northants (Boddington 1996), and three post-medieval, Ensay, Scotland (Miles 1989), St Brides, London, (Humphrey 1998) and Christ Church Spitalfields, London (Molleson & Cox 1993). The site of Barton-on-Humber, Lincolnshire has burials ranging in date from the tenth to the nineteenth centuries; over five hundred are dated to the late medieval period (Waldron 2007, 34).

The most common causes of poor or delayed growth are inadequate nutrition or exposure to infectious disease (Humphrey 2000, 23). Growth studies can therefore be used to determine differences in growth between populations and in turn to determine possible differences in nutritional and health status which may be related to economic status. There are, however, a couple of caveats that need to be stated when interpreting growth study data from archaeological human remains. Firstly, the children analysed from archaeological collections are those that died; there is no data for the children in the past who survived. Whilst some researchers have stated that this can cause potential problems (Johnston 1962; Saunders and Hoppa 1993a), others have suggested that most child deaths in the past would not have been due to chronic illness '*but rather acute, rapidly developed episodes of predominately gastrointestinal or respiratory infection*' (Lovejoy *et al.* 1990, 540), and therefore the dead children may accurately reflect the living children.

Secondly, the way in which age is determined from the skeleton often only provides an age range within which the individual should fall. To create growth profiles, however, a fixed yearly age tends to be assigned which the researcher believes to be the best match from the indicators available to be scored. Clegg (2007) has shown the wide variation between dental and skeletal maturation rates and chronological age within living populations from around the world, and suggests that ageing an individual from the same reference population can involve a difference of up to eighteen months (2007, 48). This can lead to a discrepancy between the true chronological age of the individual and the age assigned, which is based on the development of the dentition and/or maturation of the skeleton. In fact, most skeletal samples of past groups appear shorter for age than modern groups (Saunders 2008, 134), including the British sites mentioned above. However, as the data used for comparison often come from the growth data of middle class American children, with access to a highly nutritious diet and good health care, these discrepancies should not be seen as surprising (Clegg 2007, 45). Lampl & Johnston (1996) used dental development and skeletal maturation tables based on white American children to age living Mexican children. They found wide discrepancies in assigning age using these references. For skeletal age, a six year old child could be scored between four and eight years, whilst for dental age it could be between 4.75 and 7.5 years (Lampl & Johnston 1996, 349). These children, healthy but living in an environment where nutritional deficiency and infectious disease are common threats, and without adequate access to healthcare, certainly more closely resemble past populations of children than the American or European children on which most ageing reference standards are based.

Wiggins & Rogers (1995) found that skeletal development in terms of long bone length appeared to be lagging behind the dentition by approximately two years in seventy percent of individuals studied, from a sample of one hundred sub-adults from Barton-on-Humber. Lewis (2002a, 40) found that there was no significant difference between growth profiles from the rural Wharram Percy and the urban St-Helen-on-the-Walls sites, although the children from the post-medieval site of Christ Church Spitalfields were smaller for age than the medieval children. Mays (2007, 97) found that the long-bone lengths of the Wharram Percy children were significantly shorter than those of modern children of the same age. Appositional bone growth (cortical thickness) was also seen to be less than in a comparative modern sample (Mays 1999). However, as

noted above, some discrepancy between the archaeological data (dead children) and that recorded from living children may be expected; a proportion of the dead children may have had chronic illnesses which could have caused the cessation of growth for periods of time.

When using data from other sites as a comparison, it is important to ensure that the methods used for the assignment of age are known; if two researchers are using different methods, the two studies may not be comparable. In fact one of the problems with archaeological human growth studies is that there is no universally agreed method for ageing skeletal remains of sub-adults. Although there are published standards for guidance in the recording and analysis of human remains (Brickley & Mckinley 2004; Buikstra & Ubelaker 1994), they do not necessarily suggest the use of the same methods and are not exhaustive in listing all those available. Most researchers will tend to use the methods that they were taught at postgraduate level or those that they believe are the most accurate or applicable for the population under study. This will be explored further in Chapter Seven where a range of methods were used to assign age at death for the skeletal collections analysed in this study.

2.5 Summary

This chapter has reviewed how archaeologists have recently begun to approach the study of children and has suggested that research needs to encompass a biocultural approach, involving the two concepts of a child, biological and cultural. Different cultures will have different attitudes towards child care provision and in their definitions of what constitutes a child, as opposed to an adult. Definitions of "child" and "childhood" have been explored and anthropological examples of childhood stages and the roles and responsibilities associated with them discussed.

The growth and development of an infant to reach full biological maturity can take up to three decades. The cessation of long-bone growth occurs at around sixteen to twenty years of age (Mays 1998a; Scheuer & Black 2000b), the completion of the adult dentition, with the eruption of the third molars, occurs sometime after the fifteenth year (Ubelaker 1999; Scheuer & Black 2000b), and biological adulthood is seen to be reached with female reproductive maturity, averaging nineteen years of age (Bogin 2001, 95). However, this chapter has also shown that the timings of skeletal and dental development are highly variable between different populations, and that we can never

truly assign a chronological age to sub-adult skeletal remains but only a physiological age, which is in relation to the reference data available.

Chapter Three will move on to focus on the definition of a child in the late medieval period and whether childhood stages have any meaning within this culture. This information will then aid in the decision of which individuals should be analysed, for this study of late medieval children, and how they might be grouped into age categories.

Chapter 3 : The Medieval Child

'It seems inconceivable that in a period when the most popular image was that of the Madonna and Child, there was little or no understanding of or affection for the children in everyday life, yet such is the popular misconception about medieval childhood' (Oosterwijk 2001).

3.1 Introduction

In Chapter Two how different cultures perceived the role of children was discussed alongside biological definitions of a child. In this chapter the concept of the child in the late medieval period will be addressed by referring to the research of various historians. To determine the concept of a child in the past there are many different types of evidence that can be explored. The main body of this thesis will focus on the archaeological evidence for both the treatment of the dead in terms of burial practice, and the analysis of the life histories of individuals, in terms of growth, development, trauma, and disease from the osteological evidence. Late medieval burial practice and research into medieval populations, from both archaeological and historical sources, will be explored further in Chapter Four, whilst the evidence for past disturbances to growth, and disease processes, and how they can be identified on skeletal remains, will be discussed in Chapter Five. The purpose of this chapter is to review current and previous research on how children were perceived, and their place, in the medieval world.

Children appear in a range of sources from the medieval period including: historical texts such as hagiographies, medical treatises, legal documents, literature, and in the iconography and art of the period. One obvious problem with these sources is that the majority will have been written by men, and, due to the learned often being the clergy, childless men⁵. This section will discuss the research of various authors who have uncovered information relating to children in the late medieval period and how these sources can be used to infer the status of the medieval child in the minds of the adults of the period. Firstly, the medieval concept of a child will be addressed with reference to defining the different stages of a child's life and how these compare to modern views of

⁵ Gordon notes that although priests had been forbidden to marry since the eleventh century, evidence from the twelfth century suggests that many of the lower clergy still did marry, and that they were devoted parents (Gordon 1991, 153: note 22).

biological and cultural stages. Evidence for the status of children will then be explored through the appearance of the child in art, such as burial monuments. Records of the time, such as Coroners inquests (Hanawalt 1977), and the accounts compiled from the shrines of Saints (Gordon 1991; Finucane 1997), provide an insight into the attitudes of adults to the death and injury of children, as well as the types of scrapes they got into. A natural aspect of the child in our own time is to play, and evidence for toys and games of the period will also be explored.

3.2 Assessing the medieval concept of a child

Discussions on whether the concepts of childhood stages were present in the medieval period, and how this relates to the treatment and status of children, have been ongoing by historians and medievalists since the later half of the twentieth century. Ariès published a major work on the history of childhood in 1960, *L'enfant et la vie familiale sous l'ancien régime*⁶. Although his study only used evidence from as far back as the fifteenth century Ariès states that 'In medieval society the idea of childhood did not exist' (1996, 125). His evidence for this was due to the lack of depictions of children in medieval iconography and art, and that when depicted he saw them as no more than little adults. His book has influenced and been commented on by many writers of different disciplines, from historians (Wilson 1980; Burton 1989) to archaeologists (Crawford & Lewis 2008) and sociologists (Jenks 1996), and has been much criticised. Burton (1989, 209), comments on Ariès' use of purely iconographic evidence and states that he draws '*injudicious inferences from the absence of evidence*'. He also points out that it is not just children that are missing from medieval art but in fact most of secular life. Therefore by concentrating on this medium alone it is not possible for Ariès to comment on everyday life in the medieval period. He accuses Ariès of approaching the pictorial evidence on the '*philistine level*' and states that art historians are far ahead in the sophistication of their interpretive methods. '*In his darting, glancing use of iconographic evidence, Ariès was often brilliant but – in various ways and to various degrees – mistaken*' Burton (1989, 224). Wilson (1980, 139) also comments that it is the absence of modern western attitudes to children that Ariès uses in his conclusion that medieval society had no understanding of childhood. '*What that [medieval] society*

⁶ Translated into English as '*Centuries of Childhood*'.

"lacked" was our awareness; but this is not the same as saying that it had no such awareness' Wilson (1980, 142).

Another of the major flaws with Ariès' perception of childhood is that he makes reference to the medieval period by projecting the evidence from the sixteenth and seventeenth centuries backwards in time (Hanawalt 2002, 441). Ariès research, although biased and lacking in evidence especially for the medieval period, was however seminal. It led to many discussions and publications on perceptions of children from the medieval period to the present day, and to a new focus on general practices of childrearing and children's lives in the past.

DeMause (1974) took Ariès' dim view of the medieval period even further when he stated *'The history of childhood is a nightmare from which we have only recently begun to awaken. The further back in history one goes, the lower level of child care...'* (1974, 1), yet he presents little in the way of evidence to back up this harsh statement. The title "the evolution of childhood" gives away his perspective of a linear evolutionary model and he lists a "taxonomy" of contemporary child rearing modes including terms such as: "Infanticidal", for antiquity to the fourth century AD; "Abandonment", for the fourth to thirteenth centuries, "Ambivalent", for the fourteenth to seventeenth centuries; culminating in "Helping", for the mid-twentieth century and beyond. He suggests that over generations parents slowly overcame their anxieties about their offspring and developed the capacity to identify and satisfy their needs. He seems to suggest that those who are cruel to children in modern society are somehow stuck in earlier historic modes due to a slower evolution among their families (1974, 51). It is hard to believe that this discussion was ever taken seriously but his work is still often cited in books and papers on children in the past (Jenks 1996; Hanawalt 2002; Crawford and Lewis 2008).

Attreed (1983) and Lee (2010) both suggest that late medieval authors did have a concept of "child" as different to that of "adult". The evidence they cite is from the literature of the period which contains child characters. Attreed refers to the fourteenth century poem "Pearl", which tells the story of a man stricken by grief at the loss of his two year old daughter, as evidence for the emotional connection parents would have had to their children. She also cites the instance of the death of the "Princes in the Tower" under the reign of Richard III as showing the *'importance of children and adult*

obligations to them' (Attreed 1983, 43). She states how fifteenth and sixteenth century English society judged Richard III to have failed his nephews leading to the contemporary rumours of the wicked uncle and his now infamous reputation; '*the Christian west in the middle ages honoured its children, as symbols of innocence*' (*ibid.*, 53). Lee (2010) looks for examples of children who express some degree of self determination, showing them not merely as passive but as active players in their lives. His examples come from: Chaucer "the Prioress's tale", where a boy is killed for singing defiantly, and continues to sing once deceased (2010, 41), several popular tales of virgin martyrs, who choose death rather than defilement (2010, 42), and a morality play *Occupation and Idleness* devised as a moral tale for schoolboys (2010, 43), where a wilful and playful boy is the main character.

3.2.1 Childhood stages

Whereas Ariès saw children as no more than little adults, there have been many counter arguments made to the idea of a lack of awareness of the child as a separate category to that of the adult, and many writers list stages of childhood that were present in the late medieval period (Shahar 1990; Orme 2001; Fleming 2001; Hanawalt 2002). Orme (2001) makes the point that by AD1200 the church made a clear distinction between adults and children. In English common law children acquired various rights and responsibilities between the ages of twelve and twenty-one years (Orme 2001, 8). Orme (2001) suggests that Ariès' misconceptions were a product of neglecting certain forms of evidence as well as to the lack of survival of evidence (both historical and archaeological) in comparison with the later periods. In a review of the study of children in the medieval period Hanawalt (2002) refers to art, such as the ages of man (a popular depiction on church walls, stained glass and books) and early literature such as the works of Bede, to suggest that different stages of a child's life were clearly defined.

Demaitre (1977), in his work on medical writings of the medieval period within Europe, concludes that there was a general consensus on the division of childhood into three phases: infancy proper, from birth to around two years; second infancy "*dentium plantatura*", until seven years; and *pueritia* until fourteen⁷ years. Two further stages are also often cited in medieval writings *adolescentia* and *juventus* (Shahar 1990; Orme

⁷ Demaitre (1977) notes that in classical Latin this applied until seventeen years of age.

2001; Fleming 2001). Table 3-1 lists these stages and the age ranges with which they are associated.

Table 3-1: Medieval stages of childhood

Stage	Sub-stage	Age range girls	Age range boys
<i>Infantia</i>		birth until 7 years	birth until 7 years
	<i>infantia proper</i>	birth until 2 years	birth until 2 years
	second infancy	2 until 7 years	2 until 7 years
<i>Pueritia</i>		7 until 12 years	7 until 14 years
<i>Adolescentia</i>		12 to around 20 years	14 to around 20 years
<i>Juventus</i>			post adolescence

Infantia

The stage of *infantia* was seen as a time when the child needs to be nurtured especially up until the age of about two years (Shahar 1990). This first stage appears to end once the child has developed their first set of teeth and can be weaned. Michele Savonarola⁸ suggests that boys should be weaned around three years, which is six months to a year later than girls. His reasoning is because males live longer (Demaitre 1977, 474) although according to Bernard de Gordon⁹, it was because '*woman is only the guardian of the house, as Galen says, and therefore she needs less strength than man*' (as cited in Demaitre 1977, 474). These writings suggest that medics recommended a longer period of breastfeeding for boys than girls, and that this should continue until at least two years of age. DeMause (1974) lists a table of full weaning times from various sources, those that fall in the late medieval period¹⁰ range from 34 months to 9 months (DeMause 1974, 36), with 19 months the mean value.

Research has been conducted into weaning in the medieval period on infant remains from the rural cemetery site of Wharram Percy, Yorkshire (Mays 2003; Richards *et al.* 2002; Mays *et al.* 2002a). Isotope analysis on the measurement of nitrogen, strontium and calcium ratios has suggested that weaning took place between the ages of one and

⁸ A medic from fifteenth century Italy, he wrote '*De regimine pregnantium et noviter natorum usque ad septennium*' a guide for women written in the vernacular (Demaitre 1977, 463).

⁹ A French physician of the fourteenth century, he wrote '*Regimen sanitatis*' (Demaitre 1977, 466).

¹⁰ Six examples between AD 1314 and AD 1540, only two of these are from English sources.

two years. A near adult signal is reached by two years of age, suggesting the cessation of breastfeeding by this time (Mays 2003). Nitrogen levels were also shown to be lower in young children between four and eight years old than those over eight years, and it has been suggested that the diet of young children contained fewer animal products and more plant foods (Richards *et al.* 2002).

The second stage of infancy (*dentium plantatura*), starting around two years, seems to coincide with the completion of the primary dentition and the time when a child will start to walk and talk (Demaitre 1977, 466). From this age the child learns about society through observation and interpersonal relationships. Shahar (1990) states that many writers of the period try to impress upon their readers how parents need to take good care of their children at the *infantia* stage.

Pueritia

In the second stage (*pueritia*), starting at the age of seven, it was thought that a child should be able to express themselves properly, with their speech now being articulate, and that they should have an understanding of the correct codes of conduct. It is also the period of the loss of the deciduous teeth and emergence of the permanent dentition. Shahar draws attention to a link between these developments in the medieval texts (1990, 24). Due to this belief that a child should now be articulate this was seen as a time that a betrothal could be arranged. However, this was not a binding agreement from the second half of the twelfth century, with the arrangement either being accepted or declined when the child reached the stage of *adolescencia*, at twelve years of age (Shahar 1990, 24). Schooling or apprenticeship would often begin during this stage (Fleming 2001, 64). Bernard de Gordon also called this stage '*the age of concussion*' (*etas concussionis*) because '*in that age they begin to run and jump and hit each other*' cited in Demaitre (1977, 466); this indicates a knowledge of the boisterous nature of children.

Adolescentia

Adolescentia was a stage when young people could now take part in several of the religious sacraments and decide on marriage partners (Shahar 1990). This stage began at twelve for girls and fourteen for boys (Demaitre 1977, 466). This was also the age when children could bear criminal responsibility. In this third stage, independence could be gained from their parents. However, responsibility for females usually passed from

father to husband and therefore only widowed females were probably truly independent (Hanawalt 1993, 15).

Schultz (1991) disputes the existence of the stage of *adolescentia* as equating to a modern sense of the word by referring to German texts of the period. He sees girls as becoming women on marriage, which was often around the same time as puberty (1991, 534) but, as explored further in Chapter Four, age of marriage would tend to be excessively early for the nobility, but unlikely to be so for the ordinary peasant and artisan classes. Although he concedes that the “ages of man” schemes do contain the stage of *adolescentia*, he points out that the differing authors assign different age groups to this stage, in some cases it being the only mentioned childhood stage, and in others a separate stage that begins at fourteen years and does not end until around thirty years of age (1991, 530). It could therefore be suggested that some children, though not necessarily all, were viewed as adults from the age of twelve years. The wage earning of children and young people is often hidden because there is little or no recorded evidence. Dyer (1989) refers to the “life cycle servants” as young workers from twelve to twenty-five years who received pay from their employers in the form of their keep, and that they were often regarded as part of the family, with many being related to their employer. This service would tend to end with the acquisition of land, house, independent work and/or marriage (Dyer 1989, 212). Therefore, alternatively, perhaps adulthood was being delayed in the lower classes until these things could be achieved. Child employment appears to have increased after AD 1349¹¹ and one example in the court records shows the complaint of a man, owed labour by his tenants, for sending him a boy of fourteen, and a boy who harvested badly, rather than a man (Dyer 1989, 230). In this case the fourteen year old is seen as a boy, not a man. The position of the urban apprentice, with a term of seven years or more, suggests that the length of time was clearly designed to provide a pool of cheap labour for masters (Dyer 1989, 232).

Juventus

The stage of *juventus* is sometimes used for those past the period of adolescence but awaiting the full step into adulthood. It is likely that this stage was applicable mainly for

¹¹ The Black Death in AD 1348-49 reduced the population considerably and therefore led to a shortage of workers (Goldberg 2004, 166).

young men. The end of the third stage or step into adulthood appears to vary depending on the circumstances of the individual. For females, this step would probably come sooner than for males due to those who would marry often doing so at a young age, especially in the higher levels of society. For males, in some instances, adulthood could be gained as late as thirty-five years of age, and in north-west France only when married was a male seen to be a man (Shahar, 1990, 28).

3.2.1.1 Comparison of modern and medieval stages

Scheuer and Black (2000a, 10; 2000b, 468) list the terms for childhood age stages as used by paediatricians, which are as follows:

- Perinate – around time of birth, from 24 gestational weeks to 7 postnatal days
- Neonate – from birth to 28 days
- Infant – from birth to the age of one year
- Early childhood – preschool years (one to five years)
- Late childhood – six to twelve years

These groupings are often used in skeletal reports, although as can be seen in Appendix A (a list of excavated late medieval cemetery sites in England with at least 50 sub-adults recovered), the age groupings used can vary depending on the author. It is interesting that the term “preschool years” is used for early childhood, indicating that the distinction here is as much a social as a biological one.

Table 3-2: Childhood stages in years used in different disciplines.

Skeletal ^a		Evolutionary ^b		Psychological ^c	
infans 1a	0-2y	infancy	28d-3y	sensorimotor	0-2y
infans 1b	2-7y	childhood	3-7y	preoperational	2-7y
infans 2	7-14y	juvenile	7-10/12y	concrete operations	7-11y
juvenil	14-22y	adolescent	10/12-19/20y	formal operations	11-15y

Table 3-2 gives a list of childhood stages from three different disciplines, ^aEuropean skeletal biologists (Scheuer & Black 2000b, 469), ^bevolutionary biologists (Bogin 2001, 66) and ^cdevelopmental psychology (Piaget & Inhelder (1969) with reference to Phillips (1981) and Slater *et al.* (2003).

The European stages, used by skeletal biologists, are the same as the medieval stages as defined for boys. This may indicate that the work of medieval and earlier scholars has

been influential on the creation of these stages in the past. However, when the other stages are compared none are very dissimilar. The main difference in the stages quoted by Scheuer & Black (2000a; 2000b) as being used by modern paediatricians, is the slightly earlier age of reaching each subsequent stage, by one year at both early and late childhood. Whether this is due to earlier timings of biological events being seen in modern as opposed to past populations of children or due to the social aspect of definition is not clear.

Shahar (1990) suggests that the concept of varying stages from infancy to adulthood were present, at least in the minds of medieval scholars. She highlights that the medieval stages, often used in the scientific and medical works of the period, have a great similarity to the psychological stages of childhood, as defined by the French psychologist Jean Piaget¹² (see Table 2-1). The sensorimotor period equates to *infantia* proper, the preoperational period to second infancy, the concrete operations period to *puerita*, and the formal operations period to *adolescentia*, although the formal operations period starts at eleven years and therefore at the latter end of the medieval stage of *puerita*.

Hanawalt (1993) draws attention to the differences between biological and social stages within the life stages as defined for a medieval child. The most important stage here is probably that of puberty. This stage was more closely linked to both the biological and social reality of becoming an adult for females. This may be due to the fact that it was thought that girls should be married soon after puberty so that they did not have the opportunity to fornicate. Although in wealthier families early female marriage may have been desirable, and led to a discrepancy between the age of female and male adulthood, evidence from the court roll records for Halesowen, a rural village in the Midlands, suggests that male and female marriage age was fairly similar (Razi 1980). Marriages seemed to take place between eighteen and twenty-two years for both men and women, though with males probably being slightly older than their wives (Razi 1980, 63), suggesting only a three or four year age gap between them. Child marriage would have been confined to the aristocracy (a way of forming alliances and gaining status), the peasant and artisan classes having no need for it (Gies & Gies 1989, 209). In Halesowen

¹² For a synthesis of Piaget's work see Piaget & Inhelder (1969).

the minimum legal age for holding land was twenty years and therefore at this age individuals were probably classified as adult.

When the biological stages of Bogin (2001), as illustrated in Table 2-1, are compared to the medieval stages they do not match quite as closely as the psychological stages but are not radically different. The main difference is due to the earlier "adolescent" stage attainment for both sexes. Bogin's infancy stage relates to the period of *infantia* proper and the first year of second infancy. Childhood starts at age three and therefore relates to second infancy as it lasts until the age of seven. The stage of juvenile lasts from seven to ten years for girls and seven to twelve years for boys, with both girls and boys moving into adolescence two years earlier. The timing of the onset of puberty is slightly different in girls (11.3 years) and boys (11.8 years) (Hughes 1998, 50), although it appears to be the timing of the different physical attributes that occur after puberty that causes the two year difference. In girls breasts start to develop between the ages of eleven and thirteen and the mean age for menarche in Britain is 12.9 years, whilst the appearance of pubic hair occurs at 12.5 years for girls and 14.3 years for boys on average (Hughes 1998, 50). Acceleration in growth, the "growth spurt", occurs between ten and twelve years for girls and twelve and fourteen years for boys (Alexander 1969, 227) with peak height velocity of growth occurring at age twelve for girls and age fourteen for boys (Hughes 1998, 50). Bogin's adolescent stage lasts until the age of about nineteen or twenty years and therefore matches the end of *adolescentia* quite accurately. The similarity between the different stages discussed from both the modern and medieval periods suggests that the medieval childhood stages were devised through observations of both the biological and cognitive development of infants and children.

3.3 Representations of children

One way of trying to determine the way in which children were viewed in the medieval period is to look at artistic representations of them. Children are represented in several different mediums in the period including on burial monuments, in illuminated manuscripts, and in themed drawings such as the *danse macabre* and the “ages of man”.

3.3.1 Burial monuments

One of the places where we can look for representations of children is on burial monuments, which often took the form of brasses or stone tombs. Although these monuments are reserved only for the wealthier members of society they may give us a glimpse of how children were viewed and whether they were seen as worthy of memorial in their own right. The first incidence of a child appearing on a burial monument is the brass to Margaret, the little daughter of William de Vanence who died in AD 1276 (Page-Phillips 1970, 9). There is no representation of the child on this brass, which is in Westminster Abbey, merely the inscription. The first representation of children on a brass comes from c. AD 1360 with a brother and sister represented at Sherborne St John, Hampshire (*ibid.*). These examples are obviously of children from wealthy families who could afford to erect monuments to their deceased offspring. This would not be possible for the majority of the population, but it does show that children could be valued as individuals for their own sake. Children do not commonly appear on brasses until c. AD 1420 although by the 1450s they are a more regular occurrence (Litten 1991, 61). The vast majority of representations of children on brasses are shown as small figures on the monuments to their parents (see Figure 3.1 and Figure 3.2); the boys represented below their father and the girls below their mother.

Separate monuments to individual children continue to be rare. This still implies the importance of children to adults both of those living and dead, as often any deceased children are portrayed along with those still living. One way of showing children who were deceased before their parents was to depict them in shrouds, such as the four daughters of Richard and Johane Yate (died 1500) at Longworth, Berkshire (see Figure B.1 Appendix B). Four daughters in dresses are shown behind the shrouded figures. This could imply that children are immensely important and loved by their parents for their own sake, or it may indicate that the parents gained status through their children and the size of their family (“fertility status”).

Figure 3.1: Memorial brass of John (died c. 1480) and Joan Jaye.
From the chancel of St Mary Redcliffe, Bristol. Photo by H. Dawson.

Figure 3.2: Close-up of the children depicted on the brass of John and Joan Jaye.
Photo by H. Dawson.

Figure 3.3: Fifteenth century tomb in the crypt of St John the Baptist, Bristol.
The male children are depicted to the left and the females to the right. Photo by H. Dawson.

Figure 3.4: Close up of the boys situated on the left base of the tomb.
Photo by H. Dawson.

Binski (1996) sees the imagery on tombs and monuments from the fourteenth century as showing an increase in the importance of the family: Edward III (died AD 1377) had small bronze figurines of his children attached to his tomb. Two of the stone tombs in the crypt of St John the Baptist, Bristol have children represented below their parents; both are thought to date from the fifteenth century. Figure 3.3 shows the fifteenth century tomb of Thomas Rowley and his wife with their twelve children depicted on the side. The base of the tomb is much damaged but Figure 3.4 shows a preserved section of the male children; the female children are unrecognisable.

Binski (1996, 105) suggests that this imagery of the descendants replaced that of the ancestors. He also suggests that the increased child mortality rate of the late medieval period may have led to an increase in the inherent value of offspring and that, unlike the suggestions of authors such as Ariès, the high infant mortality rate did not harden the feelings of parents towards their children, in fact quite the opposite. He describes how some children on brasses are even lifted up onto pedestals. One such example is that of Eleanor, the granddaughter of John Corp (died 1391) at Stoke Fleming, (see Figure B.2 Appendix B) but, although idolised, these children are still often subsidiary (Binski 1996, 106). Page-Phillips (1970, 14) concludes that the children represented on pedestals next to adult family members are probably children who had died young.

Depictions of swaddled infants are rare but they do appear on some brasses. An example of a baby represented with the chrysom cloth of baptism can be seen at Stoke d'Abernon, Surrey dated to AD 1516 (see Figure B.5 Appendix B) and another at Hornsy, Middlesex (c. AD 1520) (Litten 1991, 61). One odd juxtaposition, from Teynham, Kent and dated to AD 1509, is of a baby in swaddling clothes next to a young girl; they are both depicted as the same size (see Figure B.3 Appendix B). The girl stands slightly in front of the swaddled baby but their similar height may indicate that they have a similar status, implying babies were as important as older children in the eyes of their parents; or perhaps the baby is a boy and thought to be as important as an older girl. Ten swathed infants are depicted on the Astley brass (AD 1467) at Standon, Hertfordshire (Litten 1991, 61). An example of mother and infant together comes from Blickling, Norfolk dated to AD 1512 and shows Anne a Wode who died in childbirth; she is holding her twins who also died (see Figure B.4 Appendix B). Depictions of infants on brasses become much more common after the Reformation (around AD

1540) as do representations of mothers and babies who died in childbirth (Page-Phillips 1970).

Monumental brasses are not very common in Somerset and no early brasses remain. One brass at St Peter's Church, Ilton depicts a baby in swaddling clothes dated to around AD 1508 (see Figure B.6 Appendix B). There are many more surviving brasses from Gloucestershire but none appear to have lone depictions of children (see Davis 1969), although many have children depicted beneath their parents. Several brasses of children are listed by Griffin (1938) for the county of Kent, including a small girl at Appledore (c AD 1520), an older girl with flowing hair, Joan, daughter of James Bourne at Bobbing (see Figure B.7 Appendix B), and several children depicted beneath their parents. One brass of a swaddled infant is present at St Paul's, Cray but is of a post-Dissolution date of AD 1584.

3.3.2 Other artistic representations

As discussed earlier, Ariès' view on medieval childhood was that it did not exist and that children were understood merely as little adults. Gies & Gies (1989) disagree with Ariès' notion of children depicted as little adults in art, and state that, in the illumination of manuscripts, children are depicted in simpler or shorter versions of adult dress. They also refer to the childhood activities depicted in some, such as children playing ball, swinging, shooting arrows, manipulating puppets, and watching puppet shows (Gies & Gies 1989, 197).

The *danse macabre* or dance of death is part of the tradition that involves the display of cadavers on tombs, and is designed to impress upon people how fleeting life can be and that they need to be prepared for their life after death by being good Christians. These macabre images of death and decay, common in Northern Europe, have been interpreted as representing the deeper decline "the waning of the Middle Ages" in contrast to the optimism of the Italian Renaissance (Binski 1996, 123). The occurrence of the Black Death in the mid fourteenth century may also have reinforced the idea of the fragile nature of life, which could end at any time. There are many representations of the dance and it is shown that death takes all from Kings to peasants, old people to small children. The inclusion of children and infants in the imagery of the *danse macabre* has led Oosterwijk (2007) to conclude that, instead of children being ignored by medieval thinkers, the infant stage was regarded as a vital stage of life.

The “ages of man” was a popular theme in the art and literature of Europe in the late medieval period, with at least one stage always dedicated to childhood. *Infantia* was usually depicted as the swaddled infant and can be representative of the first seven years of life, though some writers (Bartholomaeus c.1230) did distinguish the second stage of infancy (Oosterwijk 2007, 129), and at this stage a toddler with a baby walker is depicted in the wheel of fortune c AD 1240 (Figure 3.5). Older children are sometimes also shown playing with toys or carrying schoolbooks (Oosterwijk 2001).

The child, most often in the form of the infant Christ, was also depicted in religious iconography. The mother and child was therefore a common depiction throughout the late medieval period and the strong imagery of the loving mother must have played a part in how mothers were expected to treat their children in medieval society. The evidence for artistic portrayals leaves no doubt that children were an important and visible part of medieval society, as Oosterwijk sums up in reference to iconography, ‘the medieval popularity of the Virgin and child could only have worked if people recognised its fundamental truth: the bond of affection between mother and child’ (Oosterwijk 2001).

Figure 3.5: Woodcut depicting the seven ages of man.

From Bartholomaeus Anglicus *De proprietatibus rerum*, printed 1482 Rosenthal (2007, plate 7).

3.4 Childhood accidents, diseases and death

Records of the illnesses and accidents that befell some medieval children are recorded in accounts from the time. These include the coroners' rolls¹³ (Hanawalt 1977) and records of Saint's miracles¹⁴ (Gordon 1991; Finucane 1997). These accounts can provide information on some of the illnesses that children died from and survived, as well as the types of accidental injuries that befell them; they may also contain evidence for infanticide (Hanawalt 1977). They also enlighten us to the types of activities that children were involved in such as types of play, what errands they were running, and what type of work they carried out. From this evidence, some issues that can be addressed include; the types of accidents and the ages of the children involved and what they imply about parental care (Hanawalt 1977; Gordon 1991), parents reactions to the death or injury of their children (Gordon 1991; Finucane 1997), and how the recorded ages of children who have died compare to the ages of children excavated from cemetery sites of the period.

Hanawalt (1977) looked at coroners' rolls from both rural and urban situations for accidental deaths. Urban life is presented in the coroner's rolls from Oxford and London, and rural life from the rolls of Northamptonshire and Bedfordshire. She found that children seem to be described more often in rural than urban accidents; 18% of Bedfordshire cases as compared to only 0.9% of Oxford cases (Hanawalt 1977, 4). This may suggest that rural children had more opportunity to run free, or that in crowded towns children had more adult eyes to look out for them. Hanawalt (1977) presents the information on two hundred and forty-eight instances of accidental deaths of children in tabular form. Of these 144 (65%) involved boys and 77 (35%) involved girls.

¹³ The coroners' inquests were used for homicides as well as accidental deaths and are a unique source of evidence of the daily lives of peasants, villagers and the middle and lower classes of the towns. If a death was sudden, through homicide, misadventure, or suicide, the coroner had to be called to view the body and hold an inquest.

¹⁴ Gordon (1991) recorded accidents from the accounts of Saints' miracles from six English Saints: Thomas Becket (died 1170, canonised 1173), St Wulfstan, Bishop of Worcester (died 1095, canonised 1203), Simon de Montfort (died 1265, never canonised), St Thomas Cantilupe, Bishop of Hereford (died 1282, canonised 1320), St Edmund the martyr (died c 870, canonised c10th century), and Henry VI, King of England (died 1471, never canonised). Finucane (1997) looked at the recorded instances of miracles from northern and southern Europe. Those relevant to England included accounts related to Thomas Cantilupe, Thomas Becket, and Henry VI.

Many shrines were in use in England throughout the late medieval period and records of miracles that were performed by their associated Saint were carefully recorded. These accounts can tell us about the types of accidents and diseases from which children may have suffered, but also about the attitude of their parents and their *'often exhibited grief, guilt, or remorse over the accident'* (Gordon 1991, 146). Finucane (1997) looked at the recorded instances of miracles involving 110 neonates/infants, 155 individuals recorded as children, and 335 recorded as children with specified ages. Gordon (1991) studied the miracles from six Saints shrines recorded between AD 1170 and 1500 which contained 358 recoveries in 354 children (1991, 148). A medical doctor, Gordon states that *'they sometimes read like case histories'* (1991, 146) and that *'parents who appear in the accounts of miraculous recoveries among children, who prayed for help, made a vow, and undertook a pilgrimage, obviously cared deeply about their offspring'* (ibid.). She does not however refer to the ages of the children mentioned in these accounts.

As the writings involve Saints' miracles, the illnesses mentioned are almost always described as cured in the records. Of the named illnesses fever was the most common, followed by infections, eye problems, and epilepsy or fits. Other illnesses on the list include cripple, genourinary problems, hernia, plague, dysentery/flux, throat problems, speech problems, parasites and cancer (Finucane 1997, 97). This suggests that most children who died would be taken quite suddenly by a fever, but also that infections were common. Many fractures must have healed naturally, with little medical intervention except rest and immobility of the affected bone. However, some monks and nuns may have had some concept of bone setting (Phillips & Biant 2011, 115), and a book entitled the *'Complete Bonesetter'*, revised in AD 1656, was authored by Thomas Moulton a friar of the order of St Augustine who lived during the sixteenth century AD (Homola 1963). Archaeologically few fractures are recorded on sub-adult remains, this is probably because the sub-adult skeleton is rapidly growing and most fractures on children's bones will therefore heal fast, with any evidence of trauma to the bone being quickly erased (Roberts 2000, 345). One case is described by Gordon (1991, 155) of a little girl whose leg broke in a snare, her parents folded a silver coin and placed it within the bandage wrapped around her leg. They promised Thomas Becket the coin and one like it every year in return for her recovery. She was healed eight days after the injury.

The majority of accidents in the miracle records took place in rural villages or small towns. The most common ones found by Gordon (1991) was near drowning, at 56% of instances, followed by concussion (13%), lacerations (7%), choking (6%), suffocation (4%), fractures, sprains or dislocations (3%), abrasions (2%), burns (2%), and strangulation (2%), with the other 5% listed as “other”. These match well with Finucane’s (1997) data which are listed in the order of most instances, but not as percentages. Drowning comes first followed by injury caused by crushing/piercing, trips/falls, choking, burning and an encounter with an animal (Finucane 1997). From the tables provided by Hanawalt (1977), drowning also tops the most common cause of accidental death (49%), followed by equipment injuries (21%), fire (18%), and lastly animals (4%), heavy objects (4%) and falls (4%).

Dangers of accidental death begin at infancy. The most common accident for infants, in the coroners inquests, are those which involved being burnt in their cradle; typical cases involved chickens or pigs knocking burning straw or embers into the cradle, and fire is mentioned in 48% of cases involving one year olds (Hanawalt 1977). The extent of burns recorded indicates that children were often left alone in the house, probably while parents were working in the fields, or running errands such as collecting water. Records of burns are quite rare in the miracle records; only recorded as 2% of incidences by Gordon (1991), in contrast to 18% overall from Hanawalt’s (1977) data. The practice of swaddling babies could result in strangulation if insufficient care was taken, or in the cases where infants were tied to their cradles. In fact, parents were warned against this practice in an early fourteenth century handbook for Priests¹⁵ (Finucane 1997, 40). This handbook also advised against parents having children in bed with them in case of smothering. Infants then, as today, liked to put things in their mouths and this was often the cause of choking, one infant even choking on a pilgrims badge of St Thomas Becket (Gordon 1991, 154). Extreme grief is recorded by the parents if they had a stillborn child, especially if the child had died before baptism. There are also recorded instances of the parents praying to a Saint, which leads to the awakening of the baby, who cries and can then be baptised (Finucane 1997, 40). Finucane (1997, 47) even states, that baptism was so important that parents would baptise a child before committing

¹⁵ *Oculus Sacerdotis* written around AD 1320.

infanticide, and relates the tale of a girl impregnated by her stepfather who baptised her child before throwing it in a sewer.

The occurrence of infanticide in the period is controversial due to unreliable data; Hanawalt (1977) found only two references to the practice in England. However the death of a newborn could have easily been disguised for a natural or accidental death. Legal attitudes to infanticide were that infanticide was treated as something less than homicide, but that it was worse than negligence leading to death (Gies & Gies 1989, 204). The hypothesis that infanticide was sometimes concealed by accident is unsupported by the evidence of the classical pattern of bias against female children (Gies & Gies 1989, 204). Many more male than female babies are recorded in the miracle records: 56 boys (78%) and 16 girls (Finucane 1997, 52). Sixty-three percent of the accidental deaths of children recorded in the coroner's rolls for Northamptonshire were of males (Hanawalt 1977, 10). For older children in the miracle records, 110 boys (67%) and 55 girls are recorded by Finucane (1997, 141), and 81 boys (64%) and 46 girls are recorded in all by Gordon (1991, 141). It is possible that boys were favoured over girls and therefore it may be more likely that an appeal would be made to a Saint, but it may also be that boys were more likely to be written about, as girls are mentioned in the same way, and with the same emotions, as boys.

By the third year of age cradle deaths are no longer common, with children now open to outside stimuli. The most common accident listed for children, by all three researchers, was drowning, seen as 49% of deaths in the coroner's inquests (Hanawalt 1977) and 56% of accidents in the miracle records (Gordon 1991). The incidents of near drowning involved pits, ponds, ditches, rivers and streams, wells, mill wheels, bathtubs, harbours, rain barrels, wine casks and ale vats (Gordon 1991, 151). Water seems to have been a potential hazard to children in whatever form it was found. Toddlers like infants seem to have been commonly left alone or in inadequate care, possibly with older children or the elderly.

After children reached the age of four years old Hanawalt (1977) found that the rate of accidents dropped dramatically. From this age children could now keep up with their parents and therefore possibly spent more time with them. In fact, it seems that between the ages of four and seven years children had more supervision than in their earlier years. This is not necessarily due to a lack of concern about infants, but probably due to

the demands on their parent's during the working day. The accident pattern does not indicate that the children were working as they still seem to be entirely related to games and playing. More boys are involved in the accident reports and it is likely that boys were exposed to more risks. Girls were more likely to be involved in accidents within the home involving pots and cauldrons (19% girls: 7% boys), whilst boys were more likely to wander and be involved in drowning outside the home environment (38% girls: 55% boys). Greater physical mobility without sufficient motor skills probably caused many of these accidents, common explanations in the rolls being that a child was trying to pick something out of the pond such as floating feathers (Hanawalt 1977, 16).

In these accounts, custodial oversight, normal childish behaviour and misadventure seem to be the cause. Infants will put things in their mouths, toddlers will wander off, older children, especially boys, will play games of a risky nature, such as tree climbing and swimming in rivers. However, even girls could be boisterous; nine year old Joan tripped and fell on her knife whilst running in the garden '*as girls do*', cited by Gordon (1991, 159) from the chronicles of miracles of Henry VI. In most cases the parents, neighbours or bystanders quickly made impassioned pleas to the saint. This was sometimes accompanied by the bending of a penny over the child or measuring the child with string¹⁶. This suggests that the death of the child was a terrible thing and that all present would do what they could to prevent it happening. They also show the concern that is felt by parents for the welfare of their children, even in their admissions that they should have kept a closer eye on them, such as the Flemish sailor who let his daughter be minded on the beach by a girl '*too young to be a proper guardian*' (cited by Gordon 1991, 157). '*The behaviour and activities of the children and adolescents described were age-appropriate and typical of childhood and adolescence as we understand them today*' (Gordon 1991, 146). Gordon (1991, 163) goes as far as to say that the children depicted in these accounts enjoyed their childhood, and that they were inquisitive and adventurous, if inexperienced, and often poorly supervised.

Some of the accidents show that children were already involved in some work that perhaps they were not really fully capable of performing, such as the six year old who

¹⁶ Gordon (1991) describes these as peculiarly English rituals. The penny was offered and would be taken to the Saints' shrine on recovery of the child; the measured string would be used as a wick for a votive candle, or served as a measure for how many candles would be brought to the shrine.

fell in a well whilst collecting water (Finucane 1997, 111). A reference is made to a five year old who could not perform her tasks due to her illness. At this young age they were probably more help around the home rather than paid workers. Those injured whilst working were usually older and more able to care for themselves, such as the nine year old who fell on her spindle whilst walking and spinning. An incident of suffocation involved an adolescent girl who was working in a sand pit when the sides collapsed; she recovered after being dug out by her colleagues (Gordon 1991, 154). Parents may have taken toddlers to work with them once they could walk and talk. A fork was thrown through a man's daughter who was playing unseen in the straw (Finucane 1997, 113). The anguish of parents is often recorded even if those same parents have been careless when dealing with their offspring. One example records a French mother trying to throw herself into a well in her distress, the well which drowned her daughter (Finucane 1997, 154). Anger and shame are also emotions recorded, as in anger towards the person who may have caused an accident and shame over their own negligence (Finucane 1997, 134). Both the coroners and miracle records show that there were fewer accidents in urban settings than rural ones (Hanawalt 1977, 4; Finucane 1997, 167). It is not until they reach the ages of eight to twelve years that children now seem to be carrying out work tasks. Boys are employed as shepherds, mill hands, reapers, and servants, and girls carry out duties such as gathering wood, minding children and working in the fields at harvest-time. Accident patterns now become more closely related to those of adults (Hanawalt 1977, 19).

Finucane (1997) grouped the number of accidents by age group, whilst Hanawalt (1977) separated them by yearly age. Gordon (1991) presents no details on the ages of the children mentioned. If the data provided by Hanawalt (1977) are converted into the age groupings that Finucane presents then the instances of accidents by age group for the two types of evidence can be compared (Table 3-3).

The ages of the children mentioned in the records by Finucane (1997) and Hanawalt (1977) are highest in the younger age ranges. For the Saints miracle records it is highest for those under two years of age, and for the coroners' rolls records for those between the ages of two and four years. As will be seen in Chapter Eight and in Appendix A, children from this age range are often well represented from cemetery excavations. Both authors note that the rate of accidents decreases as the children become older, with a

marked decrease once toddlers reach the age of four in the coroner's records (Hanawalt, 1977). If the 110 instances of neonates from the Saints records provided by Finucane (1997) are added into the <2 year category, this increases the data considerably as 25% of the children listed are described as newborns. This high number shows that newborns were seen to be as worthy of a plea to a Saint as older children.

Table 3-3: Percentage of accidents or deaths recorded for children, by age.

Age range	Finucane (1977)	Finucane, with neonates	Hanawalt* (1977)
<2 years	28%	46%	23%
2-3 years	25%	19%	52%
4-5 years	14%	10.5%	10%
6-7 years	13%	10%	4%
8-9 years	8%	6%	4%
10-11 years	2%	1.5%	3%
12-13 years	6%	4%	4%
14-15 years	4%	3%	-

* data recorded up to the age of twelve years only.

Finucane (1997) suggests that the records make it clear that parents loved their children, but that love does not necessarily imply understanding the needs of those children. Adults recognised children as playful and active and that they had little discretion or judgement (Finucane 1997, 10). The ages of the children involved and the types of accidents are similar to the kind of problems we would expect unsupervised children to experience today.

3.5 Children's artefacts, games and toys

Another way to try and find information about children in the past is by recognising their activities, usually in the form of artefacts or toys which would have been used by them. Many games and toys are known from the late medieval period and a great number are depicted in Breughel's famous painting "children's games" (Figure 3.6). Hindman (1981) lists all the visible games and activities that are depicted in this painting. Some objects that we would identify as toys are present including a hobby horse, dolls, a ball, a spinning top, a swing and a pair of stilts. However, mostly the objects used are ones that we would not necessarily regard as items used for play such as, barrels, hoops, brooms, hats, sticks, an animal bladder and knucklebones. One child is even playing with a stick in some dung. The vast majority of games being played do not involve portable objects that might be thought of as toys, including fence riding, rail swinging, skirt twirling, running up an incline, running between the legs of seated

children, king of the castle, leap frog, tug of war, and games of pretend baptism and wedding processions. Activities depicted that could have caused death or injury, similar to those mentioned in section 3.4 include, swimming and tree climbing.

Figure 3.6: Kinderspiele – Children’s Games by Pieter Bruegel 1525-1569.

Downloaded from http://gardenofpraise.com/images/Bruegel_games.jpg.

Professional toymakers are recorded in Europe as early as the fifteenth century with the first in Nuremberg in AD 1413 (Wileman 2005, 42). Mygland’s (2007) study of artefacts from medieval Bergen has uncovered 2500 objects which may have been used by children, including toys and shoes. Toys included balls, marbles, skates, bone buzzers, rattles, dolls, toy boats, animal figures, humming tops, yoyos and miniature weapons. He found that the majority related to role playing which reflected adult activities (2007, 102). He also suggested that the number of toy weapons were greater in troubled times, whereas boats increased in periods dominated by shipping and trade (*ibid.*). Most of the identified toys were for boys and of interest to the seven to twelve year old age range. This suggests that, rather than being concerned with adult work and affairs at seven years, boys at least were involved in much play. There is less evidence for younger children’s toys, although the more mobile nature of older children may mean that their toys were more often lost and therefore recoverable archaeologically. There were also many older children’s shoes found, but this may also be explained by

the town location of the finds, and it is possible that they were part of the workforce. Some infant shoes have also been recovered and Mygland states that this definitely points to care of small children by putting the very young into shoes (2007, 103).

Egan (1998) has looked at the medieval toys that have been recovered from London; these like those from Bergen also tend to be of miniatures representing human figures, and household and military objects. The miniaturised household objects include stools, jugs, cauldrons, and even frying pans complete with little fish (National Geographic News 2004). It could be suggested that these are the types of toys that would be designed for girls. A number of tiny metal anchors found in the Thames may be indicators of lost toy boats, though no actual boats have been found in England (Egan 1998).

Lewis (2009) has taken the search for children's games into the landscape, and by looking at site plans from the excavations of medieval buildings and villages has concluded that some of the unexplained features may have come about by children's play. Examples include small clustered stake holes on the boundaries of complexes, which could be markers for ball games (2009, 100) and clusters of scattered stones, associated with hollows, which could have been used for a throwing game such as quoits (2009, 103). She suggests that children's activities should be kept in mind as well as adult ones for interpreting archaeological sites. *'After all, think ... how a child blind archaeologist might interpret a 'circle of upright stones' abandoned after an early Irish game of rounders'* (Lewis 2009, 105).

Crawford (2009, 55) also makes the point that for children any object may potentially be a toy but there will be few that we as adults will confidently recognise as such. Something that we can recognise as a toy will have been made for that purpose probably by an adult, but, children can and do *'transform objects into toys when they play with them'* (2009, 66), regardless of what the object is designed for. Take as an example the child described above who choked on a pilgrim's badge which she placed in her mouth; to her this was a toy and something interesting and shiny to be explored and played with.

3.6 Summary

This review of some of the current historical thinking on the concept of the child in late medieval society has shown that children were seen as having a separate identity to that of adults. Comparisons of the stages of childhood recorded from the late medieval period, to modern examples of cognitive and biological stages, suggest a close similarity. This indicates a close link between the observation of growth and development, in terms of cognitive advancement and motor skills, as well as biological aspects such as dental eruption, in dictating how a child was viewed and treated in the past.

Shahar (1990) states that the dominant view from historical texts is that the period of infancy was a time that children should be treated with tenderness and not burdened by demands for discipline and self restraint. She believes that Ariès mistakes this for benevolent neglect by using comparisons of eighteenth century practices of rigid discipline even for the very young. Hanawalt (1993) has however criticised Shahar's interpretation as largely psychoanalytical, and that her conclusion on the definite existence of a sentimental attitude toward children relies too heavily on the upper classes and moralist views of the period.

Children's lives could be precarious and the death of children in the period was undoubtedly a frequent occurrence, but, this does not preclude the love and care of parents and their grief when a child died. The depictions of children, including dead children, on the tombs of their parents indicate the importance of the family and of the children born to them, both dead and alive. The evidence from coroner's inquests, miracle records, and Hagiographies do indicate that parents were emotionally attached to their children. That the parents of the children, involved in accidents or illnesses, are emotionally overcome by grief on the loss of a child are often cited (Gordon 1991; Finucane 1997; Hanawalt, 2002).

The evidence for the development of the child, and his/hers eventual arrival into adulthood, does show some discrepancy in the timing of responsibilities between the different classes and also between males and females. Whereas at the age of twelve children may have become adult in the way they were viewed by the law, and in some of the responsibilities placed on them, it is also clear that for some members of society full adulthood was not attained until they were into their late teens or twenties. This

makes it difficult when looking at the skeletal remains of individuals to determine whether they should be included as children in cultural or social terms. As described in Chapter Two, biologically the skeleton becomes adult once all the epiphyses of the limb bones have fused, by around twenty years of age. However, in the late medieval period a child may have been treated in some respects, such as via the law, or through an apprenticeship, as an adult from the age of twelve years. The evidence suggests that those under the age of twelve were classified as children and probably still involved in childish pursuits and activities. For individuals over this age, some of them may have been treated in ways very similar to adults and they may well have been working, whilst others may still have been regarded as children. The accident patterns reviewed by Hanawalt (1977), Finucane (1997) and Gordon (1991) also indicate that childhood stages reflect how children were interacting with society and the environment in which they lived. Evidence for children's toys from the period, and the games that they played, also indicate a childhood for which, although it may have involved many hardships, there was still fun to be had. It appears that very few children would have had the full set of adult responsibilities placed upon them until they were in their late teens, or even possibly their early twenties.

Chapter 4 : Medieval populations, burial practice and taphonomic bias

4.1 Introduction

Excavations of late medieval cemeteries can provide us with a wealth of information about how people lived in the past and how they were treated after death. The larger the area of excavation, and the more individuals recovered, the more we can say about population dynamics in the period. Both cultural and natural processes have an effect on the burial environment and, therefore, on the preservation of the human remains and associated artefacts recovered by excavation. The burial archaeological record will determine how we interpret past treatment by populations of their dead. The preservation of the recovered skeletal remains will influence the demography of past populations, including infant mortality and life expectancy. This chapter will first focus on the evidence in the literature for late medieval population structures, from both archaeological and historical evidence. Evidence for late medieval burial practice from the archaeological record will be reviewed, followed by a discussion on taphonomic processes and how they can determine what can be recovered archaeologically.

4.2 Palaeodemography

Demography involves looking at the structure of living populations by using census data such as birth, death and burial records. It encompasses research into population structure (age and sex), mortality rates, fertility rates and population growth. Whilst demography looks at living populations, palaeodemography looks at data from archaeological skeletal remains. Evidence for the demographic profile of a late medieval population can be determined from historical documentary sources, or from a skeletal population excavated from a cemetery context. Both will have inherent problems and inaccuracies. In the case of historical documents, births and deaths were not recorded in a systematic fashion in the late medieval period, and historians often have to tease out the data from the records that they have available (Razi, 1980; Hanawalt, 1993). When trying to determine figures for birth and mortality rates of infants these problems may become even more pronounced. As shall be discussed in section 4.4, the small fragile bones of infants may not be recovered as frequently as the more robust bones of adults and older children from an archaeological context. When referring to historical registers, infants who died soon after birth, and possibly before baptism, may not be recorded at all.

One of the first facts to be aware of when trying to reconstruct populations from skeletal material is that we are looking at the dead and not the living. Wood *et al.* (1992) have termed this the "*osteological paradox*". The child skeletons that are recovered are from individuals that died young, and never became adults. This may imply that they are likely to have had less well adapted immune systems and have been more susceptible to stress and disease. There will never be the chance to obtain data on children in the archaeological record that will have grown up to become adults, however, some skeletal indicators that appear during childhood will still be observable in the adult skeleton, such as enamel hypoplasia and cribra orbitalia. Attained adult stature will also give us an indication of the growth potential of the population under study. It is important to be aware of these limitations when we try to interpret the lives and dynamics of the living from the remains of the dead.

Archaeological recovery can also be biased against the collection of infant bones as these are much harder to identify than adult bones. Where excavators are trained in the recognition and recovery of human remains, and where soil sieving strategies are in place this should alleviate the problem. Other problems associated with archaeological recovery methods can include whether the site is fully excavated, and whether the limit of the cemetery is known. A skeletal population will only ever be a small portion of a once living population (Waldron 1994, 13). Cultural biases can also influence skeletal samples recovered from a cemetery. These can be exclusions by sex or age within certain areas, or may involve differential burial treatment. Before any cemetery population can be analysed demographically, it is important to be aware of any cultural practices that may have influenced the recoverable skeletal population. From the results of several cemetery excavations listed in Appendix A, it appears that males seem to far outnumber females, with the excavations from St Helens-on-the Walls providing the exception. It is not clear why this should be the case; there may have been more males than females in late medieval society, or the areas that have been excavated at most sites may be favoured towards male burial. It is also known that methods, used to assign sex to adult skeletons, tend to be biased towards assigning male sex (Mays & Cox 2000, 125); however this alone could not be the reason for the high ratios of males to females seen at some sites.

4.2.1 Infant mortality

Many poor nations today have infant (child under one year old) mortality rates above 100 per 1000 births, equating to 10% of infants dying in their first year (Bogin 2001, 44). In considering mortality rates in the past, Schofield and Wrigley (1979) looked at the parish record data for the period AD 1550-1649. They found infant (<1 year) mortality rates varied by parish with the highest rate, 21.9%, at Gainsborough, Lincolnshire (a large market town), and the lowest rate, 9.4%, at Hartland, Devon (a rural parish). The low figure at Hartland suggested that some of the deaths of infants may not have been recorded. However, when those dying before one month of age (usually from endogenous causes, such as congenital defects or birth trauma) were compared with those dying after one month (usually from exogenous causes such as infectious disease), the rates of very young infants (those which would probably be less well recorded) did not seem depressed compared with previous studies on European data (Schofield and Wrigley 1979, 80). This suggests that rates below 100 per 1000 live births may not be too low for certain parishes, at least in the Tudor period, if not late medieval England. The mean rate across the eight parishes studied was 13.7% for males, and 12% for females (Schofield and Wrigley 1979, 66). The rates in their study reduced as children became older. The mean rate for those aged between one and four years of age was 8.3% for males, and 8% for females, and for those aged between five and nine years of age was 3.8% for males and 3.5% for females (*ibid*). The males had a slightly higher death rate than females in all cases. Whether this is due to a higher incidence of deaths of male children, which may be the case due to a higher incidence of live births¹⁷, or to the under recording of female children, is not known.

Mays (1998b, 201) refers to the fact that infant burials are usually only found in small numbers from late medieval cemetery sites. When comparing these figures with those inferred from historic sources, there is definitely a lack of infant remains from some sites, including St Helen-on-the-Walls, York (Dawes & Magilton 1980) and St Nicholas Shambles, London (White 1988), where infants represent only 3%¹⁸ and 5%¹⁹

¹⁷ Tables on birth and infant mortality rates published in The United Nations Demographic Yearbook (2008) consistently show for all countries, including the United Kingdom, a higher incidence of male births (ratio 1.05:1 males to females in the UK), and a higher rate of male infant mortality (ratio 1.3:1 males to females in the UK).

¹⁸ under 2.5 years

respectively of the skeletons excavated. Mays (1998b) suggests that the figures for Wharram Percy (19%)²⁰ are probably nearer to the expected figure. Mays (1998b, 201) states that infant remains are often as well preserved as adult remains; this is certainly the case for the remains from the three sites analysed for this thesis. It may therefore be more likely that excavation methods, the partial excavation of most sites, the shallowness of infant graves, and contemporary disturbance of burials due to the pressure on medieval cemeteries, may have more to do with the low recovery rate of infant remains, rather than the actual fragility of the bones themselves. Most of the infants recorded from St Helen-on-the-Walls came from within adult burials, and half of all infant bones recovered were from disturbed contexts; this supports the idea of shallow graves often being the problem for good preservation (Dawes & Magilton 1980, 27). The York parish register suggests an infant (less than one year) mortality rate of 250-300 per 1000 births (Dawes & Magilton 1980, 82), making it fairly obvious that the 3% figure is not representative of all the infants who would have died in the community.

As mentioned in Chapter Three, infanticide seems rare from the coroners' rolls and of 4000 homicide cases only two involved newborn infants (Hanawalt 1977). The murder of toddlers and older children was also rare (2% of all homicides). Some were accidental slayings, some due to burglaries, and only three cases appeared to have been malicious killings. However Hanawalt (1977) makes the point that infanticide was not consistently illegal in the late medieval period, and that a statute law was not passed against mothers killing their illegitimate children until AD 1623. In any case, infanticide could easily have been a concealed crime, making prosecution difficult. The figures provided by Hanawalt, as shown in Chapter Three, indicate that fifty percent of accidental deaths involving infants were caused by fire and twenty-one percent by drowning. Could some of these accidents have been merely neglect, or is it possible that they were premeditated murder? Often, higher female infant deaths are linked to infanticide (Mays 2000), but in the coroners' rolls the percentage of boys being involved in these accidental deaths is much higher than those for girls (63%). The fact

¹⁹ under 2 years

²⁰ under 2 years

that the discrepancy of deaths increases with the age of the children reflects modern incidences, with boys usually being more adventurous than girls and therefore more likely to have accidents. It is of course possible that with high infant mortality, possibly in the region of thirty to fifty percent, there was no need for infanticide. Children may have been highly valued as they were to become the workers and labourers needed in peasant societies.

At both Wharram Percy and St Helen-on-the-Walls it is children of six years and under that make up the highest number of sub-adult individuals recovered from the two cemeteries. At Wharram Percy the infants (<2 years) and preterm burials make up forty percent of the sub-adults and the children aged between two and seven years make up thirty-one percent. At St Helen-on-the-walls the infants make up thirty-one percent and the children aged between two and seven years, thirty-two percent of the sub-adults. Those sub-adults in the over twelve year age range make up the smallest number in both cases (18% and 9% respectively). As shown in the footnotes on the previous page, where the age ranges quoted in different reports do not correspond, it can be difficult to accurately compare the data, as different authors will group the remains into different age ranges. Therefore, unless the full inventory of each skeleton is present, it can be impossible to be able to compare the data in a meaningful way. Another cause that exacerbates this problem is the use of different ageing methods. Appendix C shows a comparison of the sub-adult skeletons from Wharram Percy which have been reported on by both Lewis (2002a) and Mays (2007) using different ageing methods (Moorrees *et al.* (1963a; 1963b), and Schour and Massler (1941), respectively). There is shown to be a statistically significant difference between the two results, implying that to enable true comparisons to be made across skeletal collections, the same methods need to be employed. This problem will be addressed again with the recording of other aspects of the skeleton such as pathological lesions in Chapter Five. Appendix A lists the details of some published late medieval skeletal collections, with more than fifty sub-adults present, indicating the numbers of sub-adult remains present and a breakdown into age categories, where this has been possible.

4.2.2 Historic evidence for demography

Whereas archaeologists look at skeletal populations, historians use historical documents to produce demographic data (Le Roy Ladurie 1978; Razi 1980; Hanawalt 1993). There are inherent problems with the interpretation of historic evidence for the demography of

late medieval populations, just as there are with archaeological interpretations. For example, in the court rolls, the records are usually only those of tenants; therefore women will be underrepresented (Razi 1980), and birth records were sadly not recorded. In addition only adults over twenty years of age are regularly recorded, as this was the minimum legal age for holding land, and children are only usually mentioned once they have reached twelve years of age. Another aspect of uncovering information about children is from records of orphans. Hanawalt (1993) reviews the data on London orphans recorded as "wards" in the Letter Books from AD 1309 to 1497. Those orphans who become wards are, however, only going to be those from wealthy families, as their inclusion in the Letters Book means that they have an inheritance. Although these are records of children, listing their survivorship and their siblings, most of these children were at least seven years old when they became wards so this will not shed any light on the demography of younger children. The record of average family sizes, from work on the Inquisition Register²¹ in the work of Le Roy Ladurie (1978), although containing a lot of detail of the villagers' everyday life is again not an accurate record of births and deaths, or even a complete list of members of the living families. Therefore, whilst it is worth exploring these sources for information on child mortality and family size in the late medieval period it must be realised that the data, like that from an archaeological excavation, will not represent all members of a population.

4.2.2.1 "Great Famine" and the Black Death

Razi's (1980) study on the population of Halesowen focused on the fourteenth century AD. In the 1320s the population reduced by fifteen percent, possibly an effect of the "great famine" years (AD 1315-1317), but had almost recovered to peak levels by the eve of the Black Death coming to England in AD 1348. A rise in marriages is recorded in times of high mortality, possibly as young villagers inherited land. A drop in marriages coincides with the "great famine", suggesting they were postponed until better times (Razi 1980, 47). After the famine from the period AD 1336-48 there is a forty-nine percent rise in marriages, possibly due to a baby boom after the famine years passed. This would also explain the rapid recovery of the population. From the years AD 1347-1350 the Black Death affected all of Europe, including England from June

²¹ The Inquisition register recorded the testimony of the villagers of Montailou, France during the period AD 1318-1325.

AD 1348 to the autumn of AD 1349. Mortality rate estimates range from 20-50% of the population succumbing to the disease (Razi 1980; Goldberg 2004; Rigby 2006).

Indirect evidence suggests that child mortality was high. In Halesowen, of the seventeen people recorded aged between twenty and thirty-nine years of age who died in the famine, five were childless (29%). Of the twenty-six victims of the Black Death in the same age group nineteen (73%) '*died without issue*' (Razi 1980, 104). As those recorded are landholders it can be assumed that they would have been married with at least one child. Therefore, child mortality would have been catastrophic. On the manor of Halesowen at least 40% of tenants died during the first outbreak and the population continued to decline into the fifteenth century due to secondary outbreaks of the plague. Three periods of high mortality coincide with the outbreaks of plague in AD 1361-2, 1369 and 1375, and although there is no specific child data, contemporary records report that the plagues of AD 1361-2 and 1369 affected heavily the infants and children (Razi 1980; 129). However, the evidence for sub-adult remains from the AD 1348/9 East Smithfield Black Death cemetery in London suggests '*that the pestilence did not carry off children preferentially*' (Grainger *et al.* 2008, 25). For the period AD 1350-1400 the mean number of offspring calculated from the court roles had dropped considerably compared to that of AD 1270-1349; from 1.8 to 1.4 for the poorest and from 5.1 to 3.0 for the richest peasant families (Razi 1980).

4.2.3 Family size and child mortality

The discrepancy in family size shown by Razi (1980) implies that more of the richer peasants' children survived to their twelfth birthday than those of the poorer families. Richer women may have married younger, and lived longer, so these results would therefore be affected by fertility as well as mortality rates. Those who lived to an old age appear to be mainly the more wealthy peasants. For example, John Schirlet from Huntingdon who died in AD 1337 was aged eighty-six years (Razi 1980, 60).

Figures for childhood mortality and the average number of children per family for London have also been explored (Hanawalt 1993). Of those wards for which the outcome of their wardship is recorded, thirty-two percent died before they came of age²²

²² 21 years for males and unmarried females; younger if a female married.

(Hanawalt 1993, 57). The average family size from the Letters Book suggests that between AD 1309-1348 (pre plague years) the average number of children per family was 1.79; this figure drops between AD 1349-1358 to 1.5 (Hanawalt 1993, 48). During the fifteenth century the number rises from 1.98 at the start to 2.2 by the second half of the century (*ibid.*). It must be noted however that this is not a full picture of the fertility cycle as it is possible that children by a first or second marriage were present who would not be mentioned (*ibid.*); neither would children who had died. The increase seen in average children per family may represent greater longevity of the parents as opposed to the children. Hanawalt (1993) notes a disparity in the number of girls and boys entering wardships. Of those counted 780 (45%) were girls and 951 (55%) were boys. This varies over the centuries with fourteen percent fewer females in AD 1309-1348, eight percent in the years AD 1349-1398, twenty-two percent in the years AD 1399-1448, then dropping to only two percent from AD 1459-1497 (Hanawalt 1993, 58). The under-representation of girls therefore decreases with the general recovery of the population in the late fifteenth century. There are 105 males to every 100 females born, from modern British data (United Nations Demographic Yearbook 2008), but females have a biological advantage in surviving disease and the initial imbalance is soon lost. Therefore, the shortfall in the wardship records indicates a pattern of early female mortality, which Hanawalt (1993, 58) suggests may be a result of difference in care and nurturing rather than female infanticide. A female child needs a wealth outlay in the form of a dowry, whereas a male child brings in wealth in the form of his wife's dowry. This may mean that male children were cosseted more than females, but it is also possible that daughters were less likely to be left an inheritance, any money possibly passing to a male relative.

Le Roy Ladurie (1978) looked at inquisition records for the French village of Montaillou from AD 1318-1325. He used the records for several families, of which eighteen had forty-two boys and twenty girls, which averages a mean of 2.3 boys per couple (girls are probably under recorded). He therefore suggests 4.5 legitimate births per family for this period.

It is thought that the great majority of medieval households consisted of nuclear families of husband, wife and children with an average family size of four to five people (Dyer 1989, 134). Maddern (2010) has recently questioned this notion of children at home

with the nuclear family. Her research on church court records, and the records of Inquisitions Post Mortem²³, has led her to suggest that the mobility of children to households outside the nuclear family was probably not a rare occurrence. She cites that nearly twenty percent of a large sample of late medieval families lost a parent before the eldest child was thirteen, and that death of a father often led to children being sent to live away from the family.

As discussed in Chapter Three, many late medieval brasses have depictions of the children of the deceased on them, both sons and daughters. A volume on the brasses of Gloucestershire (Davis 1969) contains reference to the depictions of sixty-one sons and sixty-three daughters on all the brasses listed. This evidence suggests that, even if sons were favoured, infanticide was not used as a means of getting rid of daughters, at least for the wealthier elements of society. The majority of female offspring shown on the brasses may indicate that whilst records may tend to overlook females, when it came to depicting the family on monuments, all children were equally important. The brasses also show that the number of children borne to these wealthy parents tended to be high; fourteen children was the highest recorded and four the lowest number.

4.3 Burial Practice

In general medieval Christian burial practice tends to be fairly homogenous. The body is almost always laid in a supine position with a west-east alignment and graves tend to be simple and without grave goods. However, although often subtle, there are variations that can be seen. There was a tendency in the medieval period to classify individuals according to their status whether defined by religious role, lineage, gender, age, or even pathology as in the case of people with leprosy (Gilchrist & Sloane 2005, 56). These classifications may therefore also appear in death through the location of burial, the positioning of the body, and in the presence of inclusions within the grave. Variations in the positioning of the body can include deviations from the norm for alignment, placement of the body on its side or front (prone), and differential positioning of the limbs. Inclusions within the grave can be; burial within a coffin, the presence of grave goods or linings, and the use of stone structures within the grave. By analysing these

²³ The Inquisitions Post mortem are undertaken after the death of a tenant of the crown. They establish what land they hold and the name, age and relationship of the deceased heir.

variations along with the location of each burial within the cemetery, patterns can be seen that may inform us about individual or group status.

4.3.1 Burial location within the church or cemetery

Location of burial may be an important indicator of status with more and less holy areas defined within the church and cemetery (Gilchrist & Sloane 2005, 56). Daniell (1997, 95) describes the late medieval church as a series of concentric rings with the most holy area being the high altar at the east end of the church, the holiness lessening to the west end and out into the cemetery. All the consecrated ground would have been enclosed within the boundaries of the cemetery. Intramural burials (within the church buildings) would have been reserved for those of the religious orders (usually closest to the east end), or to those able to afford such a privilege, with lay burial more usual away from the high altar. Daniell (1997) also suggests that the cemetery itself was divided into areas with some being more desirable than others. His conclusion was that the south side was more favoured than the north, and that the churchyard cross was probably a popular site for burial (Daniell 1997, 99). It has been suggested that the northern side of the church or churchyard was reserved for murderers, people who had committed suicide, and unbaptised children (Stone 1858, 390; Johnson 1912, 351). The monastic sites saw itself as the choice for burial of high status, wealthy individuals and were affronted when people chose to be buried elsewhere (Daniell 1997, 92). The monks and canons would most probably have had their own cemetery, often located at the east end of the church (Daniell 1997, 96). Being buried close to your family members may also have been important, as some of the wills of those requesting to be buried within the cemetery of SS Peter and Paul, Taunton attest (Weaver 1901; 1903; 1905 and see Appendix D).

Zoning of burials by age is evident in some cases with infant burials sometimes clustering along boundary walls or ditches of cemeteries, or around porches (Gilchrist & Sloane 2005, 67). This association with liminal situations may reflect beliefs in the soul crossing the boundary from the earth to the afterlife (Daniell 1997, 100). The burial of children within the church appears to be rare compared to adult burials (Dawes & Magilton 1980; Stroud & Kemp 1993; Mays 2007). At Wharram Percy, sub-adults were more likely than adults to have been buried in the area immediately to the north of the church and infant burials tended to be close to the north wall of the church nave (Mays 2007, 86-87); these included preterm infants, neonates and infants up to their first year

of life. Other sites have been seen to have high numbers of children buried to the north of the church, from the early medieval period at Raunds Furnells (Boddington 1996) to the nineteenth century at Wellington (Horton *et al.* 1993). As suggested earlier, the presence of infants to the north of the church may have been due to them being unbaptised, but, other sources suggest that unbaptised individuals would have been excluded from consecrated ground altogether (Shahar 1990, 51), at least from AD 1400 (Orme 2001, 124). At St Helen-on-the-Walls, Yorkshire the majority of sub-adults were excavated from the southern corner of the graveyard, although very few infants were found (Dawes & Magilton 1980, 11).

The excavations at Castle Green, Hereford discovered that the latest burials (from at least the twelfth century) tended to be of infants or young children. Some were buried with care whilst in some areas they were in shallow graves with no attempt having been made at regularity, and with a wide variety of orientation (Shoesmith 1980, 51). In AD 1398 a royal licence was given allowing Hereford Cathedral to lock its gates at night; the reason stated was to stop the secret burial of unbaptised infants as well as to stop pigs and other animals entering the cemetery and digging up graves (*ibid.*). The irregular infant graves could therefore be evidence for these secret burials. Burial of prone infants, although rare, has been noted on a few sites (Gilchrist & Sloane 2005, 72). It may be speculated that these are unbaptised infants, or it may just be that the shroud wrapped infant was mistakenly placed in the grave on its front.

The presence of graves outside of cemeteries is however rare. One example of an infant's grave, buried beneath a thirteenth or fourteenth century longhouse, is known from the village of Upton, Gloucestershire. The grave was sealed by a stone slab, and a spindle whorl appears to have been placed in the grave along with a whelk shell (Rahtz 1970, 87). The presence of even very young or preterm infants within cemeteries such as at Wharram Percy (Mays 2007) and St Oswald's Priory (Heighway & Bryant 1999), indicate that the exclusion of infants due to the lack of baptism was probably rare. With a high infant mortality rate, there was a real fear that infants may die before they had been baptised, and therefore a lay person was allowed to baptise an infant if the chances of survival appeared slim (Shahar 1990, 49; Orme 2001, 25). This appeared to extend to the baptism, by the midwife, of any part of the infant to emerge at birth if she felt the

child would be stillborn (Shahar 1990, 49; Fleming 2001, 61), suggesting that the death of an unbaptised infant would be rare.

After burial there was a strong possibility that the grave would be disturbed, especially in the popular areas of cemeteries. Of the 234 burials recovered from St Nicholas Shambles, only thirty-six were complete and half were deficient in the head area (Daniell 1997, 123). In terms of location, high status individuals will undoubtedly have chosen the more favoured positions in which to be buried, being inside the church or close to holy areas, such as the cross, if within the churchyard. Low status individuals, and those less able to pay, will have been buried in the less favoured locations. While these more and less favoured locations can be suggested in general, when faced with an excavation plan of a partially excavated cemetery area trying to determine the favoured burial spots is a difficult task. Those areas that are less disturbed may also be later extensions of burial grounds.

4.3.2 Grave furnishing and goods

The majority rite for this period would have been burial of the body that was wrapped in a shroud within an earth-cut grave. Coffined burials are also fairly frequent and burial within stone lined graves, stone-cut tombs and plank burials are in evidence; these types of burial are probably associated with higher status individuals. The fear of disease may also have led to coffined burial; for example, a high number of coffins were in evidence at the Black Death Cemetery at East Smithfield, London (Grainger *et al.* 2008). For most people, although they may have been carried to church, and to the grave, within a coffin, they would have been laid in the ground merely wrapped in a shroud (Daniell 1997, 43-44) (see Figure 4.1); the coffin being reused for another funeral. This suggests that no grave inclusions will be found with the majority of burials of both children and adults.

Figure 4.1: Burial of a shrouded body.

Detail from the Parisian book of hours 1485-90 (Gilchrist & Sloane 2005, 21).

The body of the deceased would have probably been tended by the woman of the house of the dead person, and they also would have sewn together the shroud used to wrap the body (Figure 4.2 and Figure 4.3). Shroud pins are sometimes found on excavation, and these were used to hold the shroud together during the sewing process. They may therefore be seen as accidental losses rather than dress pins meant to be buried with the body of the deceased (Gilchrist & Sloane 2005, 110). It is possible that any personal possessions could have been inserted into the shroud and therefore been included unbeknown to the rest of the funeral congregation. There are several known instances of goods being associated with children and these may be interpreted as having the role of talismans. Examples include: a small shoe buckle, a pilgrim's badge, crosses, a roman coin, a roman bead, fossils, amphora sherds (Gilchrist & Sloane 2005, 223), a Saxon coin, a necklace (Dawes & Magilton 1980, 15), a spindle whorl (Rahtz 1970, 87) and pebbles (Daniell 1997, 164).

Figure 4.2: Sewing up the shroud.

Detail from the Parisian book of hours AD1485-90 (Gilchrist & Sloane 2005, 21).

Figure 4.3: A widow kneels in prayer whilst another woman sews the shroud.

From a small vignette of AD1475-89 (Litten 1991, 59).

As many cemeteries were in use for long periods of time in Britain the disturbance of previous burials was common. Often the disturbed remains were included in the backfill of the newly cut grave, but occasionally they were placed in a deliberate and symbolic way. For example, a cross, made from long bones, was placed over a child at St Anne's, Coventry, Warwickshire (Gilchrist & Sloane 2005, 180), along with the placement of a skull into the skull and crossbones motif, and at Whithorn, Scotland an infant was placed over the remains of an adult woman, and her disturbed arm bones were also used as a cross (Cardy 1997, 551). Figure 4.4 shows the excavation of Tomb 840 from within the church at Taunton, Somerset with the disarticulated bones laid in a cross fashion over the skull of the main occupant of the tomb, an elderly male.

Figure 4.4: Crossed long bones over SK 851.

Excavated from Tomb 840, located inside the church of SS Peter and Paul, Taunton, photo COAS 2005.

Daniell (1997, 162) suggests that fewer than six nails would not have been sufficient to hold a coffin together, whilst Rodwell (1989, 164) suggests at least a dozen would be necessary. However, some coffins may have been held together with wooden dowels or pegs, such as the examples from Barton-upon-Humber, including the coffin of a child (Waldron 2007, 23), or a combination of wood and iron pegs may have been used. Simple wooden boards rather than coffins may also have been used beneath or above the body. Coffin nails associated with a burial may have been displaced from elsewhere during excavation of the grave and therefore care needs to be taken in the interpretation of coffined burials from only a few nails; conversely, no nails does not necessarily mean no coffin (Gilchrist & Sloane 2005, 114).

4.3.3 Body Positioning

Preparation of the body at home (or at an infirmary) would have influenced the decision to arrange the position of the arms (Gilchrist & Sloane 2005, 151). Other factors, including the tightness of the shroud, size of the grave, and placement within a coffin, will all influence the position in which the skeleton is recovered during excavation. Taphonomic factors will also play a part; as the body decays, the thoracic and abdominal cavities will collapse. If the arms are located over these areas they will collapse into the vacated area and, depending on the speed of sedimentation and permeability of the soil, the bones move within the area of the body (Roksandic 2002). This means that care has to be taken in the interpretation of body position, because the way a skeleton is found may not necessarily be the way in which the body was

originally laid out in the grave. The skull and mandible tend to detach from the rest of the body first, the skull having a tendency to roll backwards or to the side. Therefore although it is worth recording head position, this may indicate more about taphonomic factors involved after burial than the positioning of the body in the grave (Roksandic 2002, Gilchrist & Sloane 2005, 152). In fact, study of body positioning can aid in the interpretation of whether the body was tightly wrapped in a shroud or contained in a coffin (Roksandic 2002). Figure 4.5 depicts the excavation of a skeleton which appears to have been tightly wrapped in a shroud due to the close positioning of all the skeletal elements, even though taphonomic displacement of the bones can be seen. Some research has also been carried out into the positions of the arms of excavated skeletons and some differences in relation to sex and changes over time have been suggested, the crossing of the arms over the chest or stomach becoming more common later in the period (Gilchrist & Sloane 2005, 152).

Figure 4.5: Shrouded burial of SK 1646, aged ten years.

From area 1 of the cemetery at Taunton, photo COAS 2005.

Burial on one side is sometimes seen for young children and infants, but hardly ever for adults, suggesting that it may be deliberate (Gilchrist & Sloane 2005, 155). This may be because the flexed position is more natural for an infant to be laid rather than the supine position. Double or multiple burials are also fairly common for young children including examples at St Helen-on-the-Walls (Dawes & Magilton 1980, 11), St Gregory's Priory, Canterbury (Anderson & Andrews 2001, 340), and Whithorn (Cardy

1997, 551). Three double burials involving children were recovered during the excavation at Taunton in 2005. If two children died in the community around the same time it was perhaps reasonable, both in monetary and possibly emotional terms (the feeling that the dead child would not be alone), to bury them in the same grave. Children were also sometimes buried in the same grave as adults. These are often mothers and newborn children who both died at or soon after birth. There were several examples at St Helen-on-the-Walls of females buried in close association with infants (Dawes & Magilton 1980, 11). Examples of older children buried with adults are also known (Stroud & Kemp 1993, 142); children dying at the same time as adult relatives may have been buried with them, possibly for similar reasons as suggested for double child burials.

4.4 Taphonomy

Taphonomy is the study of the laws of burial and can involve both natural and cultural processes. Natural processes involve the decomposition of the body itself by both putrefaction, involving bacteria, and autolysis, involving autolytic enzymes, (Roksandic 2000, 101), and the nature of the sediment in which the body is buried (involving compaction, grain size and pH value). Post-depositional forces will also play a part and may modify the appearance of the skeleton and may involve the impact of roots, insects, burrowing animals, the permeability of the sediment, and the chemical nature of the permeating solutions in which the body is buried (Lyman 1994, 405). The way in which the body decomposes will also be influenced by factors such as cause of death, state of the body at death, age, sex, body mass at death, and pathology (Roksandic 2002, 101).

Cultural processes include how the body was treated after death, mode of burial, and selection of the burial site. In the late medieval period this may have involved placement of the body within a shroud or coffin, followed by interment within a soil dug grave, a stone lined or cut tomb, or a crypt or vault (Daniell 1997; Gilchrist & Sloane 2005). Time elapsed before burial may have an effect on the decomposition of the body (enabling flies to lay eggs) as well as the preparation of the body, for example the application of oils (which may deter flies). Depth of burial will also be a factor in the preservation of the grave over time, as will the reuse of the land.

4.4.1 Preservation of infants and children

Once a body is buried there are many different processes that can occur until it is recovered. The preservation and recovery of skeletal remains is one limitation that we need to be acutely aware of when studying skeletal populations. The preservation of the skeleton will depend on both intrinsic factors, including the size and density of the bone, and extrinsic factors including the type of soil, the depth of burial and types of disturbance (Buckberry, 2000). Sub-adult bones are smaller and less dense than those of most adult individuals²⁴ and may tend to be buried in shallower graves. Excavation techniques and the experience of the excavators will therefore also play a part in the amount of material that is finally recovered for analysis.

4.4.1.1 Size and mineral density of bone

Bone consists of both organic and inorganic components. About 70% is made up of the inorganic mineral hydroxyapatite, whilst the remaining 30% is organic matter and mostly the protein collagen (Lyman 1994, 72). The mineral component provides hardness and rigidity to the bone, whilst the organic matter gives bone its strength and elasticity. In skeletons the organic component has often mostly decayed leaving only the mineral or apatite. The density and size, and therefore strength, of the bones in life will also reflect the preservation of the bones after death. Sub-adult bones are in the process of growing, the “woven” bone that is deposited during the growth process is more porous and therefore less mineralised than adult bone (Lyman 1994, 85). Sub-adult bones may therefore be expected to be less well preserved in the archaeological record.

Paine and Harpending (1998) suggest that post depositional disturbance and decay particularly affects infants, as they have smaller and more fragile bones which degrade at a faster rate. At the poorly preserved site of St Helen-on-the-Walls, York sixty-five percent of excavated skeletons (both adults and sub-adults) could not be assigned to a specific age group (Boddington 1987, 187). This clearly would have implications for how representative such an assemblage would be of the contributing population.

A study to look at differential preservation was carried out at a nineteenth century mission cemetery near California (Walker *et al.* 1988). The burial records were

²⁴ Old age and disease can lead to less dense bones in adults, for example, osteoporosis.

compared to the skeletons excavated to look for any recovery biases. Comparisons of age distribution revealed that, although thirty-two percent of the burials at the cemetery had consisted of individuals less than eighteen years of age, they represented only six percent of the recovered skeletons (Walker *et al.* 1988, 185). The preservation in general at this site was poor, but the smaller size and lower density of the sub-adult bones appears to have caused more rapid and complete decay compared to those of adults. In contrast, Saunders *et al.* (1995) found good preservation of sub-adult burials at the nineteenth century cemetery at St Thomas', Belleville, Ontario, US, where the infants (less than one year of age) recovered were actually over-represented when compared to the burial records for the cemetery. A higher percentage (98%) of sub-adult individuals also had dental or skeletal age indicators preserved when compared to the adults (Saunders *et al.* 1995, 77), indicating that as this cemetery sub-adult skeletons were as well, if not better, preserved than the adult remains.

Trotter & Hixon (1974), in their study on bone weight and density (as measured by weight of dry bone/volume within its external surface) of cadavers, found a number of infant individuals (between birth and two years of age) whose bone densities were lower than those of foetal remains (Trotter & Hixon 1974, 10). They attributed this loss in bone density after birth to the rapid bone growth seen in the infant skeleton (*ibid.*, 11). In a review of the clinical literature, Rauch & Schoenau (2001) define bone mineral density (BMD) in three different ways (material²⁵, compartment²⁶ and total²⁷), depending on the way in which the density is measured. All types of measure confirmed the initial loss in bone mineral density, seen by Trotter & Hixon, in the first few months of life followed by an increase, most of which occurs in early childhood (Rauch & Schoenau 2001, 599 & 601).

²⁵ material BMD is defined as the amount of mineral in the bone matrix, and excludes the spaces for marrow, osteonal canals, lacunae and canaliculi.

²⁶ compartment BMD is defined as the amount of mineral in trabecular and cortical tissue (including the non-bone tissues such as hemopoietic and fat marrow in trabecular and blood vessels and osteonal canals in cortical bone).

²⁷ total BMD is defined as the amount of mineral within the periosteal envelope.

Symmons' (2005) measure of bone density values in a range of immature sheep bones also found that fetal bone density was relatively high followed by a dramatic loss in neonatal individuals due to low bone density, with a gradual recovery of density after birth (Symmons 2005, 90). Although sheep are not strictly comparable to humans and the size of the sample was small (thirteen individuals), this shows that the pattern may be universal to other mammal species.

Guy *et al.*'s (1997) study of infant taphonomy from medieval Hungarian cemeteries showed a deficit of remains until the age of five years was reached. They state that bone density decreased after birth and was maintained at a minimum value during the first year; by the second year it had reached the density value of the newborn and then continued to increase until adulthood (Guy *et al.* 1997, 224). Archaeologically, this may suggest that perinatal and neonatal individuals should be well represented in cemetery sites, if they were originally present, whilst it is those individuals in the birth to two year age bracket that will be underrepresented. Guy *et al.* (1997) suggest that there are two types of human remains the "infant type" and the "adult type". The adult type being seen once a child begins to walk, around the age of two/three years. They suggest that the lack of infants before this age in cemeteries is due to the poorer preservation of their less dense bones, and they warn against interpreting the contrasting high numbers of two and three year olds as due to poor weaning practices (Guy *et al.* 1997, 226).

Certain pathologies may also effect the preservation of skeletal remains (Walker *et al.* 1988, 187). For example, an adult female from Taunton (SK 3040) had considerable loss of thickness of the cortical bone of the humeri and ulnae (Dawson & Robson Brown in prep) and this condition may have been a factor in the poor condition of the skeleton compared to the majority excavated.

4.4.1.2 Soil pH

The type of soil present within a cemetery site is also a factor in determining the preservation of skeletal remains. For example, analyses of several sites located around the Mississippi river, Illinois showed that the correlation between soil pH and preservation was significant for both sub-adult and adult remains (Gordon & Buikstra, 1981). A lower more acidic pH value tends to coincide with less well preserved bone. This is because hydroxyapatite is relatively insoluble at pH 7.5 but becomes very soluble at values below pH 6 (Mays 1998a, 17). This study also showed that bone

maturity is an important factor and *'at marginal pH ranges all or most of the infants and children may be systematically eliminated from the mortuary sample'* (Gordon & Buikstra 1981, 569).

4.4.1.3 Depth of burial and disturbance

The depth of the grave in which the burial is placed will also have an effect on the preservation of the skeleton. The graves of infants and young children are likely to have been shallower than those of adults, as smaller individuals will require smaller graves. Shallow graves are more likely to be a target for scavenging animals such as wolves, dogs or pigs which may expose remains to the elements. A licence of AD 1389, obtained by Hereford Cathedral, mentions the need to enclose the cemetery due to *'the mischief done by swine and other animals that dragged the dead bodies from their resting place in the ground'* (as cited in Shoesmith 1980, 51). Shallow graves will also be more susceptible to later disturbance. Many late medieval cemeteries, including that at Taunton, appear to have been reused on a wide scale; constant re-excavation of an area to provide new graves will result in the disturbance of others. After a cemetery has gone out of use, and out of memory, the utilization of the land will also have an effect on preservation especially on shallow graves, but also on deeper ones. Ploughing of the land in rural areas and building developments in urban ones can destroy graves and burials completely, and prior to the advent of PPG16 (Dept of the Environment 1990) many disused cemeteries had been partly destroyed without record, the priory cemetery at Taunton being one of them (Hinchcliffe 1984, McConnell & Urch 2004).

4.4.1.4 Excavation and recovery

The way in which a site is excavated can have an effect on the number of skeletons that will be recovered. It is rare that a complete cemetery is ever excavated. Often only partial excavation is possible due to factors such as previous destruction of areas, the unavailability of areas for excavation, and the lack of time and funding. The presence of human bone specialists on site, and the knowledge of the excavation team in general, can also make a big difference to the recovery of bone, especially if it is poorly preserved (Roberts 2009, 74). The length of time between the excavation and a bone specialist receiving the material can also have an effect on the loss or degradation of information. As techniques have improved and specialists receive more specific training, it has become apparent that in the past information will have been missed that is regarded as important by present standards, for example recording certain pathologies

such as endocranial lesions or the failure to recognise small bones. Excavators may also unwittingly cause biases against the recovery of infants and children if they are not familiar with immature bones or are aware that the likelihood of recovery, due to preservation biases, will be less than that of adults. If graves were shallow they may be missed, especially if bone fragmentation is great. Infants can also be missed if they are within the grave of an adult (often only recognised later by the bone specialist). The excavation techniques used on the three sites analysed for this thesis will be discussed in Chapter Six and, as will be seen in Chapter Eight, both taphonomic features of the site and the excavation process did have an effect on the numbers of sub-adult bones recovered.

4.5 Summary

This chapter has discussed how different issues such as taphonomic agents, both natural and cultural in origin, can affect the preservation of sub-adult remains and how the location of burials, the reuse of cemeteries, and excavation strategies will all contribute to the loss of skeletal remains of children and infants over time. The data from skeletal collections often reflect these losses (Dawes & Magilton 1980; White 1988). Historical studies (Le Roy Ladurie 1978; Razi 1980; Hanawalt 1993) suggest that, on average, families of between one to five children were probably the norm for the late medieval period, with the richer in society probably having more children than the poor. At least five births would be expected if a woman married at twenty years of age, and if the breast feeding of each child continued until they were at least two years of age. However, in richer families, girls could marry young and wet nurses may have been employed for breastfeeding infants, possibly leading to a higher rate of births. It is interesting that girls seem to be underrepresented in the records used for all of the historical studies referred to in this chapter. All the authors use the figures given for boys and then adjust accordingly to assume that equal numbers of girls would have been born. Whether this is a true difference in the balance of the sexes in living children (possibly due to infanticide or neglect of female children), or due to a lack of interest in recording information on girls, is uncertain. The evidence from monumental brasses suggests it may be due to the latter. It is true that women are often under-recorded in records as they are rarely the head of the household unless they are widowed mothers (Hanawalt 1993, 15).

That burial practice in the period was rather uniform is certain, but the evidence from excavated cemetery sites across Britain show that variation in location and position of burial, along with the presence of grave furnishings, can help to provide information on the status of the deceased. Some differences in burial practice have been recognised between sub-adults and adults. Infants have been seen at some sites in association with boundaries and liminal situations, and are much less likely to be buried within church buildings. The area to the north of the church also appears to have been more favoured for sub-adult burial, particularly infants, at some sites. Grave goods would not be expected with either adult or sub-adult burials, but evidence has been seen for objects buried with sub-adults, whilst the practice of burying two individual at the same time (a double burial) appears to more often involve sub-adult individuals.

Chapter 5 : Childhood health and the interpretation of stress indicators

5.1 Introduction

To explore the health and nutritional status of late medieval children, an analysis of pathological changes to the skeleton (both bones and teeth) can be undertaken. Stress is defined by Selye as '*the non-specific response of the body to any demand*' (Selye 1956, 55), and markers, commonly termed "stress indicators", can be recognised on the skeleton due to the ability of an individual to recover from the causal insult (Bush 1991, 11). Evidence of stress in the developing child will potentially be apparent as diagnostic lesions on the skeleton. Here, the term lesion is used for any abnormal change to the bones or teeth which is the result of a reaction to stress. These may include short periods of growth and development cessation. Stress affecting the growth of a child can be caused by many factors, including nutritional deficiencies (Brickley 2000), infectious disease (Mensforth *et al.* 1978; Stuart-Macadam 1991), parasites (Stuart-Macadam 1991) and psychological disturbance (Bush 1991, 16). The term "stress indicator", therefore, incorporates various different lesions that can be seen on the skeleton caused by stress; some of these will remain present throughout adult life, such as enamel hypoplasia.

Factors such as nutritional deficiency and disease can cause disruption to bone growth, as described in Chapter Two. There are approximately forty nutrients which are known to be important in human nutrition, and deficiency in many of these can cause growth retardation (Binns 1998, 326). Nutritional deficiency can be caused by a lack of vitamins and minerals, a lack of calories (dietary energy), and by protein deficiency. As with nutritional deficiency, malnutrition can result from an insufficient or unbalanced diet, or from an inability of the body to absorb certain nutrients from foodstuffs. In malnourished children multiple deficiencies are often a problem as a diet which provides adequate energy will provide most nutrients (Binns 1998, 326). Those conditions associated with nutritional deficiency are often termed metabolic diseases and are connected with the way in which the body absorbs and retains nutrients essential for growth and well-being. Metabolic disease can affect the stages of bone formation, remodelling and mineralization (Brickley 2000, 183). This can cause an increase or reduction in the amount of bone tissue formed as well as poorly mineralised tissue, depending on the deficiency/disease. In contemporary populations interactions

between malnutrition and infectious disease can lead to patterns of growth faltering (King & Uliaszek 1999, 165). It can therefore be postulated that undernourished children and those prone to contract diseases, such as those associated with gastrointestinal problems and diarrhoea, may be likely to be smaller in stature (determined from long-bone length) than more well nourished children. It also needs to be realised that there is a synergy between malnutrition and infection, where the presence of one will lead to a greater likelihood of being affected by the other (Mensforth *et al.* 1978, 18; King & Uliaszek 1999, 165). Therefore, we should see nutritional status as related to more than just dietary intake, as it is closely involved with other disease processes linked to the environmental conditions in which the child lives, and to socio-economic status within the community.

Several types of lesion can be identified on the human skeleton that are thought to have an association with nutritional stress, as well as evidence for non-specific infectious disease. However, diagnosis from these lesions can be problematic as Ortner (2008, xiv) states '*one of the challenging issues in human skeletal palaeopathology is to distinguish between skeletal manifestations of anaemia, scurvy and rickets*'. Each of the pathological conditions associated with nutritional deficiency, stress and infection that can occur on sub-adult skeletons, and the typical manifestations seen, will be described in this chapter. The aim will be to assess the presence of these indicators individually, as well as in relation to each other, and to long bone lengths, and burial location.

A few studies of stress indicators and growth patterns have been carried out on late medieval skeletal collections from Britain (Grauer 1993; Lewis 2002a; 2002b; Mays 1995; 2007; McEwan *et al.* 2005; Ribot and Roberts 1996), with varying results. For example Grauer (1993) found a higher prevalence of cribra orbitalia in the older age children (10-15 years) from St Helen-on-the-Walls, and stated that earlier mortality was not associated with this lesion. Lewis (2002a, 43) also noted that the older children, from this site, with cribra orbitalia tended to be taller than those without cribra orbitalia, whereas the younger children tended to be shorter.

When analysing the prevalence rates of stress indicators in past populations it is important to know how the data has been collected. There are two types of rates used by researchers, the true prevalence rate (TPR), and the crude prevalence rate (CPR). It should be the TPR that is used where researchers are collecting and presenting new data

as this is a true rate of prevalence. For example, if analysing cribra orbitalia on one hundred skeletons, the rate of individuals scored as present for cribra orbitalia (30) out of those individuals that have orbits that can actually be scored (60) will give a TPR of 50%. However, when using data collected in the past only the number of individuals that scored presence for cribra orbitalia may have been recorded, without stating how many individuals from the population were able to be scored, in this case only a CPR could be given. For example the same population of one hundred skeletons with presence of Cribra orbitalia scored for 30 would give a CPR of 30%. True prevalence rates are used in the results chapter for this thesis, except when using the data collected by Rogers (1984) for the 1977 Taunton excavations which are crude prevalence rates.

5.2 The Dentition

The teeth of sub-adult individuals, depending on age, are in the process of forming and erupting and this process can be affected by stress. Enamel hypoplasia is the result of the cessation in growth of the enamel and is therefore related to a disturbance in the developmental process of the growing child. Caries (dental cavities) are related to diet (generally associated with carbohydrates), crown morphology and oral hygiene; the presence of carious lesions may therefore be related to the socio-economic conditions in which the child is living. Dental wear is not a disease, or caused by stress, but is included in this section as, like caries, wear rates may inform us about the diet of individuals and lead to inferences about socio-economic status. Dental wear is caused by the mastication of coarse foodstuffs, and initially involves the enamel and subsequently the underlying dentine.

5.2.1 Enamel Hypoplasia

Enamel hypoplasia is the term used to describe defects on the teeth caused by a disruption to the growth of the enamel. These defects include single or multiple pits, and lines which can range from slight marks to deep furrows within the enamel (Figure 5.1). The tooth crowns start to develop in-utero and continue developing until about seven years of age, with the exception of the later forming third molar (Hillson 1996, 125). The third molar crown can be variable in the timing of formation between seven and thirteen years (Mays 1998a, 156). Hypoplasia will therefore reflect disruption to growth of the enamel during the period of formation of the tooth.

Figure 5.1: Enamel hypoplasia (EH) on SK 2028.

EH on the canine, premolar and molar teeth of a fifteen year old from Taunton, photo H. Dawson.

Defects seen on the deciduous teeth will occur as early as the second trimester of pregnancy up until the first year of life, whilst those on the permanent dentition occur between one and seven years of age, with the exception of the later development of the third molar. Enamel hypoplastic lines tend to only occur on the permanent teeth and therefore are related to postnatal stress to the child. However, some defects, usually in the form of pits rather than lines, do occur on the deciduous dentition (Figure 5.2) and these tend to most commonly involve the deciduous canine tooth. These lesions have been termed localised hypoplasia of the primary canines (LHPC) (Skinner 1986).

Figure 5.2: Localised hypoplasia of the deciduous canine on SK 398.

An eight year old from Gloucester, photo H. Dawson.

Disruption to the growth of the tooth enamel can be caused by nutritional deficiency, childhood illness (Hillson 2003, 7), and even emotional stress (Roberts & Manchester

1995, 164). These lines will remain on the teeth throughout life, and episodes of stress as a child can be inferred from the dentition of adults as well as children. Although hereditary and traumatic causes are also implicated, these tend to be rare, with the lesions being severe in the case of genetic disorders, and localised in the case of trauma (Goodman & Rose 1991, 281).

Clinical studies have demonstrated that there are strong links between childhood infections and malnutrition, and that enamel hypoplasia is a good indicator for studies on the links between socioeconomic conditions and health in past populations (Hillson 2003). In “developed, industrialised” countries the incidence of hypoplasias tends to be less than ten percent, whilst in “undeveloped” countries hypoplasias are fairly common (Goodman & Rose 1991, 282). An initial study by Sarnat & Schour (1941 as cited in Goodman & Rose 1991) on the timing of these events in modern American children showed that most defects developed during the first year of life, followed by those in the second year. The presence of enamel hypoplasia has also been linked to earlier adolescent or adult mortality (Amelagos *et al.* 2009).

Several studies of prehistoric remains have linked the distance of hypoplastic lines from the cemento-enamel junction to the age of their appearance (Smith *et al.* 1984; Goodman & Armelagos 1989). Using this measurement they have associated the time of appearance of the majority of cases to between the ages of two and four years, and suggested the appearance of hypoplastic lines coincides with weaning. The discrepancy in the earlier timing for modern American children (Sarnat & Schour 1941 as cited in Goodman & Rose 1991) could make sense if the lines are related to weaning, as breastfeeding infants for any length of time may not have been that common in 1930s America. The problems associated with cow’s milk and the early introduction of foodstuffs (Lewis 2007, 99-100) could have caused stress related effects such as enamel hypoplasia. However, as no specific recording of diet or illness was undertaken on this 1930s American sample, this can only be speculation. Goodman *et al.* (1984a) also noticed a seasonal appearance in the spacing of the lines from the skeletons from Dickson Mounds, Illinois (AD 950-1300) and suggested this may relate to a dearth of foodstuffs at a particular period of the year.

Lewis’ (2002a; 2002b) hypothesis was that urbanisation will have led to a decline in human health. She looked at growth and stress indicators in sub-adult skeletons and

compared four English sites, one early medieval (Raunds Furnells, Northamptonshire), two late medieval (Wharram Percy and St Helen-on-the-Walls, Yorkshire) and one post-medieval (Christchurch Spitalfields, London). Lewis (2002a) found a peak in mortality between the ages of six and ten years for Wharram Percy and St Helen-on-the-Walls. This peak was associated with the presence of enamel hypoplasia at St Helen-on-the-Walls (Lewis 2002a, 46), suggesting that the presence of enamel hypoplasia was related to reduced longevity. However, Bennike *et al.* (2005) concluded that sub-adults with enamel hypoplasia tended to live longer than those without. It may be that both of these conclusions have more to do with the fact that enamel hypoplasia tends to occur on the permanent and not the deciduous dentition. When only analysing the sub-adults in a population, those with enamel hypoplasia will therefore tend to be in the older age categories (more than seven years of age).

Mays (2007) found no linear enamel hypoplasias on the deciduous dentition of the skeletal remains from Wharram Percy but did record two incidents of localised hypoplasia of the primary canines (LHPC). He found the defects located at about one half to two thirds of the crown height from the cemento-enamel junction, suggesting formation during the immediate post-natal period. The cause of LHPC is still under debate. Skinner (1986) suggested that trauma was the cause of LHPC, but only when occurring on an individual with thin alveolar bone, possibly due to being born to a disadvantaged mother. Skinner and Newell's (2003) study on non-human primates also suggests that deficiency in the surrounding bone of the jaw may expose the canine to physical trauma. However, Lukacs (1999, 360) suggests that it may be the restricted space of the canine tooth within the crypt, leading to contact between the crypt wall and the developing tooth, which may cause the defect. Whichever cause is true, it appears that nutritional deficiency is involved. Skinner (1986, 63) found that this defect was not uncommon in samples of Neolithic and modern Indian children (about 50%), but was rare from a modern Canadian clinical sample. He also found that it occurred more frequently in the lower jaw (*ibid.*). LHPC is the most common form of defect on the deciduous dentition and it has a higher prevalence in disadvantaged groups, in terms of health, nutritional and economic status (Lukacs 1999, 359).

Ogden *et al.* (2007) have reported on a number of teeth from post-medieval children with enamel defects, involving severe pitting and disruption to the cusp pattern on both

deciduous and permanent molars. They have termed this “cuspal enamel hypoplasia” and suggest it should be recorded as a distinct group of defects. In these teeth, rather than in conventional hypoplasias when the matrix production is interrupted, it appears that the ameloblasts are disrupted at the very start of the tooth’s formation when the pattern of the cusp is being laid down (Ogden *et al.* 2007, 960). This severe form of hypoplasia was fairly common on teeth from the Broadgate, London cemetery collection affecting 31.8% of sub-adults (*ibid.*).

5.2.2 Caries

Dental caries (Latin for rottenness) are one of the most common pathologies regularly recorded on archaeological skeletal collections. Termed an infectious disease, caries are the result of fermentation of food sugars (carbohydrates) in the diet by bacteria that live in the mouth, in the plaque that forms on teeth (Roberts & Manchester 1995, 46). The acids created by this process can cause demineralisation of the teeth and cavities can form. Factors that will influence the carious destruction of the dentition include diet, oral health, tooth morphology, the chemical balance of the oral environment, and mechanical stresses on the dentition (Powell 1985). Caries rates in Britain appear to have increased over time. The introduction of cane sugar during the twelfth century and its wider availability for the majority of the population from the sixteenth century caused a marked rise (Roberts & Manchester 1995, 48). Although we do not think of caries as being a dangerous disease today, in the past complications caused by infections within the pulp cavity could have been life threatening (Mays 1998a, 149).

The true prevalence rate of caries for individuals within late medieval populations averages at around fifty-three percent (Roberts & Cox 2003, 259). We would expect caries rates for sub-adults to be considerably less than those for the adult population, because they would have been using their teeth for less time. The sub-adults from Wharram Percy had a TPR for caries of 16%, whilst the adult rate was 68% (Mays 2007, 133-4). A TPR of 22% was seen for the sub-adults from St Helen-on-the-Walls (Lewis 2002a, 83). The onset of carious lesions in young children may inform us about diet, and possibly indicate poor nutrition as well as poor oral health. Poor dental health can have consequences for more general physical health, with pain and inflammation in the mouth leading to a loss of appetite and the reduction of masticatory efficiency (Powell 1985, 308).

5.2.3 Deciduous dental wear

There is a plethora of research that has been carried out assessing the dental wear of the permanent molars, yet little appears in the literature which focuses on the deciduous molars (Bullington 1991; Skinner 1997). It is perhaps surprising that rates of wear on the deciduous teeth have not been studied in the context of presenting information on the diets of children. Dental wear rates may be suggestive of different diets, as coarser foods will cause quicker rates of attrition (Powell 1985). As diet may be related to status dental wear can also be used to explore the status of individuals.

Erosion of the dental tissue is caused by the process of mastication. In the past a coarse diet, along with inclusions such as small particles of grit in foodstuffs, caused significant dental wear, the patterns of which are easily recordable. The term wear includes both attrition, caused by direct tooth on tooth contact, and abrasion caused by the contact of the tooth with an abrasive substance (Powell 1985, 308). Attrition is therefore possible as soon as the opposing teeth have erupted and are in occlusion in the jaw, regardless of the type of foodstuffs being consumed. Dental wear mainly occurs on the occlusal surface of the tooth, thereby making the molar teeth the most appropriate for which to record changes due to the larger surface area. Once a tooth has erupted and is in occlusion the processes of attrition will commence. Initially small planes or facets will appear on the tooth enamel as the cusp tips are worn; a flattening of the cusps subsequently occurs. Once the cusps have flattened, the enamel of the tooth will begin to wear exposing the dentin underneath. This process of enamel wear will continue over time until all the enamel of the tooth is worn away. It is believed that the rate of attrition should be similar for individuals from the same population or environment if they are consuming a similar diet (Mays 1998a, 60; Roberts 2009, 133).

The main measure of tooth wear in the clinical literature is based on the Tooth Wear Index of Smith & Knight (1984). However, methods are constantly being tested and revised (Al-Malik *et al.* 2001; Fares *et al.* 2009). In the modern world tooth erosion due to acidic foods (Millward *et al.* 1994) tends to be more of a problem than wear caused by abrasive foods, with secondary dentin exposure being uncommon in the deciduous teeth (Al-Malik *et al.* 2001). Socioeconomic status has been found to have some positive correlation with tooth wear in adolescents from an English living sample (Milosevic *et al.* 1994), although this was not seen in a similar sample of adults (Donachie & Walls 1995). Males have been recorded as having higher mean wear

scores in both young adult (Fares *et al.* 2009) and old adult samples (Donachie & Walls 1995).

For archaeological populations dental attrition is seen to be much more severe. Correlations between cultural factors, such as diet and food preparation techniques, and dental wear have been noted by numerous archaeological researchers (Molnar 1971; Smith 1972; Walker 1978; Dreier 1994), and several different dental wear charts have been formulated over the last fifty years for use with archaeological material (Murphy 1959; Miles 1963; Brothwell 1981; Molnar 1971; Scott 1979; Dreier 1994), mainly for use on adult skeletons. To be able to use these charts as a comparison across populations, it must be assumed that methods of food production, consumption and dental use are similar to those of the population originally studied in the formation of the chart. More recently Clement (2005) has used graphics software to take measurements of the area of exposed dentine, enabling continuous (as opposed to ordinal) data to be assigned to each tooth as a reflection of the area of wear.

Very little research appears to have been carried out on wear on the deciduous teeth, and no research appears to have focused on medieval populations in Britain. As will be discussed further in Chapter Seven, a new method was devised for recording dental wear on the deciduous molars in the hope that information on diet and status may be revealed.

5.3 Metabolic Disease

The conditions listed here, under the term metabolic disease, are related to deficiencies of vitamins or minerals, or to stress which involves the disruption of normal growth processes. Cribra orbitalia and porotic hyperostosis are believed to be linked to dietary deficiencies, although the aetiology of these conditions is still under discussion. Scurvy is caused by vitamin C deficiency and rickets by a lack of vitamin D, which is due mainly to lack of sunlight, as well as a diet lacking vitamin D. Harris lines are caused by the temporary cessation of growth in the long bones due to stress.

5.3.1 Cribra orbitalia and porotic hyperostosis

Porotic hyperostosis is a term used to describe changes to the cranial bones, as the name implies, which cause porosis, a thinning and destruction of the outer compact bone, and hyperostosis, a thickening and increase between the two cranial tables, or diploe (Stuart-Macadam 1991, 101). Cribra orbitalia manifests as porosity within the orbits of the skull

(see Figure 7.11). Both are the result of marrow expansion for increased red blood cell production (Lewis 2007, 111). These two indicators are thought to be closely related, and in both the porosity can consist of small holes in the outer table, which may increase in size and eventually link together as the outer table thins, exposing the trabecular bone underneath. Radiological studies demonstrate that the lesions display a widening of the diploic spaces and a pattern of bone spiculation termed “hair-on-end” striations (Mensforth *et al.* 1978, 4). When the orbits are affected it is usually bilaterally (Mensforth *et al.* 1978, 27; Stuart-Macadam 1991).

It has been suggested that cribra orbitalia is an early form of porotic hyperostosis although the presence of both indicators varies in frequency throughout the world (Larsen 1997, 30). In Europe the manifestation of cribra orbitalia appears to be more common than porotic hyperostosis of the cranial vault (Roberts & Cox 2003), although not all researchers differentiate between the two. Of the 230 affected skulls from the Romano-British cemetery at Poundbury, Dorset, 173 had cribra orbitalia, seven vault lesions only, and fifty showed both orbital and vault lesions (Stuart-Macadam 1991, 102). In other areas such as the Americas, both types of lesion may tend to appear together, which has also been linked with a more severe manifestation (Goodman *et al.* 1984a, 289).

These indicators have been linked to iron deficiency anaemia due to these types of bony alterations being observed in clinical patients, although there are other possible diseases which as a consequence cause such bone marrow proliferation (Mensforth *et al.* 1978, 4). Genetically inherited conditions, such as thalassaemia (found in central and eastern Mediterranean populations) and Sickle Cell anaemia (found in African populations), can along with a lack of dietary iron, result in anaemia. Genetically linked anaemia has a distribution influenced by the presence of malaria (Ortner & Putschar 1985; Jones 1992, 14). For example sickle cell anaemia evolved as an adaptive response to malaria (Templeton 1982, 16). The sickle cell is an allele²⁸ which confers resistance to malaria in both homozygotes (individuals who obtained the sickle cell gene from both parents)

²⁸ An allele is one of two or more versions of a genetic sequence at a particular location in the genome (Feros *et al.* 2010).

and heterozygotes (individuals who obtained the gene from one parent) however, in homozygotes severe life threatening anaemia can occur (*ibid.*).

Although not associated with the British Isles today, there is evidence that malaria may have been present during the late medieval period in some marshy areas of the south and east of England (Reiter 2000; Dobson 1989). Malaria is an infection caused by a parasite carried by mosquitoes and, whilst it does not affect the skeleton, as an adaptation to the disease individuals may become anaemic (Menendez *et al.* 2000, 469; Roberts & Cox 2003, 170). The word “malaria” was not used until the nineteenth century, but terms such as “ague”, “marsh fever” “tertian fever” or “intermittent fever” are thought to refer to malaria like illnesses (Dobson 1997, 295). Cases of ague are known from the nineteenth century along the coast of Kent and in the Somerset levels (Lindsay *et al.* 2010, 4). Dobson (1989, 3) refers to evidence, from as early as the sixteenth century, that malaria associated fevers were common in the marshlands of south east England, whilst “tertian fever” and “ague” are mentioned in Chaucers’ “Canterbury Tales”, written in the fourteenth century (Reiter 2000, 3). Therefore, it is possible that populations living close to Taunton and Canterbury may have had the potential to contract malaria, although it is unlikely to have been a major factor of illness and mortality in the populations under study.

Iron deficiency anaemia is considered to be one of the most important contributing factors to the global burden of disease (Benoist *et al.* 2008), and is the most prevalent nutritional deficiency throughout the modern world (Mensforth *et al.* 1978, 7); it was probably also prevalent in the past. Anaemia in children is clinically well studied and factors that affect infants in the development of anaemia include prematurity and low birth weight, which can predispose the infant to anaemia at an early age. Although low birth weight infants have been observed to acquire iron-deficiency anaemia at three months of age (Lundstrom *et al.* 1977), in normal birth weight children iron-deficiency anaemia does not occur prior to six months of age, at which time the birth stores are depleted (Saarinen 1978). This clinical observation matches that observed by Mensforth *et al.* (1978) on their study of sub-adults from the Libben, Ohio skeletal collection. Factors affecting older children will include the weaning process such as a switch to foods low in bioavailable iron such as cows’ milk and cereal grains, and the frequency of gastrointestinal infections (Mensforth *et al.* 1978, 14). Tests on two amino acids

involved in bone production, and thought to be affected by dietary iron deficiency, were undertaken on skeletal remains, with and without porotic hyperostosis, as well as a healthy modern child (Von Endt & Ortner 1977). The skeleton with porotic hyperostosis had much lower levels of the amino acids, supporting a diagnosis of iron deficiency anaemia (Ortner & Putschar 1985, 262).

More recently, a study by Walker *et al.* (2009) has questioned this widely accepted link between iron deficiency and porotic hyperostosis and cribra orbitalia. They state that recent haematological research shows that iron deficiency alone cannot account for the red blood cell production that causes the expansion of the marrow responsible for these lesions. They also suggest that the two conditions may have quite different aetiologies. They propose that it is megaloblastic anaemia caused by a vitamin B12 deficiency that is the likely cause of these pathological changes, in association with poor sanitary conditions leading to parasitism and diarrhoea. The presence of worms in the intestine can produce anaemia caused by gastric disturbance and bleeding (Stoltzfus *et al.* 1997, 157; Walden 1991), and parasite eggs have been found with the skeletal remains from Poundbury, where levels of cribra orbitalia were high (Stuart-Macadam 1991).

The presence of bacterial infection may also play a part in the appearance of anaemia (Lewis 2007, 113). Supplies of iron in the blood are needed for bacteria to thrive, and therefore the body may try to withhold iron if under attack by certain bacterial infections. This suggests that a mild iron deficiency (hypoferremia) is not necessarily a negative condition but may be one of the body's defensive mechanisms against disease (Stuart-Macadam 1992). Goodman and Armelagos (1989) found that the appearance of porotic hyperostosis was most common in children between the ages of two and six as well as in young adult females. Stuart-Macadam (1985) suggests that the lesions seen in adults are residual lesions from anaemic episodes in childhood, although it is possible that the higher prevalence in children may be due to bone and marrow physiology in development rather than a real difference in the prevalence of anaemia between adults and children (Stuart-Macadam 1991, 101).

Grauer (1993) investigated patterns of anaemia and infection from medieval York; she used both adults and sub-adults in her research on the collection from St Helen-on-the-

Walls, Yorkshire. She found that porotic hyperostosis²⁹ was more likely to be present in adults, as was remodelling of these lesions. These results were tested and found to be statistically significant. She suggests that those that survived childhood anaemia would be more resilient to disease and therefore that earlier mortality is not associated with either lesion. Lewis (2002a) found that cribra orbitalia among the sub-adult population mainly occurred between the ages of 2.6-6.5 years at the medieval sites she studied, whilst at Christchurch, Spitalfields most cases present were within the 0.6-2.5 year age category. She also found that the presence of cribra orbitalia had an effect on the growth profiles of both the St Helen-on-the-Walls (late medieval) and Christchurch, Spitalfields (post-medieval) collections.

5.3.2 Transverse lines of arrested growth or Harris Lines

Transverse lines of arrested growth³⁰ appear on the long-bones after a cessation in growth of the skeleton; they can only be seen on radiographs (Harris 1933). They are defined as a stress indicator as they only appear after a recovery from cessation of growth which, like that of the dental enamel described above, may be caused by '*any severe interference with the metabolism*' (Harris 1933, 43), such as nutritional deficiency or childhood illness. For a line to appear the growth arrest needs to be complete and followed by a sufficient recovery period before the death of the individual. Initially, cartilage growth will cease, but slight osteoblastic activity will resume, creating a thin layer (not visible with radiography). Once the child has recovered normal growth will resume, but osteoblast activity will start before the cartilage cells have created a mature template. The osteoblasts will therefore lay down bone on the primary stratum until the mature cartilage can be used; this creates the line that is visible on a radiograph (Mays 1985).

Problems in Harris line interpretation occur due to the variation of causal stresses, events ranging from an inoculation to severe malnutrition (Mays 1995, 511). To illustrate the complexity of this anomaly Mays (1985) took radiographs of the tibiae or femora from fifty-four sub-adults from the Roman cemetery at Poundbury, Dorset. He

²⁹ both porotic hyperostosis and cribra orbitalia were recorded under the term porotic hyperostosis without differentiating between the two.

³⁰ more commonly known as Harris lines, named after H. A. Harris.

found no link between the appearance of Harris Lines, long bone length, or cortical thickness of the bone. His results are in conflict with a modern clinical study that did find a link between Harris line appearance and the height of children from Guatemala, which was more pronounced in boys (Blanco *et al.* 1974). It appeared that the Poundbury sub-adults were experiencing acute bouts of stress rather than the chronic stress experienced by the Guatemalan children. Therefore, Mays (1985, 217) suggests that they had sufficient time for catch up growth before their death.

Mays (1995) also took radiographs of some of the sub-adults from the late medieval site of Wharram Percy. Again he found no correlation between the appearance of Harris lines and shorter long bone lengths, but did find that those sub-adults with Harris lines tended to have thinner cortical bone, indicating the growth of the cortex may be affected rather than growth in terms of long bone length. Although recovery was sufficient for catch up growth in length, it appears not to have been in terms of cortical thickness. A significant association was also found between enamel hypoplasia and the presence of Harris lines (Mays 1995, 515). McEwan *et al.* (2005) found no relationship between bone mineral density and Harris lines, but they suggest that bone mineral density along with cortical measurements provide an additional tool for assessing the relationship between growth and environmental stress.

Hughes *et al.* (1996) took radiographs on a selection of long bones from seventy-three individuals (adults and children) from medieval and post-medieval Ireland. They found that the frequency of lines varied depending on which bone was used, although this did not make the overall distribution vary between the different age groups: they found the tibia showed the most lines. Lines were found to have formed at all ages from as early as the first two months of life until the cessation of bone growth; the greatest number of lines formed between the ages of ten and eleven years, and they linked this to stress episodes during the growth spurt of early adolescence (Hughes *et al.* 1996, 128). They found no relationship between each bone of the same individual and the number of lines present. As lines will remodel over time they state that it is important to look at sub-adult bones that will not have remodelled. However, it needs to be remembered that these will therefore be the children who died and may therefore have suffered excess stress compared to those children of the population who survived.

5.3.3 Scurvy

Scurvy is a disease caused by a lack of vitamin C in the diet, which in turn causes defects in the formation of the connective tissues, which can lead to susceptibility to haemorrhage (Pimentel 2003, 331; Brickley & Ives 2008, 47). This can occur by normal motions such as chewing, leading to bleeding gums. Due to the rapid growth of infants and children, haemorrhage can easily occur between the lightly attached periosteum and the bone. Haemorrhage in the eye is also a symptom of scurvy and can be confused with the lesions described earlier for cribra orbitalia and, anaemia often accompanies scurvy because of the blood loss, decreased absorption of iron and folate deficiency (Pimentel 2003, 331). However, due to the haemorrhagic nature of scurvy, bone formation is usually present rather than just porosity (Mays 2008). The most common lesion seen in this disease is an irregular area of porosity on the skull, primarily associated with the external surface of the outer table (Ortner & Ericksen 1997, 216). Other indicators for scurvy include porosity of the greater wing of the sphenoid bone, on the posterior surface and palate of the maxilla, and on the mandibular ramus (Ortner & Ericksen 1997; Mays 2008; Brickley & Ives 2008). Weakening of bone structures associated with scurvy can also lead to the development of metaphyseal fractures (Brickley and Ives 2008, 49). The macroscopic features associated with scurvy all have a differential diagnosis and it was probably not uncommon in the past for individuals with one dietary deficiency to also be afflicted by another. Scurvy appears to have been uncommon in the late medieval period³¹, with most archaeological cases recorded on sub-adult skeletons from cities of the post-medieval industrial age (Brickley & Ives 2006; Brickley & Ives 2008, 55). Recently, in Britain, several cases have been identified from the early medieval period (Mahoney-Swales and Nystrom 2009), the Roman period (Lewis 2010), and the Bronze Age period (Mays 2008). In Britain, due to the seasonal climate and the lack of fresh food during the winter period, it is possible that scurvy may have been a seasonal problem.

5.3.4 Rickets

Rickets is a disease caused by a lack of vitamin D leading to a failure to mineralize the protein precursor of bone (osteoid) properly (Hochberg 2003). This leads to a reduction

³¹ Only four sub-adult individuals have been identified to have scurvy during research on medieval collections from the Museum of London (Brickley & Ives 2008, 55).

in the strength of growing bones causing inadequate mechanical strength, leading to deformation. When weight is placed on the limbs, either through walking or crawling (in young infants) the bones will exhibit the classic bowing deformity. More subtle changes can also be seen on immature bones; the ends of the growing long bones will expand due to excessive unmineralised cartilage causing increase in size of the growth plate (Roberts & Manchester 1995, 173). On radiographs the ends of the long bones will present a frayed like appearance of the growth plate (Brickley & Ives 2008, 106) with '*bristles of a brush*' appearance (Lewis 2007, 127). The ribs can also be affected with cupping deformities present on the costal ends, due to an abnormal accumulation of osteoid, known as '*rachitic rosary*' (Ortner & Putschar 1985, 274; Lewis 2007, 124). In severe cases the vertebra may become compressed and appear of decreased height (Ortner & Putschar 1985, 278), with collapse and kyphosis possible (Lewis 2007, 124), but this is usually lacking in the active phase (Ortner & Putschar 1985, 278). Enamel hypoplasias are common and dental development is often delayed in rachitic children (Lewis 2007, 122). Vitamin D deficiency can occur in both sub-adults and adults; rickets refers only to the changes that occur in the growing skeleton and is therefore a deficiency of childhood. Residual rickets refers to evidence for healed rickets, and osteomalacia is a deficiency occurring in adulthood (Brickley & Ives 2008, 91).

One case of classic rickets in a child of six to seven years of age was present at the cemetery of St Helen-on-the-Walls, and several other instances of slight deformity of the femur and tibia were also recorded (Dawes & Magilton 1980, 59). Ortner & Mays (1998) analysed the sub-adults from the late medieval site of Wharram Percy for signs of rickets and illustrated several possible indicators for this disease through which they diagnosed eight individuals (2% of sub-adults analysed). All the features showed inadequate mineralization of bone, including mechanical deformities, porosis of the skull, pitted irregular epiphyseal plates, and flaring of the bone ends, particularly at the sternal rib ends. The porous lesions of the skull which may occur in rickets are much finer than those seen in porotic hyperostosis (Ortner & Putschar 1985), there is no marrow expansion, and the porosity is due to poor mineralization of bone, rather than the expanding trabecular bone being forced through the outer table, as is the case in porotic hyperostosis. As with scurvy, rickets appears to have been fairly rare in late

medieval England³². A study of a post-medieval population from St Martins, Birmingham confirmed that the changes described above were likely to be indicative of rickets and, as would be expected, these individuals showed a higher prevalence of the disease than the rural medieval population from Wharram Percy (13% of sub-adults analysed) (Mays *et al.* 2006).

5.4 Infectious Disease

5.4.1 Non-specific Infection

Evidence for infections can be seen as periostitis, osteitis, or osteomyelitis (Ortner 2003). In periostitis periosteal bone formation occurs as a new layer of bone under the periosteum caused by the inflammation of this area from infection or trauma (see Figure 7.13). It can appear either as active woven bone which is disorganised and porous or healing/healed lamellar bone which is smoother and more organised in structure. A mixture of the two types of bone is indicative of a chronic, active infection (Lewis 2007, 135). Non-specific infections can be caused by bacteria such as staphylococci or streptococci whilst specific infections such as tuberculosis can also incorporate such lesions. There is a synergy between infection and malnutrition, where malnourished individuals will be more susceptible to disease, and infection can worsen nutritional status (Mensforth *et al.* 1978, 18; Lewis 2007, 100). A caveat is that pathological lesions will only show on the skeleton if the immune system has reacted and the individual survived for some time. If a child has succumbed quickly to a disease, there will be no evidence present on their remains.

Osteomyelitis is the term used when the infection has spread into the bone, and often involves the marrow (Ortner 2003, 181). It is characterised by necrosis (death) of the original cortex (sequestrum) due to the bacteria entering the marrow cavity. One or more cloacae will appear in the bone to enable drainage of the sequestrum. The outer periosteum will also be affected, resulting in enlargement of the shaft of the bone by a

³² Only two sub-adult individuals out of 324 have been identified to have rickets during research on medieval collections from the Museum of London (Brickley & Ives 2008, 96).

new sheath (involucrum). If the child survives the bone will eventually remodel itself (Lewis 2007, 138-140).

One of the problems when dealing with periosteal reaction in sub-adult skeletons is differentiating between pathological and normal growth that is occurring on the skeletal elements. It can be hard to determine the presence of new bone deposited due to an inflammatory cause as opposed to that deposited during the normal process of growth. Non-adult periostitis is therefore most often characterised as a unilateral isolated patch of bone raised above the original cortex (Lewis 2007, 135). However, the lesions recorded by Mensforth *et al.* (1978) frequently exhibited bilateral expression and were most common on the tibia, humerus and femur. They also noted that the endocranial and postcranial lesions occurred more frequently together (*ibid.*). If the deposits are due to a more widespread infection they will therefore be indistinguishable from rapid appositional growth; this has meant that conditions seen in infants such as birth trauma and cortical hyperostosis are rarely recognised archaeologically (Lewis & Roberts 1997). Grauer (1993) found that evidence for infection on medieval sub-adults was low, with remodelled lesions being associated with adulthood.

5.4.2 Endocranial Lesions

Endocranial lesions occur on the inner surface of the cranial bones (see Figure 7.12) and are caused by inflammation of the meninges. Lewis (2004) has defined five different types which include porosity only, fibre (woven) bone formation, capillary lesions, hair-on-end bone formation, and eroded defects. Only the first two categories were found by Lewis to occur on young infants whilst the later categories became more common in older age groups; this led Lewis (2004) to infer that in the youngest age group of 0-0.5 years the lesions may be indicative of normal growth. They are commonly found on the occipital bone but can also appear on the parietal and frontal bones. Various aetiologies have been suggested including meningitis, trauma, anaemia, neoplasia, scurvy, rickets, venous drainage disorders and tuberculosis (Lewis 2007, 141). HersHKovitz *et al.* (2002) looked at a specific type of endocranial lesion (similar to Lewis' capillary and hair on end lesions) which they call *serpens endocrania symmetrica* (SES) on adult skulls from

the Hamann-Todd collection³³. They perceived a link between the appearance of these lesions and intrathoracic disease (possibly tuberculosis) as a cause of death (Hershkovitz *et al.* 2002).

In a study carried out on medieval skeletons from Denmark Bennike *et al.* (2005) concluded that sub-adults with stress indicators (enamel hypoplasia, cribra orbitalia, maxillary sinusitis, and periostitis) tended to live longer than those without. The exception was those individuals with endocranial lesions, who were associated with decreased longevity (Bennike *et al.* 2005, 739).

5.4.3 Tuberculosis

Tuberculosis is an infectious disease caused by the genus *Mycobacterium*. Human populations tend to be infected either with *Mycobacterium tuberculosis*, which is transmitted from human to human by the inhalation of droplets from an infected individual into the lungs, or *Mycobacterium bovis*, which is transmitted from animal to human, normally through the ingestion of infected animal products such as cow's milk (Rogers & Waldron 1989, 614; Aufderheide & Rodriguez-Martin 1998, 118). The progress of the disease has a primary infection stage which causes necrosis (death) of tissues in the affected area; in a healthy individual the bacilli will eventually be enveloped by scar tissue (Aufderheide & Rodriguez-Martin 1998, 119). However, the bacilli can survive within the body creating the potential for reactivation later in life (secondary infection) due to reinfection or weakening of the immune system (*ibid.*). In contemporary populations the age groups most affected are; from birth to five years, fifteen to thirty years, and those over sixty years of age (Johnston 1995; 29). These appear to be the times of life when resistance to the disease is lowest and the youngest group are more likely to develop an active infection earlier in life (*ibid.*).

Commonly a disease of the respiratory system, also known as consumption, tuberculosis can manifest on the skeleton in a variety of different ways. Both bone formation and destruction can be involved but the latter tends to be more dominant. The most common site of the skeleton for diagnosis of tuberculosis is the spine. Termed "Pott's disease",

³³ The Hamann-Todd is a collection of over 3000 skeletons of known age, sex, stature, ethnicity and cause of death collected in the US in the early 20th century.

the cause of bony destruction is from a focal abscess at the anterior surface of the body of one or more vertebrae. The pressure applied can cause localised resorption of the vertebral body creating a scalloped and eroded appearance to the spine (Aufderheide & Rodriguez-Martin 1998, 122). If the destruction of the bone becomes severe this will eventually lead to collapse of the spine and possibly a pathological kyphosis.

The formation of new bone has also been associated with tuberculosis especially on the inner (visceral) surface of the ribs (Kelley & Micozzi 1984; Roberts *et al.* 1994; Roberts *et al.* 1998; Santos & Roberts 2001; Santos & Roberts 2006). Destructive (lytic) lesions may also appear on the ribs and be suggestive of tuberculosis (Ortner & Putschar 1985, 162; Mays *et al.* 2002b). Care needs to be taken however as although rib lesions appear more common in those with tuberculosis they are not pathognomonic (Santos & Roberts 2006).

The skull is a rare area of involvement for adults but is more common in children (Ortner & Putschar 1985, 162). The cranial vault is often the area involved usually through the haematogenous (via the blood) route. The most characteristic lesion is a round lytic focus of no more than 20mm in diameter which can lead to complete perforation of both the inner and outer tables of the skull with the defect of the inner table usually being larger than that of the outer (Ortner & Putschar 1985, 163). Areas of bone formation and resorption termed endocranial lesions (Lewis 2004) or *serpens endocrania symmetrica* (SES) (Hershkovitz *et al.* 2002) are also thought to be a possible indication of tuberculosis and especially linked to tuberculous meningitis in children (Roberts & Buikstra 2003, 101).

5.5 Summary

There are several skeletal indicators that can be recorded which can inform us about nutritional status, disease and stress experienced by children in the past. By looking holistically at these indicators, along with factors of growth and development, and information about burial practice, we can begin to extract information on the status of children. This can be both in terms of socio-economic status within their community and in terms of their nutrition and health.

There are a few papers that have been published which link the growth and health of children in Britain during the late medieval period by recording stress indicators and

infectious disease present on the sub-adult skeleton. Some such as Ribot and Roberts (1996) found no statistically significant correlation between the stress indicators they recorded (enamel hypoplasia, cribra orbitalia, periostitis and Harris lines) and long bone lengths. Mays (1995) did find a correlation between the presence of enamel hypoplasia and Harris lines, but not a relationship with longitudinal growth.

Some researchers have associated stress indicators with reduced life expectancy (Lewis 2002a; 2002b), whilst others have found that those with stress indicators appeared to have increased longevity (Grauer 1993; Bennike *et al.* 2005). In the case of enamel hypoplasias, Lewis (2002a; 2002b) suggested maternal stress may have been a factor for their earlier appearance in the post-medieval period. It was also seen to be the more affluent, in terms of monetary wealth, from Christchurch, Spitalfields that were more likely to suffer from infant and early childhood mortality, and have a slower rate of growth than their late medieval predecessors. Lewis (2002a; 2002b) concluded that it was industrialisation rather than urbanisation that contributed to a health decline among the children from Spitalfields.

Some previous work has therefore been attempted at linking stress indicators together and at comparing these between sites of different periods and levels of urbanisation. However, none of these papers appears to have focused wholly on comparisons of sites from the late medieval period or on analysing the presence of stress indicators, disease, and growth patterns, alongside details of burial location.

Chapter 6 : Sites and skeletal collections

6.1 Introduction

This chapter will outline the history of the three monastic sites that have provided the skeletal remains for this study, as well as a summary of the skeletal material excavated from them. All of the sites were under the rule of the order of St Augustine, and the houses consisted of canons living under the precepts developed by St Augustine of Hippo (AD 354-430). The canons lived less enclosed lives than many other orders, and they aimed to be of spiritual service to the communities among whom they lived, often serving several parish churches as well as their own monasteries (Coppack 2006, 12). The three sites analysed were all situated on the outskirts of fairly prosperous towns, making them worthy comparisons. The initial site that this study is based on is the Priory of St Peter and St Paul, Taunton, which was excavated in 2005, and where the author was involved as a member of the excavation and post-excavation team. Due to the first hand knowledge of this excavation, a detailed description of the methods used will be discussed. Details of the excavation which took place in 1977 will also be reviewed as a comparison with the 2005 excavation, and some of the results of the analysis of the skeletons by the late Dr Juliet Rogers will be used for comparison of the findings from the two excavations, presented in Chapter Eight.

Two other sites were chosen for analysis which had a reasonable number of sub-adult skeletons present. They were of a similar date range to the Taunton cemetery, and would provide suitable comparisons in terms of socio-economic status. Initially the goal was that the analysis would have included the remains from the Taunton 1977 excavations, along with those from Wells Cathedral (excavations 1978-1990), to enable the study to focus on children from late medieval Somerset. However, the Taunton remains from 1977 were subsequently reburied and the main skeletal records appear to have been lost; the remains from Wells cathedral have also been reburied. Therefore, the aim became to find comparable collections, with good numbers of sub-adults, which had not been subject to previous research. The skeletal collections chosen were from the Priory of St Oswald, Gloucester, held at the time by the Museum of Gloucester, and the Priory of St Gregory, Canterbury, which are curated at the University of Kent.

6.2 The Priory of St Peter and St Paul, Taunton, Somerset.

6.2.1 History of the priory

The first Augustinian priory in Taunton was founded by William Giffard, Bishop of Winchester between AD 1120 and AD 1125. It originally had five canons but became a large house, with twenty-six canons recorded in AD 1339; the number was reduced after the Black Death, by AD 1377, to fifteen (Knowles & Hadcock 1971, 175). There was already a foundation of secular priests in Taunton and it was this house, set up as a Minster possibly as early as AD 726-40 that was converted (Bush, 1984, 104). Burials have been known from the area of the Castle at Taunton since the nineteenth century, and excavations carried out in 1972 confirmed the presence of a Saxon cemetery (Clements, 1984). It is therefore believed that the original Saxon Minster at Taunton stood on or near the site of the later Castle, and Bush (1977, 37) suggests that it was located at St Mary Magdalene church, which continued to be used for worship by the monks.

Figure 6.1: Map of Taunton.

Based on that of John Wood from 1840 (Bush and Aston 1984, 76)

The building works for the Castle at Taunton were commenced in AD 1138. The close proximity of the castle and Priory probably led to the granting of a new site for the Priory (see Figure 6.1) by Henry of Blois, Bishop of Winchester in AD 1158 (Bush, 1984, 104). The land appears to have been developed slowly, with no mention of the Priory church for over a century until a charter in AD 1249 (Page 1911). Documentary evidence implies that the priory was an extremely wealthy house and there is evidence of repeated building and rebuilding (Gathercole 2002, 29). In AD 1277 there are references indicating that the priors were having difficulty financing the building of the church in '*a style of great magnificence*' (Hugo 1860, 11), with the completion possibly being as late as AD 1342 (Bush, 1984, 105). There is a mention of the cemetery in AD 1349 (Hugo 1860, 42), but it is likely that the Priory cemetery was in use before the completion of this church³⁴, and evidence from the excavations in 2005 suggests that there may have been an earlier church on the site. Several grave slabs were reused in the foundation pillars and evidence was uncovered for an earlier wall running under the area of the nave. Skeleton 5017 (Area 5) was cut by the church wall, indicating that some of the burials predate the church.

The cemetery at the site of the new priory at Taunton may therefore have been in use from the middle of the twelfth century and would have been the burial place for all the people of Taunton as well as the inhabitants of the surrounding area until AD 1446 when St Mary's cemetery was consecrated (Bush 1977, 39). The Somerset Wills however show that burial in the priory was still popular after this date (Weaver 1901; 1903; 1905 and see Appendix D). In AD 1535 the income for the priory is recorded as £286 (Knowles & Hadcock 1971, 144).

Like so many monastic buildings the Priory fell with the Dissolution of the Monasteries instigated by Henry VIII, and on the 12th February 1539 the remaining monks signed the instrument of surrender (Hugo 1860, 103). At the dissolution, the prior and eleven canons were granted a pension (Knowles & Hadcock 1971, 175). It is therefore unlikely that any more burials took place after this date. Only six years later in AD 1545 the site was granted to Sir Francis Bryan and Matthew Colthurst who, in AD 1552, sold it on to

³⁴ It is unlikely burials would have continued in the area of the castle.

Thomas More. More built a grand house on the site, and the remains of the priory buildings had disappeared by AD 1633 (Bush 1984, 105). The site of the priory and cemetery became the site of a grand house with extensive gardens and meadows. By 1796 More's building had gone and Priory House was erected on the site. Figure 6.2 shows cattle grazing the site and various earthworks which could be part of the remains of the Priory foundations. This house was demolished in 1977 and replaced by the St Johns Ambulance buildings which now lie off Canon Street. The felling of the adjacent orchard led to the excavations carried out by Hinchcliffe in the same year. The "priory barn" remains as the only standing building left from the priory complex (Figure 6.3). It is now home to the cricket museum and is located just across the road from the site of the 2005 excavations. It is thought that this building was originally joined to the north side of the priory complex, and was probably a domestic building for accommodation of visitors or servants, not becoming a barn until the eighteenth or nineteenth century (Membrey, 2010). Figure 6.4 is a reconstruction of how the priory complex may have looked.

The site that was excavated in 2005 is to the north of the 1977 excavation area. Prior to excavation it was the site of the County Garage which had been erected some fifty years earlier; the rest of the site was hard standing. There was an old yew tree which still stood in the passage onto the site from Canon Street during the 2005 excavations; sadly on my last visit it had been removed. This may have been an old association with the long forgotten cemetery, as yews are often found in old cemeteries. Elliott (1957, 258) suggests that yews were originally associated with churchyards because they were built on pagan sacred sites chosen for their yew trees. In Europe the yew is associated with poison, death and the underworld, as well as its evergreen nature making it a symbol of rebirth and immortality (Elliott 1957, 251; Owen 1981, 56). It may also have associations with "Green Man" motifs (seen within churches), as it is said that *'churchyard yews will spread a root to the mouth of each corpse'* (Graves 1961, 194). McLaughlin (2005, 58) found that yews are often located to the west-south-west of the church (as was the one at Taunton) suggesting they were to protect the church and congregation from the prevailing winds. However, yew trees were also popular garden features in the Victorian era, and the yew at Taunton may have been associated with the later house.

Figure 6.2: The site of Taunton Priory as seen in the nineteenth century.
The priory barn is the building at the right of the picture (Hugo 1860).

Figure 6.3: The priory barn, Taunton.

Photo by M. Dowling 2010

Figure 6.4: Reconstruction drawing of the priory complex.

Somerset County Council 2010

6.2.2 Socioeconomics of the town

At the centre of Taunton was the market place both literally and economically. It is mentioned in AD 904 but may have been as old as the foundation of the town around AD 700 (Bush 1977, 55). The cloth trade was the main industry of the town from the thirteenth century and references to the industry are common in the Taunton wills (Weaver 1901; 1903; 1905). Trading customs designed to prevent strangers enjoying the same privileges as the townsfolk forbade them from trading in wool or hides, to bring in scales to weigh wool, to cut cloth for sale, or to sell woad (used for dyeing cloth). Although the cloth and wool industry brought prosperity to some inhabitants of the town, industry and crowding inevitably lead to health issues. Taunton had fresh

water supplies diverted down many of its main streets though these would frequently be polluted by effluent from dyeing, tanning and sewage. The Black Death receives little mention at Taunton but Bush (1977, 131) records that '*the pestilence*' is mentioned in AD 1348-9 which had slashed market tolls for that year. Taunton also housed a leprosy hospital at St Margaret's to the east of the town, for which the priory had authority along with several other churches and chapels, such as St Mary's and St James' (Bush 1977, 38), both still in use today. The Priory canon was to receive 6d from each sick person on admission and the same again for each burial within the hospital cemetery (Bush 1977, 132). It appears therefore that both the wealthy benefactors of the Priory, the merchants and townsfolk of Taunton, as well as rural peasants living on the outskirts of the town, would all have been buried within either the church or cemetery of the Priory.

6.2.3 Excavation in 2005

The excavation within the area of the Priory and lay cemetery took place prior to development works being carried out on the site. The County Garage was to be demolished and a block of apartments built on the site, along with two other residential dwellings. Previous excavations and an evaluation carried out by Context One Archaeological Services (McConnell & Urch 2004) indicated that the site covered part of the lay cemetery of the Priory. Due to the destructive nature of the foundation piling, it was agreed that areas around the site of the piles would be excavated. Any human remains that would be damaged by the piling would be removed and retained for analysis.

This led to the initial plan that small trenches 0.8m square (being the area of the ground that would be disturbed around each pile) would be excavated and, if human remains were uncovered, these trenches would then be extended to allow complete removal of intact inhumations. These 0.8m square areas were excavated down to the natural surface due to the depth of the piling. Five different areas were eventually excavated with each having a slightly different excavation strategy. Figure 6.5 shows the plan of the excavation area.

**Figure 6.5: Excavation plan of the priory and cemetery of SS Peter and Paul, Taunton.
COAS (2010)**

N
↑

- Unexcavated graves
- Excavated graves
- Graveyard areas (see figs xxx)
- The priory Church
- Other archaeology
- Site boundary
- New building foot print
- Limit of excavation
- Post Medieval/Modern truncation

PROJECT TITLE
Former County Garage, Priory Avenue,
Taunton, Somerset

FIGURE TITLE
Site plan

SCALE	PROJECT CODE	FIGURE NO.
as shown	COAS/EXC/10/PAT	3

6.2.3.1 Area 1

An initial area the size of the house plan was stripped by machine through the modern make up and garden soils associated with Priory House. As soon as these layers were removed a layer of "bone soil" was uncovered and the remains of articulated inhumations started to appear almost immediately. The whole area was filled with disarticulated remains, confirming the densely packed nature, and past disturbance of burials within the cemetery. The underlying geology of the site is described as '*dark red sands and gravel, possibly indicating terrace or floodplain deposits*' (Place in prep).

The nine trenches to be excavated further in this area were then laid out and excavation carried out by hand. Immediately, all areas produced articulated individuals and the trenches were soon expanded in all directions to enable full excavation of them. The burials were densely packed and no sooner had one skeleton been lifted than another would be found directly underneath; some of the vertical sequences contained up to eight skeletons. Unfortunately grave cuts were only discernable at the lowest levels of the cemetery due to its constant use and reuse over several centuries. One dateable find, of a coin of Edward III, was found within an ash burial (SK 1644, pile hole 01/07); dating to the middle of the fourteenth century. There was no other dateable evidence, but the sequences of burials, layered eight deep in places, indicates the long term use of the cemetery. The unconnected excavation method of this area made it hard to distinguish firm relationships between the burials within each pile hole. However, at the time it appeared that the burials may have been laid out in rows with the children possibly being placed in the spaces between the adults; the production of a complete plan for the site is still eagerly awaited. Thirty-six sub-adults and fifty adults were excavated from this area.

6.2.3.2 Area 2

This area was the site for the new apartment block and was previously unexplored as it had lain under the buildings of the county garage. During the initial machine stripping it became clear that the area contained the foundations of a building. The location of foundation pillars and four stone-lined tombs confirmed that the nave of the Priory church had been located. Due to the importance of locating the Priory church, the exact location of which was previously unknown, the rest of Area 2 was opened up completely to enable interpretation of the buildings uncovered. Three of the tombs were close to pile hole locations and therefore excavated; the fourth was located at the east

end of the excavation area and was left undisturbed. As with area 1, small trenches were opened up for each of the pile holes to determine if any burials were present. All the burials in this area were located within the nave of the church and were only excavated if the piling would have destroyed them. In contrast to the cemetery, the grave cuts for these burials were discernable. As well as the three tombs, which contained three original inhumations, there were nine grave cuts excavated containing 10 more inhumations (some of which were partial, having been cut by other graves). Two of the burials had cut into one of the tombs, one at each end, and all that was left of the original occupant was the right femur and fragments of tibiae. One of the graves contained a rare ash burial where the base of the coffin had been covered in a layer of ash. Only one child was excavated in this area (SK 914), along with twelve adults.

6.2.3.3 Area 3

Due to the problems encountered using the method of 0.8m square trenches described for area 1, such as having to expand them in various directions as inhumations were found, it was decided to excavate two larger 2m square trenches, rather than nine small ones, for the second house platform. This was enabled by the developer (Gadds Homes) slightly modifying the locations of the piles for the building, as it was believed it would make the removal of skeletons in this area easier and therefore quicker. As before, the trench was excavated by machine until the "bone soil" layer was reached. Initially the majority of remains excavated in this area were of children and infants. Unfortunately due to legal matters regarding a covenant on this area of the site, excavation had to stop when a depth of around 15.00m OD had been reached, nearly half a meter above the depth reached in area 1 (14.35m OD). At the time we believed that this would be a temporary break in the work, but due to time and costs Gadds Homes decided that they would change their plans once again and build this house on a raft foundation, negating the necessity for further excavation of the area. This has led to limitations on the interpretation of the burials in this area; it may have been that lower down in the sequence the number of adults would have increased and the sub-adults reduced, or this may have been a preferred area for the burial of infants and children. Twenty-one children and thirteen adults were excavated from this area.

6.2.3.4 Area 4

Area 4 was opened up and excavated as a platform for the installation of the services for the site. Once again the area was excavated down to the "bone soil" by machine. A long

narrow trench (central) was also excavated, to the north, to attach with the services under Priory Avenue. At the northern end of the burial area there was a large ditch. It was thought that no more burials would be found beyond this area, but, three more complete inhumations were located, buried within the fill of the ditch, including SK 2203 a male who had been buried covered by a charred plank; evidence for two other graves was also found. The majority of the burials in the south end of this area were of sub-adults, including infants; there were twenty-eight children and twenty adults. This area appears to be at the northernmost extent of the cemetery, although it lies west of the church, and could be interpreted as being on the edge. From the central area the remains of four adult inhumations were excavated.

6.2.3.5 Area 5

A small trench was opened up in area 5 for the other end of the service pipes to be inserted. The remains of only three inhumations were recovered from this area. One of these burials, a partial skeleton of a sub-adult (SK 5017), had been cut by the wall foundations of the church, and therefore appears to predate the building. This suggests that the site was being used as a cemetery before the building of the Priory church. Two other partial skeletons of adults were excavated from this area.

6.2.4 Discussion

The lay cemetery of Taunton Priory was probably in use for centuries and, as it would have been the main burial ground in Taunton and the surrounding area, it must have originally held a vast number of inhumations. This is attested to by the fact that grave cuts were indiscernible until the lowest levels were reached, and the amount of disarticulated human bone that covered the site creating a "bone soil". After the initial cleaning of Area 1 subsequent to machining, it rained. On returning to the site the amount of bone mixed into the soil became obvious as the whole area was now clearly seen to be covered in bones and bone fragments. Therefore, the area of the cemetery excavated in 2005, and previously in 1977, is still only a minute fraction of the number of burials once interred here, and probably of those still present and undisturbed in the area. Figure 6.6 shows the location of human remains recovered in the area from the Historic Environment Record (HER).

Produced from the 2009 Ordnance Survey Supermap map with the permission of the Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office. Crown copyright Context One Archaeological Services L272

- site boundary
- previous COAS fieldwork
- listed building
- area of excavation
- Medieval
- Post medieval

1.	PRN No. 44205	Priory Barn, 15th-16th century, Grade II* listed
2.	PRN No. 44436	Canon Street excavations, 1977
3.	PSNHAS 123, 93	eleven burials, Priory cemetery
4.	PRN No. 44438	five burials, Priory cemetery
5.	PRN No. 16738	single burial, Priory cemetery
6.	PRN No. 26287	human remains, Priory cemetery
7.	PRN No. 44435	foundations, probably belonging to the Priory
8.		probable location of Thomas More's house

PROJECT TITLE
Former County Garage, Priory Avenue,
Taunton, Somerset

FIGURE TITLE
Detailed site location and baseline data

SCALE as shown	PROJECT CODE COAS/EXC/05/PAT	FIGURE NO. 2
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Although the excavation brief was to remove skeletons where they would have been disturbed or damaged by the piling, this was not possible in all cases as some of the remains continued too far outside the area of excavation. In these cases each inhumation was recorded and plastic tags with the site code and skeleton number assigned were left in the section of the trench. Initial problems encountered when excavating in the small trenches (0.8m square) were that, as lower burials were discovered, the trenches would have to be extended in order to be able to remove complete individuals (Figure 6.7). This obviously slowed down the excavation and meant that skeletons were exposed to the elements for longer than would be recommended under normal conditions.

Figure 6.7: SK327 needed to be removed to allow full excavation of SK320.

Photo COAS 2005

There was also a problem with trenches becoming flooded in heavy rain. Although all excavation was carried out under cover, the rest of the site was hard standing, so when it rained the water would flow into the trenches. Considering these problems, however, after the initial post-excavation work the majority of the skeletons appear to have remained in good condition, although the skulls are mostly fragmented. Some of these problems were solved before the excavation of areas 3 and 4 by creating larger initial excavation areas. Area 3 created its own problems by not being excavated completely, creating a sample of the population that is probably skewed in favour of children because of the likelihood of them being buried in shallower graves. There does not seem to be any differential preservation between adults and children, with many of the children and even small infants being in a very good state of preservation. It is possible that it was normal to bury children in shallower graves, therefore making them more

likely to have been disturbed by the digging of subsequent graves than those buried at the lowest depths, which on excavation tended to be adults.

The sample of 93 sub-adult and 97 adult in-situ inhumations is a good one, and although only a small portion of the entire population of the cemetery, they can be used statistically as a sample population. It is the 93 sub-adults that will be the main focus of the analysis. Figure 6.8 shows the plan of the sub-adult burials from area 1, Figure 6.9 the plans of all the excavated inhumations from area 2 and 5, Figure 6.10 all the excavated burials from area 3, and Figure 6.11 all the excavated burials from area 4.

The differences in the location and density of the human remains between the excavations in 2005 and 1977 are quite striking and indicate how the areas which are excavated will influence the interpretations made. The 1977 excavations also used machine excavation to get to the layers of medieval burials. These were excavated as an open area excavation, but time restrictions meant that the human remains were not excavated across the whole area, and work was concentrated in two smaller areas in the southern and western parts of the site. The plan of the 1977 excavation shows a much lower density of burials (Figure 6.12) than seen on the 2005 excavation, although Hinchliffe (1984, 109) states that *'many of the earlier inhumations were disturbed and the fillings of later graves contained many fragments of human bone derived from their predecessors'*; they also found the grave cuts difficult to distinguish. A closer comparison of these two excavations and the information gained from the human remains will be discussed in Chapter Eight.

Figure 6.8: Plan of sub-adult skeletons from area 1, Priory Avenue, Taunton.

Created by H. Dawson

Figure 6.9: Plan of inhumations from area 2 and 5, Priory Avenue, Taunton.

COAS 2010

<p> site boundary church unexcavated graves limit of excavation projected feature grave number skeleton number </p>		
<p>PROJECT TITLE Former County Garage, Priory Avenue, Taunton, Somerset</p>		
<p>FIGURE TITLE Areas 2 and 5 skeleton location plan</p>		
SCALE	PROJECT CODE	FIGURE NO.
as shown	COAS/EXC/05/PAT	4

**Figure 6.10: Plan of all inhumations from area 3, Priory Avenue, Taunton
COAS 2010**

ph16

AREA 3

ph19

AREA 1

PROJECT TITLE
Former County Garage, Priory Avenue,
Taunton, Somerset

FIGURE TITLE
Area 3 skeleton location plan

SCALE
as shown

PROJECT CODE
COAS/EXC/05/PAT

FIGURE NO.
6

Figure 6.11: Plan of all inhumations from area 4, Priory Avenue Taunton.
COAS 2010

- 1 2203
- 2 2206
- 3 2202
- 4 2201
- 5 2011
- 6 2034
- 7 2118
- 8 2024
- 9 2017
- 10 2021
- 11 2023
- 12 2010
- 13 2018
- 14 2012
- 15 2085
- 16 2038
- 17 2019
- 18 2020
- 19 2028
- 20 2080
- 21 2049
- 22 2098
- 23 2028
- 24 2045
- 25 2089
- 26 2100
- 27 2094
- 28 2106
- 29 2075
- 30 2116
- 31 2044
- 32 2072
- 33 2119
- 34 2013
- 35 2043
- 36 2081
- 37 2050
- 38 2048
- 39 2006
- 40 2077
- 41 2091
- 42 2068
- 43 2078
- 44 2096
- 45 2090
- 46 2112
- 47 2082
- 48 2120
- 49 2103
- 50 2007
- 51 2093
- 52 2008
- 53 2105
- 54 2108

PROJECT TITLE

Former County Garage, Priory Avenue,
Taunton, Somerset

FIGURE TITLE

Area 4 skeleton location plan

SCALE

as shown

PROJECT CODE

COAS/EXC/05/PAT

FIGURE NO.

5

Heidi Dawson

Figure 6.12: Plan of the Canon street excavations of 1977.

From Hinchliffe 1984, 107.

CANON STREET 1977

Periods 1, 2 & 3

6.3 The Priory of St Oswald, Gloucester

In geographical terms the closest skeletal collection to Taunton of late medieval sub-adults from a lay cemetery attached to a priory, was from the priory of St Oswald, Gloucester. This site was used for burial from the Roman period until the post-medieval period. The dating evidence for burials associated with the late medieval period was good, and sub-adults from this period were therefore chosen to be used for comparative analysis to the Taunton collection. The site was also located on the outskirts of a town and from the same monastic order (Augustinian) as that of the Taunton priory. The underlying geology here was described as sand with underlying lias clay (Heighway & Bryant 1999, 48).

6.3.1 History of the priory

The Augustinian priory of St Oswald was founded in AD 1153 on the site of a former Minster church (Gilchrist & Sloane 2005, 238). The Minster church was founded in the latter years of the ninth or early tenth century (Heighway & Bryant 1999, 7) by Ethelfleda and her husband Ethelred (Page 1907). It was a relatively poor house (Herbert 1993, 15); in AD 1283 the priory had seven canons as it did in AD 1536 when it had an income of £90 for the year (Knowles & Hadcock 1971, 140). The church still partially stands today and is a scheduled ancient monument (Figure 6.13 and Figure 6.14). The excavations have shown the rebuilding of the church from its initial foundation as a Minster till its dissolution in AD 1537 (Heighway & Bryant 1999, 22). The church was left in ruins and is depicted on Speed's map of 1610 where the priory is located at C, to the north west of the town (Figure 6.15).

Figure 6.13: The internal standing wall that remains of St Oswald's priory.

Photo by H. Dawson

Figure 6.14: View of the external wall of St Oswald's priory.

Note post-medieval graves still in-situ, Photo by H. Dawson

Figure 6.15: John Speed's map of Gloucester, 1610.

Downloaded from <http://faculty.oxy.edu/horowitz//home/johnspeed/Cities11.htm>

6.3.2 Socioeconomics of the town

Gloucester was founded as a Roman town, with a fort established here in the first century AD. It had little more than an agricultural economy in Saxon times (Heighway & Bryant 1999, 4). The economy of medieval Gloucester was based mainly on the industries of ironworking, cloth making and the leather trades, with an extra dimension based on the river trade of the Severn (Herbert 1993, 22). The wine trade played an important role in creating wealth for the merchants and wool was also exported (*ibid*). In the later medieval period (AD 1350-1540) attention was shifted from wool to cloth production which brought prosperity to the town (Schofield & Vince 2003, 29). Evidence for a substantial iron working industry can be deduced from the fact that slag was common enough for the roads to be metallised (Schofield & Vince 2003, 126). Like Taunton, Gloucester was also a market town. Agricultural produce was important, with apple and pear orchards being plentiful in the surrounding countryside as well as the local fish trade. Fish was an important commodity for the requirements of the local religious houses due to the restriction of meat eating on certain days. The assessed wealth of the town in AD 1337 was £510, with a population of 2239, and it is ranked lowest of the large towns listed by Goldberg (2004, 43). The cemetery at St Oswald's

would have been used by the population over which the house had the cure of souls (Heighway & Bryant 1999, 199). The parish was a large one but mostly involved the rural inhabitants from around the town and possibly the less wealthy, the suburbs outside the north gate of Gloucester being the more wealthy area (Schofield & Vince 2003, 66).

6.3.3 Excavation methods

Excavations took place around the church in 1967, 1975-6 and then 1977, 1978 and 1983. An open area method of excavation was used with 10cm wide baulks left in place (Heighway & Bryant 1999, 47). The 1967 excavations included trenches I to VII and took in the medieval west range, the 1975-6 season excavations were carried out in the western area with trenches IX, X, XIV and XV and extended to include VIII, XII and XI. Trench XX was part of the cemetery south of the church, and a machine cut trench XIX at the west of the site. Trenches XVI, XVII and XVIII were also machine cut to try and locate the remains of Priory House. The 1977 season included the area north of the ruined wall (trenches XXII and XXIII), an area of the nave (trench XIII), and the Anglo-Saxon cemetery south and south-east of the church (trenches XX, XXI and XXIV). In 1978 the north transept area was excavated (trench XXVI), and in 1983 the east end of the church (trench XXV). Figure 6.16 shows the plan of the excavated areas with the sub-adult skeleton numbers analysed for this thesis marked at the places of burial. Appendix E contains copies of the original plans from the site.

The site was multi-period with burials ranging from Roman to post-medieval periods. Over 600 skeletons have been recorded from the site overall (Heighway & Bryant 1999, 194). The burials were mainly dated by their relationship with the phases of building changes to the church. Therefore, the remains analysed for this study were dated as either c AD 1120-1230³⁵ or c AD 1230-1540³⁶. In 1881 more than forty skeletons were discovered in a garden just south-east of the medieval church; although thought to have been Roman at the time, it is more likely that they were late medieval in date (Heighway & Bryant 1999, 197); these were not retained.

³⁵ These were dated by the building of the north transept c AD 1120 and the construction of the west range c AD 1230, when the south west area of the cemetery was taken out of use.

³⁶ These were dated up till the conversion of the north aisle to a church c AD 1540.

The number of burials from the Norman period (1120-1230) was 180, with a MNI of 193 individuals. For the late medieval period (1230-1540) the number of burials was thirty-four, with a MNI of 34 individuals (Rogers 1999, 229). A high number of very young infants (perinates and neonates) were recovered from the north of the church close to the wall, these tiny remains were not recognised immediately on excavation and some may have been overlooked (C Heighway pers.com). Rogers (1999) records sixty-seven individuals, under fifteen years of age, for the Norman period and nine for the later medieval. Sixty-five sub-adults were analysed for this study; sixty of these were from the Norman period, and only five from the later medieval period. Figure 6.16 shows the plan of the excavations at Gloucester, with the location of the sub-adults analysed marked as skeleton numbers. Trench areas which contained burials used for the analysis are XXII and XXIII, to the north of the church, VIII and XIII within the nave of the church, XI within a passageway next to the church, and IX and XIV situated to the west of the church (Heighway and Bryant 1999, 46).

There are therefore at least eleven skeletons, noted in the report that were not analysed; this was either because they could not be located in the store (as was the case for nine skeletons), or that they consisted of fragments only. Of those that could not be located, eight had dentitions present. Although these skeletons could not be located at the time of analysis, copies were made of the original skeleton sheets to ensure that no significant difference would be made to the overall demography of the site by the non-inclusion of these remains for this study. At the time of analysis the skeletal remains were held by Gloucester City Museum although, due to space restrictions, they were to be recommended for reburial at some point in the future (David Rice pers. com). This collection has recently been moved to the University of Reading, it is believed that the missing skeletons have been located (David Rice pers.com), and that the suggestion of reburial is no longer an issue.

**Figure 6.16: Plan of the location of excavated trenches at St Oswald's priory.
Sub-adult skeleton numbers marked, (after Heighway & Bryant 1999).**

+ 120/75

+ 160/75

3.3 The Story of St Gregory's Hospital

The first reference to the site of St Gregory's Hospital is found in a report by the parish priest in 1711. The report states that the site was a 'good one for a hospital' and that it was 'well situated for the purpose'. The report also mentions that the site was 'well watered' and that it was 'well exposed to the sun'. The report was signed by the parish priest, John Thomas, and the vicar, John Thomas.

3.4.1 History of the priory

The priory of St Gregory was founded in 1130 by William I, King of England. It was originally a priory for the Order of the Holy Sepulchre. The priory was later converted into a hospital in 1534 by Henry VIII. The hospital was then converted into a school in 1540 by Edward VI. The school was then converted into a hospital in 1547 by Edward VI.

XIX

6.4 The Priory of St Gregory, Canterbury

The third collection chosen for analysis comes from the excavations of the church and cemetery of the priory of St Gregory, Canterbury. The excavations from the cemetery had recovered a good number of sub-adult remains, although no analysis for these has ever been published³⁷. The priory and cemetery date to the late medieval period, and the priory, like Taunton and Gloucester, lay on the outskirts of a town and was also of the order of Augustinian priors. The soils associated with the site were described as brown clay loam (Hicks & Hicks 2001, 23).

6.4.1 History of the priory

The priory of St Gregory was founded sometime between AD 1084 and AD 1086 by Archbishop Lanfranc (Duncombe & Battely 1785; Woodcock 1956; Knowles & Hadcock 1971). It was originally for six priests who ministered in the nearby hospital of St John the Baptist (Knowles & Hadcock 1971, 152). In fact it appears that the site of St Gregory's was originally referred to as a hospital (Page 1926, 157). The canons of the priory were to administer to the infirm people of St John's hospital '*for the good of their souls*' and also to take care of burial (Duncombe & Battely 1785, 420), for which Lanfranc '*provided so much land, tithes and rent, as seemed sufficient for their maintenance*' (Hasted 1801). It appears, therefore, that the inmates of the hospital of St John were given free burial if they died there. However, it was not only the hospital inmates that were buried within the cemetery of St Gregory's priory. Brent (1879, 241) states that '*an extensive burying ground was attached to it, not appropriate to the hospital alone, but to the parishioners of Northgate*'. Hasted (1801) also lists details of a number of wills of people wishing to be buried within the church or cemetery of St Gregory's, including Ceffry Holman of Northgate parish buried in the church before the window of St Martin, John Coke also of the parish and buried within the churchyard, and Robert Smyth '*tarrying within the hospital of St John*' who was also buried within the cemetery.

The priory also held the relics of St Edburg and St Mildred, although disputes about the true resting place of the relics of St Mildred, with St Augustine's priory, lasted for

³⁷ Only the human remains associated with the church buildings and the west entrance to the church are included in the publication by Hicks and Hicks (2001).

centuries (Woodcock 1956). The hospital and church stood outside the north gate of the city and is shown on Speed's map of Canterbury (Figure 6.17), where St Gregory's priory is situated at the top left, marked number 14 (see red circle); St John's hospital is on the other side of the road. Both were for the benefit of the poor and the infirm (Page 1926, 211). The original church consisted of a simple aisleless nave and square chancel, and the graveyard was situated to the south of the church (Hicks & Hicks 2001, 1). The church did not become an Augustinian house until AD 1133, and had thirteen canons in AD 1291 with an income of over £27 a year (Knowles & Hadcock 1971). The number of canons appears to have reduced over the years and in AD 1535 there was a prior and six canons, with an income for the house of £121 (Knowles & Hadcock 1971, 139). In AD 1785 part of the priory was listed as still standing, but as only '*one large room*' (Duncombe & Battely 1785, 420). Nothing remains to be seen of the site today, and the area has been developed.

Figure 6.17: John Speed's map of Canterbury.

Downloaded from <http://faculty.oxy.edu/horowitz//home/johnspeed/Cities6.htm>

6.4.2 Socioeconomics of the town

Canterbury was known for its many religious houses and in particular its cathedral which held the shrine of Thomas Beckett. This shrine brought many pilgrims to the town '*and devotees of all ranks, with whom the town was almost daily crowded*' (Hasted 1800). Pilgrims would have bought souvenirs such as badges, or a pewter containing holy water. Many examples have been recovered from deposits by the Thames, including a number from the shrine of Thomas Beckett (Schofield & Vince 2003, 191). In the town many of the inhabitants made their living out of the monks (there were several houses), either as servants or suppliers of goods and skilled labour. The main industries recorded at Canterbury from AD 1400-39 are the provision of victuals, textiles, leather, and clothing (Goldberg 2004, 41). The assessed wealth of the town in 1337 was £599, with a population of 2574, quite low compared to other similar sized towns (Goldberg 2004, 43).

6.4.3 Excavation methods

Excavations of the buildings and cemetery of the Priory of St Gregory, Canterbury were undertaken between 1988 and 1991 by the Canterbury Archaeological Trust, in advance of redevelopment of the area. Excavation was by the open area method and all skeletal remains were removed. Details of the cemetery excavations to the south of the church have not been published; a plan of the excavated area including the skeletal remains is shown in Figure 6.18, with only the analysed portion of the burials shown in Figure 6.19. This is partly due to the funds for the project being exhausted; details of the skeletal remains from the cemetery were noted by the late Trevor Anderson but never published, and some (but not all) of his notes are now located at the University of Kent, along with the collection of skeletal remains from the site. The area involving the priory church and buildings has been published (Hicks & Hicks 2001) and the plan of this area is shown in Figure 6.20.

A total of 1342 articulated skeletons were excavated from the cemetery, church and priory of St Gregory's (Anderson and Andrews 2001, 338). The published report only dealt with ninety-one burials associated with the church and priory, of which twenty-two were sub-adult and sixty-nine adult burials. Anderson (unpublished) notes 1223 skeletons from the cemetery; of these, 294 are listed as sub-adult and 929 as adult. He breaks down the sub-adult skeletons into foetus (seven), infant (ten), child between one and five years (96), child between six and eleven years (83), and juvenile between

twelve and nineteen years (98). Only a fraction of this number of sub-adult skeletons was analysed for this study. The purpose of analysing the Canterbury remains was to use them as a comparison for the Taunton and Gloucester data already collected. Only six and three skeletons, respectively, had been analysed that were older than 12 years of age, so it was decided that the best use of time would be to focus on the sub-adults that were in the younger age categories. It was also decided, due to time restrictions on the use of the University of Kent laboratory, that only those skeletons that had some of the dentition present, as well as at least one measurable long bone, would be selected for analysis. Overall, one hundred and four individuals, ranging in age from perinatal foetuses to those of twelve years of age, were analysed. As with the Gloucester material some of the skeletons could not be located in the store. Some notes were also taken from the skeleton sheets of the individuals not included in this analysis, created by the late Trevor Anderson, but a large proportion of these could not be found in the archive during my visit.

**Figure 6.18: Plan of the cemetery area to the south of St Gregory's priory.
Unpublished plan from the Canterbury Archaeological Trust**

St Gregory's Priory cemetery

**Figure 6.19: Modified plan of the south cemetery with sub-adults analysed shown.
Modified from the unpublished plan from the Canterbury Archaeological Trust**

St Gregory's Priory cemetery

Figure 6.20: Plan of the priory church and buildings.

Hicks & Hicks unpublished version from the Canterbury Archaeological Trust

ORIGINAL

HICKS

ILLUSTRATION SHOWING THE RECORDED STRUCTURAL REMAINS

6.5 Summary

The three collections of sub-adult remains analysed for this thesis all come from comparable lay cemeteries, attached to Augustinian priories, located on the edge of southern English towns. The cemetery at Taunton would have undertaken the burial of individuals from all levels of society, as it was the only burial ground in use in the area for part of the period. The priory was a wealthy one and the burials recovered in the 2005 excavations are all situated close to the priory complex of buildings; this may be a favoured place for burial (compared to the burials located in the 1977 excavations), and the skeletons recovered may therefore represent a fairly high status group. The cemetery at Gloucester was in a rural non-prosperous area, so the majority of those buried here may be of a fairly low socioeconomic status, compared to other burial sites in Gloucester. However, the location of most of the burials from this excavation, is fairly close to the church buildings. As St Gregory's was associated with the nearby hospital of St John, it is known that inmates of the hospital would have been buried in the cemetery here. The fact that Canterbury was a pilgrim town may also mean that non-local people were often buried in the cemetery. As burial appears to be free for the poor, there should be many low status burials within this cemetery, but wills of the period also show those with money requesting to be buried within both the church and cemetery. A study of the palaeopathology of the adult skeletons from St Gregory's is currently being undertaken by Lactia Kress, a PhD student at the University of Reading. Her results may give some indication of the numbers of chronically ill individuals being buried in the cemetery, possibly representing the hospital inmates or pilgrims in search of a cure. The dating of the majority of the burials is slightly earlier for the Gloucester remains than for those of Taunton and Canterbury, for which the majority of burials appear to date to the later centuries of the period; (although their foundations are not too dissimilar).

The different excavation strategies may have led to differential preservation and recovery of the skeletal elements between the three sites. With two of the excavations being undertaken prior to PPG16 (Department of the Environment 1990) it is likely that the funds available may have been less, especially for any post-excavation analysis; this is certainly so for Canterbury where no post-excavation strategy was in place for the publication of the cemetery burials. Even post PPG16 (now PPS5) excavations can

suffer from funds availability; the final report for the Taunton 2005 excavations is still outstanding due to the collapse of the developer (Gadds Homes) and cessation of funds. In general, the remains of the sub-adults from the three sites should provide a good comparison of the health, growth and development of children in the late medieval period, as well as providing some information on burial practice. Table 6-1 shows a list of the sites and the number of individual analysed.

Table 6-1: Number of burials for each site.

Site	N	N sub-adults	analysed	N adults	analysed	Date
Taunton	190	93	93	97	97	AD 1158 – 1539
Gloucester	227	76	65	151	-	AD 1120 – 1539
Canterbury	1342	316	104	998	-	AD 1086 – 1539

Chapter 7 : Methodology

In this chapter the methods used for the analysis of the skeletal remains will be described along with a fuller discussion of why certain methods were chosen over others. The forms used for data collection will be referred to in the text, and these can be viewed in the appendices. Details of the burial, skeletal and dental inventories will be described first in sections 7.1, 7.2 and 7.3, followed in section 7.4 by a detailed discussion of ageing methods applicable to sub-adult remains. No adequate scoring system for deciduous dental wear was available in the literature, so a new method based on that by Skinner (1997) was created for this analysis; this will be discussed in detail in section 7.5. The recording of metric and non-metric traits will be detailed in section 7.6 followed by the recording of pathology in section 7.7. Section 7.8 will give details on how a database was created, to enable storage and analysis of the data; and section 7.9 will outline the questions to be addressed using the data collected, and will include a discussion of the statistical methods used.

7.1 Burial Inventory

A recording form was created to enable the details of the funerary context for the Taunton excavations to be recorded (Appendix F). The details recorded included: the location of the burial, the orientation and position of the body and skull, the depth of burial, whether there was evidence for coffin burial, the presence of any coffin nails, shroud pins, or pottery associated with the burial, and any other finds. All this information was readily available for the Taunton excavation; some but not all of the information was available for the Gloucester and Canterbury collections. Notes were in the archive for Gloucester of body position, coffin presence, and associated small finds. For Canterbury an overview plan of the burials was available, though the author suspects that this did not accurately show limb position, none of the sub-adult remains analysed were noted as having a coffin present or the association of any small finds. For the analysis the location of each burial was divided into four categories; whether individuals were buried within the church or priory buildings (1), west of the church (2), north of the church (3), or south of the church (4). There were no burials recovered east of the church for any of the sites. As discussed in Chapter Four location of burial may have an association with status. Burials within the church were reserved for those who could afford the privilege, whilst the north side of the cemetery was probably least favoured.

At Taunton excavation, areas 2 and 5 fell within the church, and areas 1, 3 and 4 were located to the west of the church. At Gloucester there were trenches that were within the area of the church buildings (VIII, XIII and XI), to the north (XXII and XXIII), and to the west (IX and XIV). At Canterbury burials were located from the published plan within the church and to the west, and from the unpublished plan to the west of the church (those west of the tower), and to the south. As can be seen, not all sites, therefore, have individuals present in all of the categories listed. Some of the individuals from Taunton could have been placed in the south of the church category, depending on the interpretation of how far away from the west end of the church the remains would have to be. As the full extent of the church buildings was not known, and due to the late completion of the plan of the excavation by the archaeological unit involved, it was decided to interpret all of the cemetery burials as being located west of the church.

The distance of burial from the church was also divided into three categories; those within the church buildings (1), those within 10 metres of the church (2) and those over 10 metres from the church (3). It would have been possible to include a fourth category indicating those more than 20 metres from the church buildings, but due to the late completion of the plan for the Taunton site this was not possible. The category probably would have had few individuals represented in it.

7.2 Skeletal Inventory

Separate recording forms were created to record the information from the skeletal remains (Appendix F). The initial recording forms were created to record as much information as possible about the Taunton sub-adults, this being a recently excavated collection with no prior analysis. Not all of the information recorded was presented in this thesis, as some data, such as the information on non-metric dental traits, was deemed irrelevant to the focus of the research questions posed. The recording forms were used in their original format for the analysis of the Taunton and Gloucester skeletons, but were later slightly modified for the recording of the Canterbury individuals. This was done as it was felt that too much time was being spent on details that it appeared would not be very useful for the underlying premise of this study, and with time limited for the Canterbury data collection it was important to focus on how to answer the main questions. Each of the skeletons was recorded on a separate recording form which was designed to record either infants or children. Pictures for the visual recording were redrawn after Lewis (2007, 29) for young infants, and after Brickley &

McKinley (2004, 57) for older sub-adults. Overall completeness of the skeleton was assessed as a percentage of the skeleton present (in increments of 5%), and for the purpose of some of the analysis was categorised into groups as >75%, 50-75%, 25-50% or <25%. Each skeleton was also scored as good, medium or poor preservation which, although subjective, is useful to compare between the differing areas of excavation. In general the human remains preservation was good from all the sites therefore, the remains scored as poor were poor compared to the majority of the remains from the sites analysed, as opposed to being poorly preserved in general. Surface erosion of the skeleton, including root markings and general erosion, was recorded after McKinley (2004).

An inventory detailing the bones found in the sub-adult skeleton was created, with the bones grouped into cranial bones, long bones, axial bones, hand/foot bones, and flat bones. Each bone was recorded as a percentage of the bone present (in the same categories as above) or ticked if complete or near complete. Epiphyses were recorded if present and the stage of fusion or ossification of each bone was also recorded; fusion and ossification age stages from Scheuer & Black (2000b) were noted on each form for ease of comparison.

7.3 Dental inventory

Each tooth present was recorded using the numbering system and diagrams from Buikstra & Ubelaker (1994). This numbering system was chosen over that most commonly used in British publications, the Zsigmondy system³⁸, as each tooth is assigned a different number and therefore has ease of use for database entry and less chance of error. The deciduous teeth were also numbered, rather than identified by letters. Tooth eruption stages were recorded as present and erupted (P), erupting (not yet in occlusion) (E) and unerupted (U). Other indicators for scoring teeth included tooth present socket missing (T), tooth lost post-mortem (N), tooth lost ante-mortem (X), jaw and teeth not present (J), tooth broken (B), caries in tooth (C), abscess present (A), deciduous tooth shed (S). Caries were scored for all teeth, both deciduous and permanent, and abscesses could be scored when the mandible was present. In the case

³⁸ This system uses a grid and numbers the permanent teeth as 1-8, repeated for each quarter of the dentition, and uses the characters A-E for the deciduous dentition (see Connell 2004, 8).

where a tooth was loose, but it was clear whether the tooth would have been present in the jaw or unerupted, T/P or T/U was used. The formation sequence of each tooth was also recorded, where possible, using the diagrams of Moorrees *et al.* (1963a), for the deciduous teeth, and Moorrees *et al.* (1963b) for the permanent teeth. Formation of each tooth was also recorded on the diagrams from Buikstra & Ubelaker (1994), by shading in the appropriate part of the crown or root. Recording formation stages for each tooth provides benefits over recording only data on eruption stages as each tooth develops over a span of several years as opposed to eruption which, as well as being a single event, will also relate to eruption through the gingiva (gum), in radiographic data, as opposed to the alveolar bone of the jaw which is the nature of archaeological material. The development of the dentition covers a span of nearly two decades, with the deciduous crowns forming whilst the infant is still in-utero (Schour & Massler 1941), and the completion of the roots of the third molar occurring around seventeen years of age (Smith 1991).

7.3.1 Dental pathology and non-metric traits

Dental pathology was recorded separately for each tooth. Enamel hypoplasia was recorded according to Roberts & Connell (2004) as type of defect (linear horizontal grooves, linear vertical grooves, linear horizontal pits, non-linear array of pits, and single pits), the position of the defect (cusp, middle section of the crown, or neck), and the severity seen (just discernable line, clear groove, or gross defect). Each line or pit observed was also marked on a second diagram of the dentition, photographed, and a measurement was taken from the cemento-enamel junction of the tooth to the defect. All teeth with complete crowns were scored for enamel defects. Calculus was recorded on all teeth present within the mandible, as slight, medium or severe and whether the lingual or buccal side of the tooth was affected (Brothwell 1981, 155). Some non-metric traits were initially recorded, (see Table 7-1), and a selection of the more common traits was chosen from Buikstra & Ubelaker (1994) and Scott and Turner (1997). Traits were recorded where the crown or root was complete as relevant. These traits were later felt to be of no relevance to this research and the results are therefore not presented.

Table 7-1: Dental non-metrics recorded.

W	Winging (upper central incisors)
I	Reduction in size of upper lateral incisors
R	Root number if abnormal
C	Cusp number if abnormal
Car	Carabelli's trait (upper molars)
S	Supernumerary teeth

7.4 Ageing

Ageing from the teeth has benefits over other ageing methods, as growth and development of the dentition takes place over the whole range of sub-adult ages whereas skeletal development can take place in punctuated growth spurts (Scheuer & Black 2000a, 12-13). There are several methods that can be used for ageing the dentitions of sub-adults. Five are discussed here which are most frequently used within the archaeological literature; and these were all used to age the individuals in this analysis.

The chart of Schour & Massler (1941) is a pictorial representation of the formation and eruption stages of the complete dentition from radiographic evidence. This chart was based on the work of Logan & Kronfeld (1933), whose research used autopsy material from deceased US children, with some modifications made based on Schour's work on crown development (Hillson 1996, 126). The record of the development of the actual tooth, as opposed to radiographic evidence, is therefore more comparable to archaeological specimens, but all material used was from children who had died. As discussed in Chapter Four archaeological remains of sub-adults are also from those who had died as children, so this should not present too much of a discrepancy as comparable data. This method is widely used and has scored well when tested for accuracy on archaeological material (Liversidge 1994).

Ubelaker (1999) published a chart based on that of Schour and Massler (1941) but this was specifically modified for use on Native American skeletal collections. This chart is widespread in modern textbooks for osteoarchaeologists, and as it has been designed for working on archaeological skeletal material may be preferable to use. However, it may not be the best method if the changes made were due to a difference in timing of formation and eruption of teeth within Native American populations, compared to the population of European origin that the chart was originally based on.

The chart created by Gustafson & Koch (1974 as cited in Hillson 1996, 135) is a diagrammatic representation of crown formation, crown and root completion times, and eruption timing of the complete dentition from radiographic and dissection evidence, although it does not contain any information on the third molar. The chart was devised by using all the information from known studies that was available, and although it will average out any extreme values from these studies, and probably be better than the least accurate data used, it will possibly also detract from the accuracy of the best studies (Smith 1991). This chart is read by using a ruler and holding it across the chart to the place where there is a best match for all the available teeth recorded. The assigned age can then be read from the chart.

The most well used charts to record tooth formation stages are those created by Moorrees *et al.* (1963a, 1963b). They show formation and resorption stages of the mandibular deciduous canine, deciduous first molar, and deciduous second molar (1963a), and formation of the permanent mandibular first and second incisors, canine, first and second premolars, and all molars (1963b). Both charts were created from radiographic evidence on 136 boys and 110 girls from the longitudinal growth studies of the Fels Research Institute, Ohio, US. For the permanent incisors a second dataset was used from radiographs of Boston children taken for a Harvard longitudinal study. These charts also need to be read with a ruler held at the point closest to the formation stages; this method is however quite time consuming, and there are also separate charts for female and male children. As assignment of sex to the sub-adults under study is not possible, tables for the deciduous teeth have been created from the original data giving a mean age for each formation stage, taking into account the data for both females and males (Appendix F). This is something that has been done for the permanent teeth previously by Smith (1991), although her tables still separated females and males.

Smith (1991) created tables of mean ages for the permanent mandibular dentition using the original data of Moorrees *et al.* (1963b). These tables will be used for ageing the permanent dentition, but averaged for males and females. Smith also created a table of predictive ages, which are slightly higher than the means created by the original data set. This was done because, if a tooth is being recorded as a certain stage, it will have already reached the stage and therefore be more likely to be of an age which falls between the stage attained and the following stage. The age of attainment tables can

answer the question “at what age does the transition in stage occur?”, whereas the age prediction tables are designed to answer the question “what dental age should be assigned to this child” (Smith 1991, 159). One obvious difference seen in the tables is that the final stage of closure of the root apex cannot be used in the prediction tables, as once this event has passed the child could be at any age over that of the age of attainment for this stage. Smith (1991) produced good results when she tested the prediction tables, but she only used four children. Separate tables were created, collating the data from Smith (1991) and Moorrees (1963a; 1963b) for use in ageing, and are presented in Appendix F.

Liversidge (1994) tested the methods of Schour & Massler (1941), Gustafson & Koch (1974), Moorrees *et al.* (1963a; 1963b), and Smith (1991) against a sample of sixty-three skeletons aged between birth and five years, and of known age at death, from the Christchurch Spitalfields skeletons. She found that all the methods slightly underestimate age but that the chart of Schour and Massler (1941), and the diagram of Gustafson & Koch (1974), performed better than the age formation stages. Liversidge (1994) goes on to recommend use of the Schour & Massler (1941) chart even though this is the earliest method devised. Saunders *et al.* (1993b) tested the formation stages of Moorrees *et al.* (1963a; 1963b) in their study of the nineteenth century sub-adults from a cemetery in Belleville, Ohio. They determined the ages of the children from the burial records, and recommend that a combination of the deciduous and permanent teeth worked best. They also recommend excluding data on the maxillary incisors due to their biasing effect indicating an older age when compared to the other teeth (Saunders *et al.* 1993b, 185). They also suggested that the added step of creating prediction tables as performed by Smith (1991) did not add any value when assigning age to the sub-adults studied here (*ibid.*).

These different methods for ageing will be used to enable a comparison to be made between the ages assigned using each method and also to enable the data collected for this study to be comparable to other data sets recorded by different osteoarchaeologists. For example, Mays (2007) used the Schour & Massler (1941) chart to assign ages to the medieval skeletons from Wharram Percy, whereas Lewis (2002a) used the age tables of Smith (1991) for the four sites she used to compare urban and rural sites, covering the early medieval to the post-medieval period.

All dentitions were recorded with teeth present either in the jaws or as loose teeth. Where teeth were present within unbroken jaws radiographs were taken to aid in dental ageing by enabling the formation stage of the tooth to be seen. Scanned images of these can be seen in Appendix G. This was only possible for the Taunton material which is curated at the University of Bristol. Time restrictions on the analysis of the Gloucester material, and the location of the Canterbury material at the University of Kent, meant that radiography was not possible for material from these two collections. One implication of using radiographs to aid in ageing the Taunton dentitions, but not the dentitions from the other sites, is that the Taunton ages may therefore be slightly more based on tooth formation than the other sites. They will also be more accurate where no loose teeth were present to indicate formation stage. The radiographs for the Taunton mandibles were taken in the Centre for Comparative and Clinical Anatomy on an Acoma Mobile X-ray Unit DFX50 set at 45 KV. The broken nature of many of the jaws observed within the collections studied was actually helpful in enabling closer ageing of the sub-adults, and in many cases without the need for radiographs. At the same time there was an opportunity to take a few radiographs of tibiae from the Taunton collection to explore whether any Harris lines would be visible. A full analysis of Harris lines on the sub-adults from the three skeletal collections was outside the limit of this research, but the evidence suggests that there may be potential for such a study in the future; the data are presented in Appendix G.

7.4.1 A Comparison of ageing methods

Whilst recording data from the three sites involved in this study it became clear that in many cases the methods of Schour & Massler (1941) and Smith (1991) put the same individual into a different age category, often by a year and in some cases by two. As Mays (2007) and Lewis (2002a) have both published information on the ages of individuals from Wharram Percy, using these two different methods, their results were available for a comparison of the two ageing methods. Mays (2007) used the Schour and Massler method, and Lewis that of Smith. As with the results of this study, the ages given did appear to differ for the two methods. To test whether this difference was statistically significant a Wilcoxon Signed Rank Test was performed on the dataset. The Wilcoxon Signed Rank Test is designed for use when comparing repeated measures and takes account of the size of differences between two closely related sets of data (Bryman & Cramer 2005, 171). The results show that the difference in ageing methods

is statistically significant ($Z = -7.178$, $p = 0.000$), with the ages of the Wharram Percy sub-adults assigned by Mays being higher in eighty-seven out of one hundred and fifty-seven incidences than those assigned by Lewis (2002a). The same assignment of age was given only fifty-eight times.

A significant difference ($Z = -6.438$, $p = 0.000$) was also seen between the two ageing methods from the data collected for this study; the Schour and Massler ages assigned were higher than those of Smith in sixty-eight out of two hundred and one incidences. The number of incidences where the ages came out as the same for the two methods was 124 (62%), compared to the 37% equal scores between the Mays and Lewis data. This may indicate that there is an element of subjectivity in using the ageing methods described, and that the differences are reduced where only one individual has recorded each method, although it is also possible that assignment of one age method could influence the assignment of the other when the analyses are being carried out at the same time. To test this, each age method would have to be used to assign age after an interval of time. The test clearly shows that the assignment of mean ages using the formation method of Smith tends to underage compared to the pictorial chart of Schour and Massler, and is in agreement with the conclusion of Liversidge (1994). As the under ageing of sub-adult dentitions has been shown to be a problem, the ageing method given precedence was that of Schour & Massler (1941).

7.4.2 Intra and Inter Observer error tests

Thirty individuals were picked at random, from the sixty-eight individuals that had dentitions present, to be assigned age by the author at a time period over a year after the initial age assignment, and by the author's supervisor. The method used was that of Schour & Massler (1941), and the data were recorded using the forms in Appendix C. The data collected were then tested for intra and inter observer errors. Statistically, there was no difference in the assignment of age at different periods of time by the author but there did appear to be a significant difference in the ageing of the sub-adult dentitions between the two observers. This discrepancy tended to be the slight over-ageing of dentitions by the second observer compared to the author; this difference was by a year in nine cases and by two years in three cases. Where the age assigned gave a difference of two years the individuals all fell into the period where the deciduous teeth were all present but no permanent teeth were yet at the stage of eruption. Details of the dataset and the statistical tests used are given in Appendix C.

7.5 Dental wear

There appear to be no standard charts, in the literature, for recording wear on deciduous teeth. Due to the young age of the children analysed for this study it was felt important to record wear on the deciduous teeth, as this may aid in interpretations of diet and status. Photographs were taken and sketches made of the wear pattern seen on each available deciduous molar tooth. Initially each tooth was also assigned to a stage as described in Skinner (1997). Although the stages he cites were not designed specifically for deciduous molars, Skinner used them for a study of sub-adult remains (albeit late Pleistocene hominins); these stages differentiate between the different stages of enamel wear prior to dentine exposure which are seen in newly erupted teeth. After recording the Taunton dentitions it was clear that some modification of these wear stages was necessary, leading to a new aim of creating a method of recording dental wear specifically for deciduous teeth. Firstly, this was to aid exploring dietary status and secondly, as a possible aid in ageing dentitions from late medieval individuals, with the possibility that this may be useful for the large collection of disarticulated material still to be analysed for the Taunton collection.

Whilst ageing using the formation and eruption of the teeth is fairly accurate, the rate of eruption can present problems between the ages of two and six years. This is because by the age of two years the deciduous dentition will be fully erupted and in occlusion, but the permanent teeth will not start to erupt until around six years of age. If the teeth are still firmly held within the mandible and there is no access or funds for radiography (meaning the formation stages of the teeth cannot be recorded), then it can be difficult to ascertain whether the child is nearer two or six years of age, as seen in the inter observer error test results referred to earlier. When the rest of the skeleton is complete, the fusion stages of bone elements across the skeleton, such as the occipital bones and vertebrae, will be of use to gain a more accurate age; however when dealing with poorly preserved postcranial material or disarticulated mandibles this information may also be absent. Work has been carried out using measurements of sub-adult mandibles to aid in the determination of age in forensic contexts (Franklin & Cardini 2007), but this requires the mandible to be complete. In archaeological material the mandible will often have lost the condylar process to erosion or fragmentation, and in some cases accurate measurements may therefore be difficult. It is when dealing with mandibles without

loose teeth, but poorer preservation of other skeletal elements, that referral to dental wear patterns may be of use in assigning a more accurate age to an individual.

Only the first and second lower deciduous molar teeth (dm1 and dm2) were selected for analysis. The molar teeth are the most important in mastication and their wear is thought to be the best indicator of diet. Only the lower teeth were used for this study as some variation has been noted between wear on the upper and lower molars (Brothwell 1981, 72), with the upper molars tending to wear at a slightly slower rate (Powell 1985, 324); archaeologically mandibles also tend to preserve better than maxillae. Molar teeth also tend to be recovered in the jaw of individuals, whereas the anterior teeth often come loose. It was therefore felt that the lower molars would provide the best focus if the results were to be of use for future comparative studies. Four hundred and fifty-eight teeth from 142 individuals could be analysed for dental wear, comprising 216 first deciduous molars and 242 second deciduous molars. One hundred and fifty-four teeth (71 dm1 and 83 dm2) from 46 individuals were recorded from the priory of SS Peter and Paul, Taunton, 77 teeth (38 dm1 and 39 dm2) from 23 individuals from the priory of St Oswald, Gloucester, and 227 teeth (107 dm1 and 120 dm2) from 73 individuals from the priory of St Gregory, Canterbury.

The three stages defined by Walker *et al.* (1991) in developing a wear standard for use in ageing were employed. Firstly the dentitions were aged using an indicator with a known relationship to chronological age, that of dental formation and eruption. Secondly the dental wear of the molars was recorded on an ordinal scale, and finally the relationship between the independent age indicator and the dental wear score was analysed. Each lower deciduous molar was scored for dental wear, with any molar teeth badly affected by caries being excluded from the analysis. As mentioned above, initially the stages on a scale of 0-8 as described by Skinner (1997) were recorded, but, it was often the case that the wear pattern appeared to fall between the stages described. Two extra stages were therefore created and a diagrammatic chart devised to enable a more accurate picture of the wear patterns to be recorded. A description of the stages is presented on page 161, and diagrams of each of these stages are shown in Figure 7.1. Photographs of the dentitions at different stages of wear are also presented in Figure 7.2 to Figure 7.9. There is no diagram shown for stage 0, as at this point there is no wear present. No dentitions analysed for this study had reached stage 10; it is unlikely that

this late stage of wear would be reached in the ten years that the deciduous molars may be in use. Skinner (1997) found no individuals with this level of wear among his sample.

7.5.1 Intra and Inter Observer error tests

Thirty dentitions were chosen at random from the 46 dentitions that had one or more deciduous molars present for intra and inter observer tests. The author scored dental wear at least one year after the initial scoring of the teeth, and the author's supervisor also scored the dentitions using the descriptions and pictorial chart devised by the author, which she had not used before. No statistically significance difference was shown for the scores recorded either for the intra or inter observer error tests. This is encouraging and suggests that the system devised for scoring wear on the deciduous teeth by the author could be used adequately by other researchers. Details of the data collected and the statistical tests are given in Appendix C.

7.5.2 Dental wear stages

Stage 0: No attrition visible. The teeth are either unerupted or have recently erupted with no sign of wear.

Stage 1: Enamel faceting. Attrition is visible as tiny planes or facets which reflect the light.

Stage 2: Enamel rounding. The cusps of the molars are slightly rounded and have lost their peaks and angular faceting.

Stage 3: Enamel flattening. The cusp tips of the molars are flattened and there is trace or no dentin exposure.

Stage 4: Dentin exposure (initial). One or two islands of dentin are exposed usually on one side of the tooth only (buccal).

Stage 5: Dentin exposure (middle). Three-five cusps have dentin exposure with islands on both sides of the tooth visible but are still quite small.

Stage 6: Dentin exposure (near complete). Dentin islands are visible on all or most cusps and are larger than at stage 5.

Stage 7: Dentin exposure (considerable). The dentin islands now resemble diamond shapes or rectangles as more dentin is exposed.

Stage 8: Advanced dentin exposure. At this stage there is coalescence of two or more islands of dentin even to the point where enamel is only seen at the centre of the occlusal surface.

Stage 9: Enamel ring. The occlusal surface of the enamel is worn away leaving only a ring of enamel circumferentially. There may be darkly stained islands of secondary dentin.

Stage 10: Root involvement. At this stage the tooth is worn to the root. This stage was not seen in any of the teeth analysed and it is probably a very rare occurrence for deciduous teeth to wear to this level before being exfoliated naturally.

Figure 7.1: Dental wear stages

Ldm1 = left deciduous first molar

Rdm1 = right deciduous first molar

Ldm2 = left deciduous second molar

Rdm2 = right deciduous second molar

Figure 7.2: Dental wear stage 1 (molar 1) SK 104 Gloucester

Figure 7.3: Dental wear stage 2 (molar 1 and molar 2) SK 434 Gloucester

Figure 7.4: Dental wear stage 3 (molar 2) and stage 4 (molar 1) SK 914 Taunton

All photos by H. Dawson

Figure 7.5: Dental wear stage 4 (molar 2) SK 1637 Taunton

Figure 7.6: Dental wear stage 5 (left) and 6 (right) (molar 2) SK 2023 Taunton

Figure 7.7: Dental wear stage 7 (molar 1 and 2) SK 118 Taunton

All photos by H. Dawson

Figure 7.8: Dental wear stage 8 (molar 1 and 2) SK 349 Gloucester

Figure 7.9: Dental wear stage 9 (molar 2) and 8 (molar 1) SK 716 Canterbury

All photos by H. Dawson

7.5.3 Permanent teeth dental wear

The dental wear chart of Brothwell (1981) was used for recording dental wear on the permanent dentition. To enable descriptive statistics to be performed easily Brothwell's stages were renumbered to be real numbers: 1 = 1; 2 = 2; 2+ and -3 = 3; 3 = 4; 3+ = 5; 4 = 6 (Figure 7.10). No higher dental wear scores than Brothwell's stage four were recorded.

Figure 7.10: Renumbering of Brothwell's dental wear stages.

7.6 Metrical and Non-metrical data

Table 7-2 and Table 7-3 show the list of measurements recorded from Buikstra and Ubelaker (1994) for infants and young children with some additional measurements from Scheuer & Black (2000b). For older children cranial measurements (Table 7-4) were recorded where possible (Howells 1973), and mandible measurements (see Table 7-5) according to Brothwell (1981). It became clear that certain measurements were possible to take more often and would therefore prove more useful, whilst some could rarely be taken and were discarded on the modified recording forms used at Canterbury. Measurements were only taken when the bone involved was complete, and as the cranial measurements could rarely be taken the results for these are not presented.

Table 7-2: Postcranial measurements taken for sub-adults.

Bone	Max length	Max distal width	Max width midshaft	length	width	length of spine
Femur	√	√	√			
Tibia	√		√			
Fibula	√		√			
Humerus	√	√	√			
Ulna	√		√			
Radius	√		√			
MC1	√		√			
MT1	√		√			
Clavicle	√		√			
Scapula				√	√	√
Ilium				√	√	
Ischium				√	√	
Pubis				√		

Table 7-3: Cranial measurements taken for infants and older sub-adults*.

Bone	length	width	height	width of processes	length of body
pars basilaris*	√	√			
pars lateralis*	√	√			
lesser wing of sphenoid	√	√			
greater wing of sphenoid	√	√			
body of sphenoid	√	√			
zygomatic*	√	√			
petrous and mastoid	√	√			
maxilla	√	√	√		
mandible	√			√	√

Table 7-4: Additional cranial measurements taken for older sub-adults.

GOL Glabello-occipital length (g-op)	ORB Orbit breadth, left
BNL Basion-nasion length (ba-n)	NLB Nasal breadth (al-al)
BBH Basion-bregma height (ba-b)	Palate breadth, external (ecm-ecm)
XCB Max cranial breadth	Palate length (pr-alv)
ZMB Bizygomatic breadth (zy-zy)	FMB Bifrontal breadth (fmt-fmt)
BPL Basion-prosthion length (ba-pr)	EKB Biorbital breadth (ec-ec)
NPH Nasion-prosthion height (n-pr)	FRC Nasion-bregma chord (n-b)
NLH Nasal height (n-lowest point)	PAC Bregma-lambda chord (b-l)
OBH Orbit height, left	OCC Lambda-opisthion chord (l-o)

Table 7-5: Mandibular measurements taken for older sub-adults.

Bicondylar width (W1)	Minimum ramus breadth (RB)
Bigonial breadth (GoGo)	Gnathion-infradentale height (H1)
Foramen mentalia breadth (ZZ)	Max mandibular length (ML)

Cranial non-metric data (Table 7-6) were scored as present, absent or un-recordable according to Hauser & De Stefano (1989) and Berry and Berry (1967), with degree of presence scored for a few as per Hauser & De Stefano (1989). Post-cranial non-metric traits (see Table 7-7) were scored according to Finnegan (1978). Non-metric traits are not often scored for sub-adults in the literature, due to a general trend for hyperostotic traits in older individuals (adults) and hypostotic traits in younger individuals (sub-adults) (Saunders 1989, 101). Some traits, such as the metopic suture, are of course always present in infants, and some areas may not be developed enough to score accurately in the immature skeleton. However, some traits seem to be worth recording on immature skeletons if only to determine the onset age of appearance or disappearance of such traits. The chosen selection was of those traits that could be scored accurately on immature individuals during research undertaken into evidence for relationships between individuals in Bronze Age Wessex (Dawson 2004, unpublished MA dissertation). These included traits that appear to make a fairly early appearance such as the third trochanter on the femur, or those that are always present in infants and can therefore be recorded to infer the age at which the trait should disappear, such as the metopic suture.

Table 7-6: Cranial non-metric traits.

Metopic suture	Coronal ossicle	Ossicle in occipito-mastoid suture
Metopic fissure	Sagittal ossicle	Condylar facet double
Supranasal suture	Apical bone	Divided hypoglossal canal
Frontal grooves	Inca bone	Auditory exotosis
Supraorbital foramen/notch	Lambdoid ossicle	Palatine torus
Infraorbital suture	Asteronic bone	Maxillary torus
Infraorbital foramen	Parietal notch bone	Mental foramen>1
Zygomatico-facial foramen	Parietal foramen	Mandibular torus
Bregmatic bone	Sutura mendosa	Mylohyoid bridge

Table 7-7: Postcranial non-metric traits.

Bone	Trait		
Femur	Allen's fossa	Third trochanter	
Tibia	Medial squatting facets	lateral squatting facets	
Humerus	Septal aperture	Supracondyloid process	
Scapula	suprascapular foramen		
Ilium	Pre-auricular sulcus	Accessory sacral facets	
Patella	Vastus notch		
Atlas	Facet formation	Posterior bridge	Lateral bridge
Cervical	Transverse foramen		

7.6.1 Stature

Most of the skeletons analysed have at least one measurable long bone, but in most cases some of the long bones were missing, broken, or damaged and therefore unable to be measured. This means comparative data are reduced; for example those skeletons with only arm bones measured cannot be compared with those that have only leg bones. Goode *et al.* (1993) noted this problem when dealing with sub-adult skeletons and recommended using a standardized method that enables the measurements from any bone to be plotted on a single graph. One way to be able to compare all individuals with at least one long bone measure is by calculating stature. However, whereas long bone length is an accurate measurement, the calculation of stature, using equations created from living children, will only provide an estimate of that individual's stature and will introduce a certain amount of error to the measure. A benefit of calculating estimated statures for archaeological skeletons is that it allows them to be compared with modern studies which present mean statures of living children at different ages.

When analysing adult skeletons the stature equations of Trotter (1970) as cited in Brothwell & Zakrzewski (2004, 33) are routinely used. However, stature for sub-adults is not usually mentioned in archaeological reports and is also under utilised in forensic cases (Cardoso 2009). Several methods of calculating estimated stature for sub-adult remains are available and Cardoso (2009) has recently reviewed three of these (Telkkä *et al.* 1962; Feldesman 1992; Smith 2007) on known age twentieth century autopsy cadavers from Portugal. He found that the equations of Smith (2007) provided the smallest mean difference between the true and estimated stature when tested on cadavers of known age. All three methods were seen to tend towards an underestimation of stature, as measured by cadaver length, with the femur/stature ratio method the least accurate (Cardoso 2009, 15). Another advantage in using the Smith equations is that they use measurements on the diaphysis of the limb bone whereas the method developed by Feldesman (1992), and used by Mays (2007) on the Wharram Percy material, includes the epiphysis in the measurements taken and are therefore only presented from the age of eight to eighteen years. The ease of use of the Smith equations is also a positive factor. It must be stated that the measurements taken are all from radiographs on living children from the United States of America during the twentieth century. There will undoubtedly be some discrepancy when using dry bone measurements in place of those taken from radiographs, and Smith (2007, 539) states the measures '*will vary somewhat from lengths measured on dry bones*'. However, as a guide to compare stature estimates of late medieval children with the statures of modern children these equations can be useful, as long as these problems are recognised. Another benefit of using the Smith equations is that stature can be calculated for all of the long bones, whereas Feldesman only calculated stature from femur length. This is useful for archaeological material where whole skeletons are often not recovered; where any long bone can produce a stature estimate this will create a larger dataset. Although all the long bones can be used to estimate stature it has been suggested that certain bones will produce a more accurate result. The equations of both Telkkä *et al.* (1962) and Smith (2007) are more accurate when the upper limb bones are used as opposed to the lower limb bones (Cardoso 2009, 17).

Longitudinal studies have shown that leg growth is mostly responsible for rapid stature growth periods (Buschang 1982), and is therefore also most sensitive to environmental conditions which may affect stature. The Portuguese remains used by Cardoso (2009)

were from children of a low socioeconomic background, and as a consequence they may have lower relative leg lengths compared to the US children used in the formulation of stature estimate equations. This could lead to the underestimation, in general, of stature in Cardoso's study. Cardoso (2009) suggests that, due to more pronounced stunted growth on the leg bones during hard times, the arm bones may be a better estimate of stature and this may be the reason that the Feldesman method had most error, due to this method only using the leg bones. Smith (2007, 539) mentions that as long bones increase in length (and therefore as children get older) the variance in stature becomes wider. She also noted that boys tend to have relatively longer forearms than girls (Smith 2007, 542).

Stature estimations have also been attempted from the second metacarpal bone (Himes *et al.* 1977) from radiographs. The applicability for archaeological material is here limited in young children. In adults the metacarpals are easy to tell apart due to the differences in the articular surfaces. In young children the articular surfaces are not well developed, and therefore it can be difficult to identify differences for the second to fifth metacarpals which become '*more recognisable as ossification spreads into the bases*', and are therefore easier to identify in older sub-adults (Schaefer *et al.* 2009, 214). If first metacarpal length could be used, this would be useful in an archaeological context; the first metacarpal tends to be well recovered and often will be complete even when the long bones are fragmentary.

The stature estimates calculated for this study are from Smith's (2007) equations. These seem to be the most suitable for younger children (which make up the majority of the remains from the three sites under study), as well as being seen to have the least errors (Cardoso 2009).

7.7 Pathology

Each bone was studied for any pathological lesions and the site and type of pathology was recorded where found. Lesions of porotic hyperostosis (scored when one or more bones of the calotte where present) and cribra orbitalia (scored when one or two of the orbits were present) were recorded according to Stuart-Macadam (1991) as grades 0-5, with activity of the lesion determined according to Mensforth *et al.* (1978). Figure 7.11 shows examples of the stages recorded; grade 5 was not seen in any of the individuals analysed.

Endocranial lesions (scored when one or more bones of the calotte where present) were recorded as to the type of lesion according to Lewis (2004): Grade 1 porous lesions, Grade 2 fibre bone, Grade 3 capillary lesions, Grade 4 hair-on-end lesions, and Grade 5 eroded defects (Figure 7.12). Lesions of non-specific infection (periostitis) were recorded as either woven or lamellar bone, and as active or healed according to Mensforth *et al.* (1978). Any porosity and striations were also recorded (Figure 7.13) as they may represent the stage prior to bone formation (Ribot & Roberts 1996, 70); these were mainly seen on the medial shafts of tibiae and, due to their frequent occurrence on the collections analysed, may be features of normal growth on sub-adult bones. Lewis (2007, 135) suggests care in the interpretation of periosteal bone growth, as in the long bones '*appositional growth involves the deposition of immature disorganised bone on the cortical surface*', and suggests that non-adult periostitis is characterised by a unilateral isolated patch of bone raised above the original cortex (*ibid.*). All pathology noted was described and the area affected marked on a separate drawing.

Cribra orbitalia Grade 1

SK 2077 Taunton

Cribra orbitalia Grade 3

SK B171 Gloucester

Cribra orbitalia Grade 2

SK B104 Gloucester

Cribra orbitalia Grade 4

SK B106 Gloucester

Figure 7.11: Photographs of cribra orbitalia grades.

All Photos by H. Dawson

Porosity (1)

SK 310 Taunton

Capillary lesions (3)

SK B378 Gloucester

Fibre bone (2)

SK 2078 Taunton

"Hair on end" lesions (4)

SK 95 Canterbury

Figure 7.12: Photographs of endocranial lesion grades.

All photos by H. Dawson

Porosity

SK 914 Taunton

Woven bone

SK B136 Gloucester

Striations

SK B123 Gloucester

Lamellar bone

SK 800 Canterbury

Figure 7.13: Photographs of different levels of periostitis recorded.

All photos by H. Dawson

7.8 Data analysis

The analysis of such a large set of data required a bespoke database to be created. In order to determine the best way of storing the information, and to enable queries on the data to be run, to aid in interpretation, an underlying logical data model was established, thus identifying the relationships and hierarchy of the data. Figure 7.14 shows a simplified representation of the logical data model created, with each category title signifying a table to be created in the database. Each category contains all the information relevant to it. **Site** contains information on the site that the skeleton comes from. **Ex. area** holds information on the area or trench number where the skeleton was located. **Pile hole** relates to information recorded from the Taunton excavation only, where each square which was to have a pile driven in to it by the developer was numbered. **Context** contains information on each context, including context number. The **Remains** category holds all the information that relates to an individual skeleton, such as age at death, and preservation. **Bone** holds all the information on individual elements of the skeleton, such as length of bone; each bone recorded will have a separate entry. **Bone cat.** contains a list of categories of bones: skull, axial, long bone, flat bone, hand/foot bone. **Bone type** contains the name of each element of the skeleton, i.e. femur. **Bone side** is a list of possible places of where the bone is located in the body: left, right, midline, unsided. **Tooth** contains all the information about each separate tooth recorded. **Tooth no.** is a list of the numbers assigned to each tooth i.e. 51 is the right upper second deciduous molar.

Figure 7.14: Logical data model.

A list of the attributes for each table is given in Appendix H. Once the logical data model was created a database was designed and implemented using Microsoft Access 2002 version 10. An Access database was chosen so that relationships between the data could be easily recorded, something not possible in a standard spreadsheet, such as Excel. Access was used to perform queries on the data. If the data was to be explored further, in the creation of charts and statistical analysis, the results were copied into Excel 2002 version 10 and/or SPSS 2007 version 16. Excel was used for more simple tasks, such as the creation of charts and tables, whereas SPSS was used for the statistical analysis. Initially all data were analysed using descriptive statistics consisting of mean, median, standard deviation, and minimum and maximum values. As many of the recorded scores were on an ordinal scale the median was used; for some of the non-parametric tests used it is the median that is tested as opposed to the mean.

7.9 Questions and hypotheses

The main purpose of this thesis is to uncover information regarding the status of children as reflected in the evidence from both burial practice and the life history information that can be gained from the analysis of individual skeletal remains. The data collected can be used in several different ways to try and gain an understanding of how different burial practices included or excluded children of different ages, and if the presence of physical signifiers of status, such as pathology, relative dental wear and growth, in individuals relate in any way to differing burial patterns. The data collected will be tested using various statistical techniques which are described alongside the hypothesis being tested in this section. Significance is assigned when the p value is less than or equal to 0.005.

7.9.1 Demography

The age structure of the children recovered by excavation, according to burial location will be explored. In Chapter Three several stages of childhood were defined as being present in the late medieval period. These stages have been used in the analysis to determine the spread of the different age groups of children across the cemetery sites. The aim here is to see if children at these different stages in their lives were treated in a different or similar way. If the evidence suggests differential treatment this may relate to the status of a child changing as they age. This will be explored for each of the sites and for the data collected as a whole. Preterm and neonate individuals will be considered separately. Analysis of the adult skeletons at Taunton was also undertaken by the

author, as part of a separate report (Dawson & Robson Brown in prep), and therefore any difference in treatment between the adults and children can also be investigated for this site.

Question 1: Is there a difference between the distribution of sub-adult and adult burials by site?

H_0 : The number and distribution of sub-adult and adult individuals are equal across sites.

H_1 : The number and distribution of sub-adult and adult individuals are not equal across sites.

Statistical test: Chi-square test for independence.

Chi-square test for independence

The Chi-square test for independence is used to explore the relationship between two categorical variables. It looks for differences in the data and determines whether the difference is great enough that the probability of this being the result of chance variation is at an acceptably low level (Shennan 1997, 106). This test is used when exploring the relationship between two categorical variables; each of the variables can have two or more categories. There are some assumptions of the data that need to be met, and this can create problems when certain categories within the dataset are small. The lowest expected frequency in any cell should be five or more, with at least 80 per cent of the cells meeting these criteria. If this assumption is violated it is possible to use the Fisher's Exact Probability Test instead. The values of interest are usually the Pearson chi-square (sometimes the continuity correction will be used, for example when the results are in a 2x2 table), and the significance value.

Question 2: Is there a difference between the distribution of sub-adult age ranges by site?

H_0 : The number and distribution of sub-adult age groups are equal across sites.

H_1 : The number and distribution of sub-adult age groups are not equal across sites.

Statistical tests: Kolmogorov-Smirnov test, Kruskal Wallis test, and Mann Whitney test for two independent samples.

Kolmogorov-Smirnov

Where continuous data were present the Kolmogorov-Smirnov test was used to check for normality. This was done to aid in the choice of test to choose when analysing the data. If the data were normally distributed then a parametric test could be used; if not the non-parametric equivalent test would be used.

The Kolmogorov-Smirnov test was also used to statistically test the significance between two unrelated samples. This test is based on the difference between the two cumulative distributions of interest (Shennan 1997, 57). The cumulative distribution was used for exploring age and growth between sites.

Kruskal-Wallis test

The Kruskal-Wallis test is the non-parametric alternative to the one way analysis of variance (ANOVA) test. It allows comparison of the scores of a continuous variable for three or more groups. As it is a non-parametric test the scores are converted to ranks and it is the mean rank of each group which is compared; this is a between groups analysis. The values of interest from the test output are the chi-square value, the degrees of freedom, and the significance level.

Mann Whitney test for two independent samples

The Mann Whitney test for two independent samples is the non-parametric alternative to the independent samples T-Test, and can be used when the assumptions needed for the T-Test are not met. Like the T-Test it compares two different groups by comparing the values of some continuous variable. The values of interest are the Z value, degrees of frequency, and the significance level. Rather than a comparison of means (as is the T-Test) this test compares the median values and converts the scores to ranks across the two groups, it then compares the ranks to determine if the values for the two groups differ significantly.

Question 3: Is there a difference between the distribution of preterm and neonate burials by site?

H_0 : The number and distribution of preterm/neonate individuals are equal across sites.

H_1 : The number and distribution of preterm/neonate individuals are not equal across sites.

Statistical test: Kolmogorov-Smirnov test, Kruskal Wallis test, and Mann Whitney test for two independent samples.

Question 4: Is there a difference between the distribution of sub-adult and adult burials by burial location?

H_0 : The number and distribution of sub-adult and adult individuals are equal by burial location.

H_1 : The number and distribution of sub-adult and adult individuals are not equal by burial location.

Statistical test: Chi-square test for independence.

Question 5: Is there a difference between the distributions of sub-adult age ranges by burial location?

H_0 : The number and distribution of sub-adult age groups are equal by burial location.

H_1 : The number and distribution of sub-adult age groups are not equal by burial location.

Statistical tests: Kolmogorov-Smirnov test, Kruskal Wallis test and Mann Whitney test for two independent samples.

7.9.2 Funerary Context

Although rare in the late medieval period, a few finds were associated with the burials at Taunton, and some are noted in association with the remains at Gloucester in the site report, and on the skeleton sheets from the archive. At Canterbury, although the skeleton sheets were not available to be viewed, the plan lists any finds that were located in association with burials. These will be referred to in relation to the ages of the individuals with which they were associated, in the case of the children, and compared to the evidence for finds recovered in association with the adults, where the information is known.

Question 6: Is the placement of the body for burial similar for sub-adults and adults?

H_0 : There is no difference in the placement of the body for burial between sub-adults and adults.

H_1 : There is a difference in the placement of the body for burial between sub-adults and adults.

Statistical test: Chi-square test for independence

Question 7: Is the presence of evidence for coffins similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for coffins between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for coffins between sub-adults and adults.

Not tested statistically.

Question 8: Is the presence of evidence for grave goods similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for grave goods between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for grave goods between sub-adults and adults.

Not tested statistically.

Question 9: Does depth of burial differ for sub-adults and adults?

H_0 : There is no difference in the depth of burial between sub-adults and adults.

H_1 : There is a difference in the depth of burial between sub-adults and adults.

Statistical test: Independent samples T-Test.

Independent samples T-Test

The independent samples T-Test is used to compare the mean scores of two different groups by comparing the values of some continuous variable. As a parametric test assumptions need to met, such as normality of distribution and equal variances (which is tested in SPSS using Levene's test). The values of interest are the T value and the significance level. This test will indicate if there is some significance difference between the two groups of data.

7.9.3 Preservation

As discussed in Chapter Four, many authors note that poor preservation of infant and child remains means that they are often underrepresented. The state of preservation

between the different age groups will be explored to see if, as suggested, it tends to be poorer for infants than older children. For Taunton the preservation of the adults can also be compared with those of the children to see if there is any noticeable difference. Where the burials are located can also be explored in relation to preservation. For example, those within the church may be assumed to have better preservation, whilst those in popular areas of the churchyard may be more poorly preserved, due to constant disturbance.

Question 10: Is there a difference in preservation and completeness of the skeleton between sub-adult and adult skeletons?

H_0 : The preservation of the remains are equal for sub-adults and adults.

H_1 : The preservation of the remains are not equal for sub-adults and adults.

Statistical test: Chi-square test for independence and Mann Whitney test for two independent samples.

Question 11: Is there a difference in preservation and completeness of the skeleton by site?

H_0 : The preservation of the remains are equal across sites.

H_1 : The preservation of the remains are not equal across sites.

Statistical test: Chi-square test for independence, Kruskal Wallis test, and Mann Whitney test for two independent samples.

Question 12: Is there a difference in the percentage of elements recovered from each skeleton by site or burial location?

H_0 : The percentage of elements recovered are equal across sites, and by burial location.

H_1 : The percentage of elements recovered are not equal across sites, and by burial location.

Statistical test: Kruskal Wallis test and Mann Whitney test for two independent samples.

Question 13: Is there a difference in surface erosion on the skeleton by site or burial location?

H_0 : The surface erosion recorded on each skeleton is equal across sites, and by burial location.

H_1 : The surface erosion recorded on each skeleton is not equal across sites, and by burial location.

Statistical test: Kruskal Wallis test and Mann Whitney test for two independent samples.

Question 14: Is there a difference in preservation and completeness of the skeleton by age?

H_0 : The preservation of each skeleton is equal across age ranges.

H_1 : The preservation of each skeleton is not equal across age ranges.

Statistical test: Kruskal Wallis test and Mann Whitney test for two independent samples.

Question 15: Is there a difference in preservation and completeness of the skeleton by burial location?

H_0 : The preservation of the remains are equal by burial location.

H_1 : The preservation of the remains are not equal by burial location.

Statistical test: Chi-square test for independence, Kruskal Wallis test, and Mann Whitney test for two independent samples.

7.9.4 Dental Wear

Dental wear will be explored on the deciduous molar teeth of each sub-adult. This will be assessed as a possible marker for differing diets between individuals, from different sites and areas, to see if burial status may be linked to differing dental wear patterns. As the recording method is original, created during this research, the results will also be explored to see whether there is any potential for using the method to aid in ageing late medieval children. If the different sites produced similar dental wear results then the data could be pooled to give an indication of dental wear rates for the population of late medieval children as a whole. The data collected were tested for normality using the Kolmogorov-Smirnov statistic. As the distributions were not seen to be normal, a range of non-parametric tests were chosen to explore the dataset.

Question 16: Is there a difference between dental wear scores recorded and burial location?

H_0 : The dental wear score of same age children is equal across burial locations.

H_1 : The dental wear score of same age children is not equal across burial locations.

Statistical test: Kruskal Wallis test and Mann Whitney test for two independent samples.

Question 17: Is there a difference between dental wear scores recorded and site?

H_0 : The dental wear score of same age children is equal across sites.

H_1 : The dental wear score of same age children is not equal across sites.

Statistical test: Kruskal Wallis test and Mann Whitney test for two independent samples.

7.9.5 Episodes of stress

Indicators of stress will be explored to see how they affect the growing child. As described in Chapter Five, these will include cribra orbitalia, enamel hypoplasia, periostitis, endocranial lesions and porotic hyperostosis. Caries rates will also be explored under this heading. Whether there are any differences between sub-adults and adults, and by age of the children, and the presence of stress indicators will be explored, as well as differences by site and by burial location. Whether the presence of stress indicators on the skeleton has any relationship to growth, in the form of shortened long bone length or stature will also be tested.

Question 18: Is there a difference between the presence of stress indicators, or caries, between sub-adults and adults?

H_0 : The presence of stress indicators, or caries, recorded is equal between sub-adults and adults.

H_1 : The presence of stress indicators, or caries, recorded is not equal between sub-adults and adults.

Statistical test: Chi-square test for independence.

Question 19: Is there a difference between the presence of stress indicators recorded by site?

H_0 : The presence of stress indicators recorded is equal across sites.

H_1 : The presence of stress indicators recorded is not equal across sites.

Statistical test: Chi-square test for independence.

Question 20: Is there a difference between the presence of stress indicators recorded by burial location?

H_0 : The presence of stress indicators recorded is equal by burial location.

H_1 : The presence of stress indicators recorded is not equal by burial location.

Statistical test: Chi-square test for independence.

Question 21: Is there a difference between the presence of stress indicators recorded by sub-adult age grouping?

H_0 : The presence of stress indicators recorded is equal by age group.

H_1 : The presence of stress indicators recorded is not equal by age group.

Statistical test: Chi-square test for independence.

Question 22: Is there any relationship between the presence of two different stress indicators?

H_0 : There is no relationship between the presence of two different stress indicators.

H_1 : There is a relationship between the presence of two different stress indicators.

Statistical test: Chi-square test for independence.

7.9.6 Growth and development

Growth and development of children has been shown to be related to health and nutritional status. Growth will be explored in terms of long bone lengths, which will also be translated into estimated statures for each individual. Differences between burial locations and the different sites will be explored, and if any relationship can be seen with dental health or stress indicator presence. When dealing with growth in terms of long bone length, several problems arise which mean that statistical tests cannot be used in certain cases. As growth is strongly correlated to age, only individuals of a similar age can be compared; this reduces the number of individuals that can be tested together and in most cases this becomes too low to use statistical tests. Converting long bone lengths to estimated stature creates a larger sample, as those individuals with only a femur length can now be compared to those with any other long bone length. Development will be explored for the individuals in terms of fusion ages for the skull and vertebrae, which develop over a period from infancy to middle childhood.

Question 23: Do the remains of similar age individuals from the three different sites have a similar stature?

H_0 : There is no difference between stature for similar age individuals for the three sites.

H_1 : There is a difference between stature for similar age individuals for the three sites.

Test: One Way Analysis of Variance (ANOVA) and Regression lines of best fit.

ANOVA – one way analysis of variance

This test is used where an independent variable has three or more groups and allows comparison between groups of a dependent continuous variable. To use this parametric test the data has to be normally distributed, be of equal variances (this is tested in SPSS using the Levene test for equality of variances), and the observations must be independent of each other. The values of interest are the F value, degrees of frequency, and the significance level. This test will inform the user if there is significance between the groups, but not where the significance falls. Therefore, a post hoc test needs to be performed to determine between which groups the difference lies. The Tukey test is used where possible (in some cases the amount of data were not sufficient to be able to apply the Tukey test). The Tukey test highlights where the difference is between the groups and provides a mean difference value.

Regression Lines of best fit

Regression lines are used as a way of visually depicting the relationship between the independent (x) and dependent (y) variables on a graph. A straight line can be added which depicts a linear trend in the data. This line represents the relationship between x and y for each variable. The equation of this line can be calculated and how well this equation describes the data (the fit) is expressed as a correlation coefficient R^2 (R-squared). The closer R^2 is to the value of 1 the better the fit and the closer the line passes to all the data points.

Question 24: Does burial location have any effect on stature in similar age individuals?

H_0 : There is no difference between stature for similar age individuals and burial location.

H_1 : There is a difference between stature for similar age individuals and burial location.

Statistical Test: ANOVA, Independent samples T-Test, and Regression lines of best fit.

Question 25: Does the presence of stress indicators have any effect on stature in similar age individuals?

H_0 : There is no difference between the presence of stress indicators and stature for similar age individuals.

H_1 : There is a difference between the presence of stress indicators and stature for similar age individuals.

Statistical Test: ANOVA and Regression lines of best fit.

7.10 Summary

The data recorded for this exploration of child health and status was that which was seen to be of value when analysing sub-adult remains. Not all of the data will be utilised fully within Chapter Eight, which is a presentation of the results, as this chapter will focus on the data that are relevant to the specific research questions that were outlined in section 7.9. The rest of the raw data will be presented in Appendix J. The methods described above are those that were considered and employed in the analysis of the data collected, and reference should be made back to this chapter where necessary during the presentation of results in Chapter Eight, and the following discussion in Chapter Nine. As has been discussed, there are many different methods that can be employed when analysing human remains and those chosen here are the ones that would seem to be the most appropriate for the sub-adult populations under study. There are also several different types of statistical tests that could be performed on the dataset; again the most appropriate test depending on the structure of the data being explored for each question has been employed. For the presentation of results in the following chapter the statistical test, or tests, used will be stated, and the results that showed significance presented. Where no statistical significance was seen when performing a test, this will be noted but the values not presented.

Chapter 8 : Results

The following chapter presents the results of the data collection and analysis undertaken for this thesis. The results have been collated into sections based on the objectives outlined in Chapter Seven. Section 8.1 Demography will detail the demographic profile of all the skeletons recovered from the three collections detailed in Chapter Six. The focus will then be on comparisons of the sub-adult populations from the three sites. Section 8.2 will detail the evidence for the funerary context from the three sites. Section 8.3 will focus on the preservation of the material. Section 8.4 will describe the results of the study of dental wear rates for the three sub-adult populations. Section 8.5 will analyse the presence and absence of stress indicators, on the Taunton population as a whole and on the three sub-adult populations. Section 8.6 will detail the growth and development of the sub-adults from the three populations and will involve an exploration to see if the presence of stress indicators on a skeleton has any effect on growth, and finally Section 8.7 will describe any other pathology noted on the sub-adult individuals from the three populations.

8.1 Demography

This section will test the hypotheses for questions one to five outlined in Chapter Seven. For the Taunton collection, as both the sub-adults and adults were analysed, the demography of the whole cemetery population is presented. Summary sheets that were written by Dr Juliet Rogers, and the human remains report (Rogers 1984), have also been used to compare the skeletal material analysed from the 1977 excavations at Cannon Street, Taunton to the results from the authors' analysis of the remains from the 2005 excavation. For the comparative sites, only the sub-adults³⁹ were analysed as a comparison to the Taunton sub-adults, therefore, to present an initial full demographic profile of these two sites, data from Rogers (1999) for the adults, and data from the skeleton sheets from the archive for the sub-adults not analysed by the author were used for Gloucester. Data from Anderson & Andrews (2001) and a summary by Anderson from the archive was used for Canterbury. The way in which the age ranges were

³⁹ For Gloucester 65 individuals were analysed of a potential 87 individuals. The data for the 22 skeletons not analysed by the author are presented in the demographic profile of the site from data in the original skeleton sheets by Rogers in the archive. For Canterbury, 104 individuals of a potential 217 were analysed. Only those individuals which had their dentition present were chosen to be analysed, and these were all grouped as under twelve years of age by Anderson. Ninety-nine individuals were aged between 12-20 years by Anderson.

summarised by Anderson is not compatible with the age ranges used by the author, so the full demographic profile presented uses the data collected by Anderson.

8.1.1 Taunton population

Figure 8.1 shows the number of individuals assigned to each age group from the Taunton collection. Ninety-three sub-adults were retained for analysis along with ninety-seven adults. The adult group consists of sixty males, or probable males, and twenty-nine females, or probable females, a ratio of 2:1. Eight individuals were of undetermined sex. The age group with the most individuals present is the two to seven year olds.

Figure 8.1: Demographic profile of the Taunton population.

Figure 8.2 divides the numbers of sub-adults and adults present for each area excavated. As can be seen mostly adults were present in areas 2 and 5, within the church (these were also mostly males), whilst in area 3 mostly sub-adults were recovered.⁴⁰ The results are statistically significant using the chi-square test for independence (chi-square 14.401, degrees of frequency (df) 3, significance (p) 0.002). A higher number of females than males were also recovered from area 3. The other two areas show fairly

⁴⁰ However, see Chapter Five for details of the incompleteness of excavation in this area.

equal numbers of adults and children, with area 1 containing slightly more adults and area 4 slightly more sub-adults.

Figure 8.2: Excavations areas, children versus adults.

Figure 8.3 shows the mortality profile of the two Taunton excavations in comparison to each other. The number of sub-adults recovered was considerably less for the 1977 excavation. When the numbers of adults and sub-adults is tested statistically between the two sites using the Chi-square test for independence the results are significant (chi-square 3.952, df 1, p 0.047). This indicates the difference in sub-adult numbers as the number of adult remains recovered for each site was of a similar number⁴¹. Forty-four adults could not be assigned to a definite age range for the 1977 excavation data, and this was sometimes due to the age being assigned as very general (35+) or the age being recorded as adult. For the older individuals Rogers listed them as 40+ or 45+ years, hence the discrepancy of 50+ (related to the 2005 data) or 40+ (related to the 1977 data) years on Figure 8.3.

⁴¹ Ninety-seven adults were analysed for the 2005 excavations and ninety-six for the 1977 excavations.

Figure 8.3: Demography of the complete Taunton population, including 1977 data.

The profile of the sub-adults from each of the excavations is fairly similar, although no neonates were recovered from the 1977 excavations, and a considerably higher proportion of the sub-adult population were of those individuals aged between twelve and twenty years of age. For the adult population the young adults recovered matches exactly from the two populations, whereas there is a considerable lack of middle-age adults; these may be represented in the unaged adult category. The number of males and females recovered from the 1977 excavation was equal; forty-two males and forty-two females.

8.1.2 The Gloucester population

Figure 8.4 shows the number of individuals assigned to each age group from the Gloucester collection. Due to a discrepancy in the recording of age ranges between the author and the data used from Rogers (1999), where the young adult range starts from fifteen years, the age ranges presented go from seven up to fifteen years and then fifteen up to twenty-five years. Eighty-seven sub-adults and one hundred and thirty-four adults were recovered. The adults consist of fifty-five males and forty-two females, a ratio of 1.3:1. Thirty-seven individuals were of undetermined sex. The highest sub-adult range seen is for the preterm infant and neonate age category.

Figure 8.4: Demographic profile of the Gloucester population.

8.1.3 The Canterbury population

Figure 8.5 shows the number of individuals assigned to each age group from the Canterbury population. The age ranges here are those used by Anderson & Andrews (2001). Three hundred and sixteen sub-adults and nine hundred and twenty-nine adults were excavated from the church and cemetery of St Gregory’s priory. Of the adults, five hundred and ten are male and four hundred and thirty-four female, a ratio of 1.2:1. Forty-nine individuals were of undetermined sex. For the sub-adults the highest number of individuals is in the one up to six year age group, with middle-age adults being most highly represented.

Figure 8.5: Demographic profile of the Canterbury population.

8.1.4 Sub-adult mortality: comparison of all sites

The age profiles of the sub-adult skeletons analysed from each site are shown in Figure 8.6 to Figure 8.8. As noted in Chapter Six, none of the sites have provided a complete set of sub-adult skeletons which were buried in the cemeteries. All the sub-adults excavated from Taunton were analysed, most of those from Gloucester, although twenty-two could not be located in the store room⁴², and only those skeletons which had dentitions and were categorised as twelve years or under by Anderson were analysed for Canterbury⁴³. Table 8-1 and Figure 8.6 and Figure 8.8 show that Taunton and Canterbury appear to be very similar in their distribution of ages, with most skeletons being in the two up to seven years age group, and then in the seven up to twelve year group. The profile of Gloucester (Figure 8.7) is notably different with the preterm and neonate burials making up the largest group, and the number of individuals tending to decline as the age range increases.

Table 8-1: Number and percentage of individuals in each age range for all sites.

Age range	Taunton	%	Gloucester	%	Canterbury	%
neonate	6	6	21	32.5	7	7
0 up to 2 years	14	15	13	20	15	14
2 up to 7 years	38	41	15	23	57	55
7 up to 12 years	23	25	12	18.5	25	24
12+ years	12	13	4	6	-	-
Total	93		65		104	

This difference was tested to see if it was statistically significant using the Kolmogorov-Smirnov test for two unrelated samples. This test is based on the difference between the two cumulative distributions of interest (Shennan 1997, 57). The cumulative distribution is shown in Figure 8.9. When the data for Taunton and Canterbury were compared no significant difference was seen but when both were compared to Gloucester there was a significant difference (see Table 8-2).

⁴² The ages of the individuals that could not be located were taken from the original skeleton sheets in the archive and when plotted no significant change was seen in the demographic profile presented in Figure 8.7.

⁴³ Not all of the original skeleton sheets could be located, but Anderson had created a summary of the sub-adult ages in ranges of: foetus, 0-1 year, 1-5 years, 6-11 years and 12+ years (juveniles). The data collected for Canterbury for this study were put into these age ranges for comparison and showed a similar profile indicating that the sample studied is reflective of the whole sample excavated.

Figure 8.6: Sub adult mortality (Taunton).

Figure 8.7: Sub adult mortality (Gloucester).

Figure 8.8: Sub adult mortality (Canterbury).

Figure 8.9: Cumulative age distributions of the three sites.

Table 8-2: Results for age range tested by site (Kolmogorov-Smirnov).

Sites tested	most extreme differences	Z	P (2-tailed)
Taunton & Canterbury	0.136	0.953	0.324
Taunton & Gloucester	0.308	1.905	0.001
Canterbury & Gloucester	0.312	1.970	0.001

The cause of this significant difference between Gloucester and the other two sites is that there are many more very young infants present from the excavations at Gloucester. There are several factors that could account for this and these will be discussed further in Chapter Nine.

8.1.5 Infant mortality: comparison of all sites

Table 8-3 and Figure 8.10 show the numbers of preterm or neonate individuals analysed from the three sites. Gloucester has notably more young infants present than the other two sites and nearly half of these are preterm infants. Most of the preterm/neonate infants present are in the 38-40 week category, which is around the normal time of birth; this is also seen at Taunton. However, for Canterbury the number of post-natal deaths is higher. Whilst the data for Taunton and Canterbury is normal using the Kolmogorov-Smirnov test, that for Gloucester is not. Therefore a Kruskal Wallis test was used to test for any significant differences between the sites. Although the figures for Gloucester include very young infants there is no statistically significant difference (chi-square 3.971, df 2, p 0.137).

Table 8-3: Number of preterm/neonate individuals for each site

Age in weeks	Taunton	%	Gloucester	%	Canterbury	%
23-25	0	0	1	5	0	0
26-28	0	0	0	0	0	0
29-31	0	0	2	9	0	0
32-34	0	0	1	5	2	28.5
35-37	0	0	5	24	0	0
38-40	5	83	11	52	2	28.5
41-43	1	17	0	0	3	43
44-46	0	0	0	0	0	0
47-49	0	0	1	5	0	0
Total	6		21		7

Figure 8.10: Infant mortality (preterm and neonate burials).

8.1.6 Age range by location and proximity

8.1.6.1 Taunton sub-adults and adults

Table 8-4 gives the location and proximity for the individuals from Taunton grouped as sub-adult or adult. Statistical significance was seen in both cases when these groups were tested using the chi-square test for independence. Adults are more likely to be buried within the church, but sub-adults are more likely to be buried close to the church than adults.

Table 8-4: Location and proximity data for the sub-adults and adults from Taunton.

Location	Sub-adults	Adults	chi-square	P
within church	2	14	7.763	0.005
west of church	91	83		
Nearness				
within church	2	14	13.930	0.001
<=10m	24	11		
>10m	67	72		

8.1.6.2 Sub-adults from all sites

Table 8-5 to Table 8-12 show the number of individuals within each age range for the different locations and proximity to the church from the three sites and as the data from all sites pooled together. At Taunton part of the inside of the church was excavated as well as several areas to the west of the church, area 4 being on the northern edge of the cemetery. For Gloucester areas inside the church and to the north and west were excavated. At Canterbury most of the burials are from the cemetery located to the south of the church, some are located outside the west front of the church, and some to the west of the tower; the remaining are from within the church.

At Taunton the majority of burials were located to the west of the church; this is due to the excavation only covering this area. Only two sub-adults were excavated from within the church (the whole area was not excavated), a three year old child and a fifteen to twenty year old adolescent⁴⁴.

⁴⁴ This individual SK 5017 was cut by the wall of the church so may have been buried within the earlier church structure or have been buried outside the west front of the original church which may not have extended this far; the archaeological evidence is unclear.

Table 8-5: Taunton ages by location.

Taunton	within church	west of church	Total
around birth		6	6
0 up to 2 years		14	14
2 up to 7 years	1	37	38
7 up to 12 years		23	23
12+ years	1	11	12
Total	2	91	93

Table 8-6: Proximity to the church Taunton

Taunton	church	<=10m	>10m	>20m	Total
around birth		4	2		6
0 up to 2 years		2	12		14
2 up to 7 years	1	10	27		38
7 up to 12 years		7	16		23
12+ years	1	1	10		12
Total	2	24	67		93

Table 8-6 implies that infants that died around the time of birth tended to be buried more closely to the church (though not within it) than the other age ranges, who were mostly buried at least 10m from the church buildings.

Table 8-7 shows that the majority of infants that died under the age of two years at Gloucester were buried to the north of the church. Two neonate burials were located within the church buildings; one of these was an unborn child present within the abdomen of a female skeleton.

Table 8-7: Gloucester ages by location.

Gloucester	within church	west	north	Total
around birth	2	1	18	21
0 up to 2 years		4	9	13
2 up to 7 years	4	9	2	15
7 up to 12 years	3	5	4	12
12+ years	1	2	1	4
Total	10	21	34	65

Table 8-8: Gloucester ages by proximity to the church.

Gloucester	church	<10m	>10m	>20m	Total
around birth	2	19			21
0 up to 2 years		13			13
2 up to 7 years	4	7	4		15
7 up to 12 years	3	6	3		12
12+ years	1	3			4
Total	10	48	7		65

Table 8-8 shows that most of the burials excavated at Gloucester were located close to the church; however, this is partly due to the nature of the excavations being in the area around the ruined church buildings. Few remains were located more than 10 metres from the church and these included children only in the ages from two up to twelve years. The majority of preterm/neonate burials were located in the same area (several of these were also excavated from the same burial pit). This may support the theory that a special area for still born children was set aside at this cemetery, although a small number (3) of preterm/neonate individuals were excavated from within the other two areas.

The burials at Canterbury are quite uniformly distributed in their location (Table 8-9). Due to the nature of the excavation, the majority of the individuals were located in the cemetery which was situated to the south of the church, although a reasonable proportion of children were located to the west of the church, in close proximity to the building. Only children over two years of age were recovered from within the priory buildings.

Table 8-9: Canterbury ages by location.

Canterbury	within	west	south	Total
around birth		2	5	7
0 up to 2 years		4	11	15
2 up to 7 years	2	17	38	57
7 up to 12 years	1	8	16	25
Total	3	31	70	104

Table 8-10 shows that a higher number of children under two years of age were located further from the church (>10 m) whilst the majority of those in the older age ranges were located within 10 metres of the church. This is somewhat in contrast with what can

be seen at Taunton (preterm/neonate burials close to church) and Gloucester (under two year olds close to church).

Table 8-10: Proximity to church by age ranges.

Canterbury	church	<10m	>10m	>20m	Total
around birth		3	4		7
0 up to 2 years		6	9		15
2 up to 7 years	2	38	17		57
7 up to 12 years	1	13	11		25
Total	3	60	41		104

As might be expected few sub-adult burials were excavated from within the church buildings at any of the sites. At Taunton two sub-adults, one a child of three years and the other an adolescent aged between fifteen and twenty years of age, were excavated from within the nave. At Gloucester six individuals were located in the nave, two preterm/neonate burials, one two year old, one four year old, and two seven year olds. Four more individuals were associated with the cloister walk of the church (added around AD 1140), one two year old, one five year old, an eight year old and a fifteen year old. At Canterbury two sub-adults, one three year old, and one ten year old, were buried inside the nave, and one six year old was located between the west range and the cloister.

When the data for all sites are pooled together (Table 8-11 and Table 8-12), the majority of infants buried around the time of birth are situated to the north of the church (this information however comes only from the Gloucester data), although they appear at all of the possible locations (Figure 8.11 and Figure 8.12). Few of those two years and older are buried to the north. All the other age groups are mainly buried to the west of the church (due to the majority of Taunton individuals). All age groups, except the birth up to two year group, have been recovered from within the church buildings. This does not mean however that none were located there due to the incompleteness of the excavation of church buildings, particularly at Taunton.

Table 8-11: Location of age ranges.

All sites	Church	West	North	South	Total
around birth	2	9	18	5	34
0 up to 2 years		22	9	11	42
2 up to 7 years	5	63	2	38	108
7 up to 12 years	5	36	4	16	61
12+ years	3	13	1		17
Total	15	143	34	70	262

Figure 8.11: All sites (location of age ranges).

Table 8-12: Proximity of age ranges.

All sites	Church	< 10m	> 10m	>20m	Total
around birth	2	26	6		34
0 up to 2 years		21	21		42
2 up to 7 years	7	55	48		110
7 up to 12 years	4	26	30		60
12+ years	2	4	10		16
Total	15	132	115		262

Figure 8.12: All sites (proximity to church by age range).

The percentage of those buried close to the church is highest among the infants who died around birth. This is interesting if it is assumed that being closer to the church is associated with higher status. However, many of the infants represented come from Gloucester where the majority were buried close to the church but on the north, or less favoured side. For the other ages roughly half were buried within the 10m distance and half beyond, excepting the oldest age range of 12+ years, where the highest percentage were buried further from the church. However, the Canterbury data do not include the sub-adults in this age range, which may lead to a change in the distribution.

When tested statistically using the Kruskal Wallis test there is a significant difference in the number of individuals in each age range buried to the north of the church (chi-square 35.968, df 3, p 0.000), with those to the north falling in the lower age ranges.

Table 8-13: Mean ranks of the four locations.

Location	N	Mean rank
church	15	155.37
west	143	145.21
north	34	64.65
south	70	130.84

The mean ranks reflect that those buried within the church tend to be of a higher age than those buried in the cemetery, but this has no statistical significance. The Mann

Whitney test for two independent samples was used to test each location against each other location separately; only the north showed significance when compared to all the other locations.

When the proximity to the church was tested using the Kruskal Wallis test a significant result was seen (chi-square 10.413, df 2, p 0.005).

Table 8-14: Mean ranks of the three proximity groups.

Proximity	N	Mean rank
church	15	155.37
< 10 m	132	117.42
> 10 m	115	144.54

The Mann Whitney test for two independent samples was then run to ascertain which groups the significance related to. Only those buried <10m, as opposed to those buried >10m, showed a significant difference (Z -2.960, p 0.003). This reflects that the majority of younger children tended to be buried closer to the church. Although the mean rank for those buried within the church is the highest, due to the small numbers represented this can not be proved to be significant statistically.

8.2 Funerary Context

This section will test the hypotheses of questions six to nine outlined in Chapter Seven. All details of the funerary context were available for the Taunton collection, including separate plans of all the skeletons. For the two comparison sites only the details of finds for the sub-adults were recorded. Scans or photographs of the relevant plans were made, where possible, for Gloucester, and for Canterbury the individuals analysed were separated out from the main plan to enable their positioning to be seen more clearly.

8.2.1 Taunton population

8.2.1.1 Position of burial

Body positioning appears to be fairly uniform within the Taunton cemetery. The sub-adults and adults tend to be buried in slightly different positions, and there is some subtle variety amongst both the groups of sub-adults and adults. Several different body and skull positions were recorded by analysing the plans and photographs of the skeletons during excavation and are listed below.

- A supine, legs straight, arms by sides
- B supine, legs straight, arms straight but over pelvis/femur
- C supine, legs straight, arms/hands crossed over stomach area
- D supine, legs straight, arms crossed over chest area
- E supine, legs flexed, arms by side
- F supine, legs flexed, arms crossed over stomach
- J supine, legs straight, left arm across stomach, right arm across chest
- K supine, legs straight, right arm across stomach, left arm across chest
- N burial disturbed in antiquity
- O not enough of postcranial skeleton present
- P legs only present and straight
- S burial appears to have been tightly shrouded
- X no burial position recorded

Table 8-15 shows the burial position of the sub-adults and adults from Taunton. Of the fifty-six sub-adults that could be assigned burial position the majority (71%) were laid out supine, with legs straight and arms by their sides. Another twelve individuals were buried supine with straight legs, but the positioning of their arms was not determined. Eleven individuals had their arms resting over their body (20%), in three cases

uncrossed over the pelvis area, and in the other eight cases the arms were crossed and over the stomach area. Not all of these individuals were older children, five were twelve years or older, three were aged eight or nine years, and three were aged between three and six years. The youngest child was the three year old buried within the nave.

Table 8-15: Body Position of Taunton sub-adults and adults.

Body	Sub-adults			Adults		
Position	Both arms	Right	left	Both arms	right	left
A	39	1		1	1	
B	3					
C	3	2	3	39	8	4
D					1	
E	4					
J				4	1	
K				1		
N	15			4		
O	4			8		
P	12			24		
S	1					
X	6			1		
Total	87	3	3	82	11	4

Figure 8.13: SK 308 lower legs slightly flexed inwards (neonate)

COAS 2005

Figure 8.14: SK 2108 legs flexed to the right (9 months)

Four individuals (7%) were buried with their legs slightly flexed, three were newborn infants and the legs were flexed inwards, in a natural position (see Figure 8.13). The other newborns did not have the lower legs present or had been disturbed. The fourth was an infant under the age of one year whose legs were flexed to the right (see Figure 8.14), the body having possibly been laid on its side; the other three infants under one year had straight legs. One individual, of around 10 years old, appears to have been tightly wrapped in a shroud due to the constriction seen at the shoulder girdle, and the movement of bones within a very tightly defined space. Twenty-five burials were either too incomplete to determine body position, had been disturbed in antiquity, or the burial position had not been recorded on excavation (due to disturbance).

Of the sixty adults that could be assigned burial position the majority (85%) were placed in the supine position, with arms crossed over the stomach area. In contrast to the sub-adult majority, only two adults (3%) were laid supine with their arms by the side. One adult had both arms crossed over the chest (2%) whilst another six adults had one arm over the chest and the other over the stomach area (10%), the majority (5) having the right arm across the chest.

When those individuals with arms by their sides or over the pelvis were grouped together and tested against those with their arms across the body, using the chi-square test for independence, the difference in burial positions for sub-adults and adults was seen to be statistically significant (chi-square 75.50, df 2, p 0.000).

Position of skull

Skull position was also recorded on the sub-adults and adults from Taunton, and the results are shown in Table 8-16. The different skull positions are listed below.

- A facing upwards (used where the skull appears to have been laid in this position)
- B facing left (north)
- C facing right (south)
- D disturbed
- O no skull present
- X skull position not recorded

Twenty-four of the forty-nine sub-adult skulls recorded appear to have been laid facing upwards (49%). For those that were laid with the skull on one side there was a marked preference for facing south with sixteen individuals (33%) recorded, as opposed to nine skulls facing north (18%). Fifteen skulls were too disturbed or broken to record, twenty-three individuals had no skull present, and for six the skull position was not noted on excavation (due to disturbance).

For the adults forty-five out of the fifty-six recorded skull positions were laid facing upwards (80%). Six were facing to the north (11%) and five to the south (9%). Eight individuals had disturbed skull positioning, thirty-two had no skull present, and one had no position recorded. When tested using the chi-square test for independence a statistical significance was seen between the sub-adult and adult skull positions (chi-square 15.064, df 4, p 0.005), with the adult skulls much more likely to be facing upwards than the sub-adults.

Table 8-16: Skull position of Taunton sub-adults and adults.

Skull Position	Sub-adult	Adult
A	24	45
B	9	6
C	16	5
D	15	8
O	23	32
X	6	1
Total	93	97

This analysis indicates that the most usual burial position for children was to be laid out with arms and legs straight and with the head facing upwards. For the neonates all three that could be assigned a position were laid with slightly inward flexed legs. One of the burials with flexed legs faces south, two skulls face upwards, and one was disturbed. Care must be taken with the interpretation of skull positioning, as discussed in Chapter Four; the skull is the first part of the body to detach during decomposition (Lyman 1994, 145) and is therefore likely to move position in the ground.

Three potential double burials all involving sub-adults were recognised. In area 4, SK 2080 (aged 9 years) and SK 2089 (aged 9 years) were laid next to each other on the natural bedrock with their hands together (see Figure 8.15). In area 1, SK 1617 (aged 10 years) and SK 1620 (aged 5 years) were also laid together, again with hand bones

entwined. The third example does not involve the laying over of the hands, so it is less certain that the two individuals were buried together (see Figure 8.16), though it appears likely, and involves SK 1205 (aged 7 years) and SK 1206 (aged 8 years). In all cases they were laid out straight on their backs with their skulls facing south, with the exception of one skull which had been disturbed in antiquity.

Figure 8.15: Double burial of SK 2080 & SK 2089

COAS 2005

Figure 8.16: Double burial of SK 1205 & SK 1206

8.2.1.2 Grave fittings

The child buried within the church (SK 914) has evidence for an elaborate coffin, with fifteen nails surrounding the body (Figure 8.17). The only other sub-adult individual to have good evidence for a coffin, with thirteen nails surrounding the body, was SK 101 (14 years). Skeleton 327 had five nails present; four nails were present with SK 2028, and three with SK 2078. In most instances these nails were recorded as over, rather than around, the body and may be residual nails from the mixed nature of the cemetery deposits. Another eight burials had two nails recorded with them, and ten had one nail recorded; again these cannot be taken as evidence for coffined burials. However, this does not preclude burial within a coffin with few or no iron nails (Gilchrist & Sloane 2005, 114), and one of the adult individuals SK 2203 was buried within a coffin without nails.

Thirteen adults had evidence for burial within a coffin; three from area 1, four from area 2, one from area 3, and five from area 4. Of these coffins one had no evidence for nails but instead the remains of a preserved charred plank and soil staining were recorded. The others had coffin nails surrounding the body; the highest number was thirty-three with SK 2085, and the lowest was three with SK 1008, for which most of the burial had been cut by SK 1009. Ten other individuals had three nails associated with them; six had two nails, and eleven only one. Fifteen adults had iron staining or pieces of iron adhering to the skeleton.

Figure 8.17: SK914 child buried in nave, the white markers indicate coffin nails.

COAS 2005

8.2.1.3 Grave inclusions

Few grave inclusions were recovered from sub-adult graves. Ten burials had pot sherds either associated with them or contained in the backfill of the grave; the majority of these were of late medieval coarse or sandy wares (Mephram in prep). Eleven individuals had copper staining present on their skeleton. Four had staining on one or more ribs, five on the skull, and one on the tibia. One of the eleven individuals and another three individuals had pieces of copper alloy associated with them. SK 2089 was

recorded as having the copper alloy situated between their distal tibiae. It is possible that these signify evidence for shroud pins. Five individuals had iron staining or pieces of corroded iron adhering to their bone. This may be evidence for confined burials or could be residual nails disturbed from other burials. Four other burials had notes that metal finds had been associated with them but no other details were given. It is likely that these consisted of coffin nails, although some copper alloy objects (unidentified) were also present on excavation.

Grave inclusions were also fairly sparse for the adults. Seven individuals had copper alloy objects associated with them (one a possible shroud pin), and one individual a lead nail. Seventeen other adults had some copper staining in evidence on the skeleton. Fifteen adults had pieces of pot found associated with them or in the grave fill. The fill of the tomb containing SK 844 had a bone stylus contained within it dating to the thirteenth or fourteenth century. Two burials SK 908 and SK 1642 had been laid on a bed of ash within a coffin. The ash has been analysed and both have been shown to contain fine ash, charcoal, burnt and unburnt animal and fish bones, and charred cereal grains; wheat for SK 908 and barley for SK 1642 (Vaughan-Williams in prep). Wheat was a higher status grain and it is notable that it was found in the higher status church burial, whereas barley was in the cemetery burial. A silver halfpenny from the reign of Edward III, dated to AD 1344-52, was also associated with the ash burial SK 1642. This burial had been badly disturbed by inter-cutting burials but the coin was located in a hollow where the skull would have been, and it may be speculated that it was an offering placed over the eyes or in the mouth.

8.2.1.4 Depth of burial

The depth of burial was recorded on excavation for each skeleton at the skull, pelvis and feet, where possible. Table 8-17 gives the mean, minimum and maximum values for all depths recorded on excavation for the sub-adults and adults at Taunton. The depths are recorded as metres above sea level or OD level 0. The mean values for the sub-adults are higher than those for the adults, indicating that more sub-adults were buried higher up in the burial sequence than the adults. This was also statistically significant using the T-test⁴⁵ for the pelvis and feet values (T -4.460 df 137.71 p 0.000; T -2.993 df 121 p 0.003). The values for skull depth were also statistically significant using the Mann

⁴⁵ The Kolmogorov-Smirnov test indicates a normal distribution of data.

Whitney test⁴⁶ (Z -2.994 p 0.003). This indicates that the sub-adults were being buried in shallower graves than the adults.

Table 8-17: Descriptive statistics of depth of burial for each skeleton.

Sub-adults	N	Mean	Std dev	Min	Max
Skull	62	15.02	0.21	14.42	15.35
Pelvis	66	14.98	0.21	14.41	15.31
Feet	56	14.99	0.21	14.45	15.30
Adults					
Skull	65	14.88	0.26	14.33	15.35
Pelvis	74	14.81	0.25	14.25	15.22
Feet	67	14.86	0.25	14.40	15.36

8.2.2 Comparison sites

Details on the grave furnishings and inclusions were recorded for the sub-adults analysed from the other sites by information given in Heighway and Bryant (1999) and Hicks & Hicks (2001), and from details from the skeletons sheets and plans for Gloucester. Details on the depths of burial were not analysed for either Gloucester or Canterbury.

8.2.2.1 Position of burial

Position of burial can be seen on a few photos and the plans from Gloucester. Some attempt was therefore made at assigning burial position for the sub-adult skeletons; not all individuals were drawn as true representations on the plans, with the neonate or preterm skeletons usually not drawn at all. Table 8-18 gives details of the body position of the sub-adult burials analysed, and Table 8-19 the skull positions. As with Taunton, the majority of sub-adults were laid out in position A, with only eight individuals having one or both arms crossing the body. One seven year old (SK 171), recovered from within the church, was laid with their arms across the chest; no sub-adults were laid in this position at Taunton.

Some details of the adult body positions are given in the report of the Gloucester excavations (Heighway & Bryant 1999). For the earlier Norman period the majority of

⁴⁶ The Kolmogorov-Smirnov test indicates the data is not normally distributed.

burials, including sub-adults, are buried with their arms by the sides; in the later medieval period the majority are buried with their arms crossed over their waists. Males were more likely to have their hands placed on the pelvis and females their arms placed by their sides. However, more females than males had their arms crossed over their chests.

Table 8-18: Body position of Gloucester skeletons

Body Position	Both arms	Left arm	Right arm
A	13	1	3
B	3	1	
C	6		1
D		1	
E	1 (legs only)		
F	1		
N	6		
P	8		
X	19		

Table 8-19: Skull position of Gloucester skeletons

Skull Position	
A	14
B	6
C	5
D	8
O	4
X	28

For Canterbury the plans, from Hicks & Hicks (2001) and the unpublished cemetery plan, are not truly representative of the actual skeletons, so they have not been used to determine body positioning. All individuals were laid supine and aligned east-west, with heads to the west, and most of the sub-adults appear to have been laid with their arms to the sides of the body. A photograph of skeletons 31 and 32 from outside the west front of the church at Canterbury shows that this is a double child burial. Both individuals are of two years of age and they are both laid out supine with their arms to the sides and skulls facing upwards.

8.2.2.2 Grave fittings and inclusions

In the details on the skeleton sheets written during the excavations at Gloucester six sub-adults are said to have had evidence for a coffin. Ages ranged from two to eight

years, and one individual was a 38 weeks neonate buried next to an adult female, presumably its mother. Another ten individuals had coffin nails associated with them, ranging from one to three nails, and three other individuals had evidence of iron staining on their bones. One individual had copper alloy staining on the left mandible. Stones had been placed around the head of a fifteen year old, whilst in one of the coffin burials, of a two year old, the head was rested on a stone, and charcoal had been placed in the base of the coffin. Another coffin burial also had some charcoal around the stomach area of the burial of an eight year old. One skeleton was associated with a piece of medieval pottery, one with a piece of medieval tile, and twelve were associated with animal bones. One individual was associated with two bone pin fragments.

The plan for the cemetery of St Gregory's, Canterbury lists iron objects and the presence of coffins. None are shown for any of the sub-adult burials analysed here. Skeleton 61 did have two coffin nails in one of the bags of skeletal material, and nine skeletons had iron staining present on the skeleton. Two individuals also had copper alloy staining on their bones.

8.3 Preservation

This section will test the hypotheses of questions ten to fifteen outlined in Chapter Seven. It has been suggested (see Chapter Four) that sub-adult remains may not preserve as well as those of adults, and this has been used as an explanation of the lack of child remains from medieval cemetery excavations (Boddington 1987). The preservation of the sub-adults and adults from Taunton were compared to see if this held true for this collection.

8.3.1 Taunton adults and sub-adults

Table 8-20 shows that the preservation of the sub-adults and adults from Taunton is very similar. In both cases the majority were recorded with as good preservation, with a few more adults than sub-adults falling in this category. A slightly higher percentage of adults were recorded with poor preservation, than the sub-adults. When tested using the Mann Whitney test for two independent samples no statistical significance was seen.

Table 8-20: Preservation of Taunton individuals.

Taunton	Good	%	Medium	%	Poor	%	Total
Sub-adults	45	49	43	46	5	5	93
Adults	54	56	35	36	8	8	97
Total	99		78		13		190

Table 8-21 shows the completeness of the individual skeletons for the adults and sub-adults was also similar, with slightly more adults in the >75% completeness group but also in the <25% group. When tested using the Mann Whitney test for two independent samples no statistical significance was seen.

Table 8-21: Completeness of Taunton individuals.

Taunton	>75	%	50-75	%	25-50	%	<25	%	Total
Sub-adults	29	31	23	25	23	25	18	19	93
Adults	40	41	24	25	10	10	23	24	97
Total	69		47		33		41		190

8.3.2 All sites (sub-adults)

The occurrence of many children including neonates at the three sites implies that preservation was generally good at all of them. Table 8-22 confirms that the majority of skeletons were recorded as good, on a scale of good, medium and poor, with hardly any skeletons recorded with poor preservation.

Table 8-22: Preservation.

	Good	%	Medium	%	Poor	%	Total
Taunton	45	49	43	46	5	5	93
Gloucester	51	78	13	20	1	2	65
Canterbury	55	53	48	46	1	1	104
Total	151		104		7		262

Gloucester has the highest percentage of remains recorded as good (Table 8-22), whereas at Taunton and Canterbury the results are slightly lower but similar to each other. That Gloucester has more individuals recorded with good preservation is statistically significant (chi-square 15.681, df 2, p 0.000). If preservation is analysed in terms of completeness, and particularly in terms of the recovery of small elements (such as the phalanges), a different picture emerges.

Table 8-23: Completeness.

	>75	%	50-75	%	25-50	%	<25	%	Total
Taunton	29	31	23	25	23	25	18	19	93
Gloucester	24	37	12	19	19	29	10	15	65
Canterbury	33	32	38	36	27	26	6	6	104
Total	86		68		74		34		262

Table 8-23 shows the completeness of the skeletons and indicates that the Taunton and Gloucester figures are more similar, whereas Canterbury has fewer individuals with a small percentage of the skeleton remaining; however this is mainly due to the selective nature of the Canterbury material rather than an accurate assessment of the complete collection of sub-adults. No statistical significance was seen for completeness in either the grouped data, or using the original percentage values assigned for the three sites.

The number of measurable long bones also indicates the good preservation at Gloucester where, of the 185 bones measured, none had to be reconstructed. For the Taunton material, of 248 measurable bones, 76 were reconstructed, and at Canterbury, of 322 measurable bones, 65 had to be reconstructed.

When the percentage of elements present, of all possible elements,⁴⁷ for each site is tested statistically using the Kruskal Wallis test there is no significance seen between the three sites (chi-square 1.776, df 2, p 0.412).

However, a difference from the three sites can be seen when the number of small bones are compared. At Taunton sixty-four individuals (69%) had one or more hand phalanges present (543 in total), at Gloucester it was thirty-one individuals (48%) (154 total) and at Canterbury forty-seven individuals (45%) (261 total). Eleven small elements were grouped and tested statistically using the Kruskal Wallis statistic. These were ear ossicles, hyoid bone, carpals, metacarpals, hand phalanges, manubrium, sternum, patella, tarsals, metatarsals and foot phalanges. A significance difference was seen between the three sites (chi-square 8.495, df 2, p 0.014). The mean rank for Taunton was 23.18, Gloucester 11.18 and Canterbury 16.64. The difference in the numbers of small bones represented from the three sites may have more to do with recovery than preservation, and the results show that recovery from Taunton of small elements is much higher than at the other two sites, with Gloucester having the least successful recovery. The much higher number of phalanges recovered from Taunton is striking. The reasons for this may be numerous, but the two main reasons are most likely to be the presence of on-site osteoarchaeologists during the excavations at Taunton, and that the excavations at Gloucester and Canterbury were rescue excavations predating PPG16. Small bones such as hand and foot phalanges can easily be missed on excavation if the excavators are not familiar with sub-adult skeletons, and if no sieving has taken place.

The number of elements which would be present for each site if a skeleton was complete was determined and then the number of elements recovered as a percentage of this was calculated. Figure 8.18 to Figure 8.20 show the percentage of elements recovered for each site. Gloucester shows good recovery of skull elements. The very high recovery of mandibles seen for Canterbury is due to selection of the children analysed as those which could be aged by dental eruption and formation. For the smaller bones of the skull (hyoid, ear ossicles) Taunton has a much higher recovery rate, as well

⁴⁷ For example if 65 skeletons are present at Gloucester then the possible number of frontal bones is 65 and of hand phalanges is 1820 (65 multiplied by 28).

as for the vertebral bodies. Higher recovery rates for all smaller bones can be seen at Taunton whilst for the larger bones Gloucester has better preservation. It must be made clear, however, that the data for Canterbury is not really comparable as the children analysed from this site were selected for the presence of dentitions and at least one measurable longbone. Therefore, those remains with fewer elements preserved from the site will not be included in this study. Therefore, whilst we would expect to see high percentages for the mandible and maxilla and upper arm bones at Canterbury, it is interesting that Gloucester still has a higher percentage of leg bones recovered, indicating that Gloucester preservation was probably the best but that the excavation strategy was not designed to recover small bones, such as those of the fingers and toes. This compares favourably to the preservation recorded as good, medium or poor for each individual skeleton. Therefore, even though the percentage present of Gloucester skeletons is lower, the preservation is better, and conversely, whilst the recovery of small elements was good for Taunton overall, the preservation of the remains was probably the poorest of the three sites, bearing in mind that preservation in general is good for all of the sites analysed.

Surface erosion was not recorded separately for each bone; the highest grade seen anywhere on the skeleton was recorded for each individual (Table 8-24). In general none of the collections were adversely affected by surface erosion, but statistical significance was seen using the Kruskal Wallis test (chi-square 8.810, df 2, p 0.012, mean ranks Taunton 141.68, Gloucester 110.40, and Canterbury 135.58). This indicates that Gloucester has significantly less surface erosion on the remains than the other two sites, again indicating better preservation overall for the Gloucester skeletons. The Mann Whitney test for two independent samples confirmed this.

Table 8-24: Surface erosion.

	0	1	2	3	4	5	Total
Taunton	0	41	50	1	1		93
Gloucester	5	39	17	1	3		65
Canterbury	0	55	39	6	3	1	104
Total	5	135	106	8	7	1	262

Figure 8.18: Elements present, skull and axial.

Figure 8.19: Elements present, upper body.

Figure 8.20: Elements present, lower body.

8.3.2.1 Preservation by age range

It has been suggested that infant remains are often not recovered from cemetery sites due to the fragile nature of their remains (Walker *et al.* 1988; Paine & Harpending 1998). The preservation of the remains seen at Taunton, Gloucester and Canterbury does not back up this suggestion (see Figure 8.21 to Figure 8.23). In contrast those individuals that died around birth show the highest level of good preservation of all the age ranges across the three sites. This indicates that where infant remains are recovered they tend to be in good condition, but this does not rule out the fact that where they are poorly preserved they may not be recoverable at all.

For individuals aged between birth and two years preservation is much less likely to be scored as good compared to the other age ranges for both Taunton and Canterbury; Gloucester has similar levels of preservation across all age ranges. The lowest levels of good preservation are interestingly seen in the twelve years and above age groups at Taunton and Gloucester (no individuals were analysed in this age group from Canterbury).

When preservation is tested by age range a statistically significant result is seen (chi-square 25.857, df 4, p 0.000).

Table 8-25: Mean ranks for preservation by age range.

Age range	N	Mean rank
neonate	34	91.00
0 up to 2 years	42	148.07
2 up to 7 years	110	140.76
7 up to 12 years	60	116.38
12+ years	16	167.12

The mean ranks in Table 8-25 indicate good preservation for the neonate group and the 7 up to 12 year group. The Mann Whitney test for two independent samples confirms that these groups have better preservation levels compared to the other age groups. However, when the three sites are tested separately, only Canterbury shows any statistical significance, indicating that it is the remains from this site that are more well preserved for these ages.

Figure 8.21: Taunton age range preservation

Figure 8.22: Gloucester age range preservation

Figure 8.23: Canterbury age range preservation

Figure 8.24: Skeletal completeness by age range for Taunton

Figure 8.25: Skeletal completeness by age range for Gloucester

Figure 8.26: Skeletal completeness by age range for Canterbury

When the completeness of the skeleton is analysed a slightly different result is seen (see Figure 8.24 to Figure 8.26). As with preservation, the completeness of infant skeletons is generally good for all the three sites; most of the individuals in the neonate and birth up to 2 year categories are over fifty percent complete. The majority of the 2 up to 7 year, and 7 up to 12 year categories, are also more than fifty percent complete. However, Taunton has a completely equal spread of those individuals with fifty percent or more present and less than fifty percent present for the 2 up to 7 year olds. At Taunton those aged 12+ years are mostly less than twenty-five percent complete whilst at Gloucester they are mostly more than fifty percent complete.

When the completeness percentage of all the individuals is analysed statistically against age range using the Kruskal Wallis test the preservation of those in the age range 7 up to 12 years is significantly higher than the other groups (chi-square 23.427, df 4, p 0.000). Table 8-26 shows the mean ranks for the age ranges.

Table 8-26: Kruskal Wallis mean ranks for all sites

Age range	N	Mean rank
c birth	34	127.76
0-1.9 years	42	109.81
2-6.9 years	110	125.49
7-11.9 years	60	167.72
12+ years	16	94.38

When the three sites are analysed separately Taunton and Gloucester show no significant difference for completeness by age range (Taunton chi-square 6.745, df 4, p 0.150; Gloucester chi-square 7.449, df 4, p 0.114). Canterbury does show statistical significance, with the 7 up to 12 year olds showing higher completeness, matching the result seen when the sites are pooled together (chi-square 20.245, df 3, p 0.000).

It therefore appears that it is the high number of skeletons that are more than seventy-five percent complete in the 7 up to 12 year age range from Canterbury (19 individuals) that is creating the significance. Care needs to be taken here as this is probably the result of the selective analysis mentioned previously for the Canterbury skeletons. These results do however indicate that age does not appear to be a significant factor in the rate

of preservation or the completeness of skeletal remains, and definitely disputes the suggestion that infant remains will preserve less well than older children and adults.

When the neonate skeletons are looked at separately for completeness of the skeleton only five are in the less than twenty-five percent present category, with all of these coming from Gloucester; four were excavated from the pit containing several infants. This may indicate, as suggested earlier, that if neonate remains are only partially articulated they may not be so easily recognised on excavation as the remains of adults. It is the fact that the pit, containing these preterm and neonate individuals, was excavated as one context (260) that has led to these remains being retained, and counted as separate individuals. If they had not been within a clear context, at this excavation, they would have been reburied as disarticulated remains (Heighway & Bryant 1999, 201).

8.3.2.2 Preservation by burial location

The preservation of the remains was explored according to the location of burial within the cemeteries and the proximity of burial to the church (Table 8-27 and Table 8-28). Initially the data from all sites was pooled and a Kruskal Wallis test was performed. Preservation by location showed statistical significance (chi-square 11.266, df 3, p 0.010).

Table 8-27: Preservation by burial location.

Location	Good	Medium	Poor	Total
church	8	7	0	15
west	77	60	6	143
north	29	4	1	34
south	37	33	0	70
Total	151	104	7	262

Table 8-28: Preservation by proximity.

Proximity	Good	Medium	Poor	Total
church	8	7	0	15
<=10m	72	56	4	132
>10m	71	41	3	115
Total	151	104	7	262

Table 8-29: Mean ranks for burial locations.

Location	N	Mean rank
church	15	135.50
west	143	137.17
north	34	96.38
south	70	136.11

Table 8-29 shows the mean ranks for each burial location, and indicates that those buried north of the church have more remains scored as good than those from the other locations. Separate Mann Whitney tests confirm that it is the burials to the north that are significantly different to the other locations. This is not what would necessarily be expected as there is a majority of infant remains buried north of the church. However, it has already been shown that the best preservation of the three sites is that at Gloucester, and all the burials situated north of the church come from the Gloucester cemetery. When the sites are analysed separately for preservation by location there is no significant difference seen for any of them.

No significant difference was seen for preservation by proximity when the pooled data were analysed. However, when the Taunton data were analysed separately, there was a significant difference for preservation by proximity to the church (chi-square 8.857, df 2, p 0.012). The mean ranks indicated that preservation was better for those individuals buried furthest from the church. This may reflect the preferred location for burial being closer to the church and therefore the higher level of disturbance of these burials. The completeness of the remains was also explored according to the location of burial within the cemeteries and the proximity of burial to the church (Table 8-30 and Table 8-31).

Table 8-30: Completeness by burial location.

Location	<25%	25-50%	50-75%	>75%	Total
church	1	2	4	8	15
west	20	36	41	46	143
north	8	6	10	10	34
south	4	18	26	22	70
Total	33	62	81	86	262

Table 8-31: Completeness by proximity to church.

Proximity	<25%	25-50%	50-75%	>75%	Total
church	1	2	4	8	15
<10m	18	35	45	34	132
>10m	15	24	32	44	115
Total	34	61	81	86	262

Significance was seen when completeness by proximity to the church was tested with the data pooled for the three sites (chi-square 6.472, df 2, p 0.039). No significant difference was seen when the sites were analysed separately.

Table 8-32: Mean ranks of proximity to the church.

Proximity	N	Mean rank
church	15	156.37
<10m	132	120.20
>10m	115	141.22

The mean ranks in Table 8-32 imply that the difference is between those buried within the church and those buried nearby. Those buried within the church buildings have a higher score and therefore more skeletons with a higher percentage of completeness are present. This would be expected as the burials within the church are likely to be more protected from disturbance. Those buried close to the church are likely to be in the most popular, and therefore heavily used, part of the cemetery, so the lower percentages present here are what might be expected due to the inter-cutting of burials. The Mann Whitney test shows that the difference is between those buried furthest and those buried close to the church. The numbers of individuals within the church are too small to show statistical significance.

8.4 Dental wear

This section will test the hypotheses for questions sixteen and seventeen outlined in Chapter Seven. A new method for recording dental wear on the deciduous molars was devised, as discussed in Chapter Seven. This was done in order to explore status through diet, and to investigate the applicability of dental wear as a tool to aid in ageing sub-adult remains. This section focuses on the results of this research. The permanent molars present were also scored for dental wear using the chart of Brothwell, and a note on these results are presented in Appendix I.

Descriptive statistics for deciduous first molars (dm1) and deciduous second molars (dm2) were calculated separately for each site, including the median, mean, standard deviation, minimum and maximum figures for each age group, along with the number of teeth (N). These are presented in Appendix I. The data for the three sites were then pooled together and Table 8-33 and Table 8-34 show the statistical data for all the sites grouped together. The mean dental wear scores for both dm1 and dm2 are shown graphically for each of the sites: Taunton in Figure 8.27; Gloucester in Figure 8.28; Canterbury in Figure 8.29, and all sites are pooled together in Figure 8.30. The individual stages recorded for each of the teeth are shown graphically by age in years for all the sites in Appendix I.

8.4.1 Taunton

One hundred and fifty-four teeth (71 dm1 and 83 dm2) from forty-six individuals were recorded for the Taunton population. The dental wear recorded shows that dentine exposure occurs quite quickly according to age in this population. Figure 8.27 shows a sudden rise in mean dental wear stage between the ages of two and three in both the first and second deciduous molars. However, the presence of one individual (SK 606) with considerably more wear at the age of three is likely to be causing this sudden rise. This indicates that care using this method needs to be taken to look for outliers. Another individual with a higher dental wear stage for age (SK 3207) appears to be causing a higher wear stage overall for age five rather than age six children; the lack of teeth recorded in the six year age category probably exacerbates this problem. It is of course these outliers that may be able to tell us about differences in diet and therefore possibly status; however, removing the outliers makes no great difference to the values shown in Figure 8.27. From age seven there is a more gradual increase in wear especially for the second molar. Low numbers of first molars recorded may be the cause of the mean stage

to be higher for age nine year olds than for age ten year olds; no first molars were recorded for the eight year age category.

Figure 8.27: Taunton dental wear mean stages.

8.4.2 Gloucester

Seventy-seven teeth (38 dm1 and 39 dm2) from twenty-three individuals were recorded for the Gloucester population. A gradual increase in wear is seen between the ages of one and six years; one individual with severe wear on a first molar is an outlier causing the increase in mean wear of the first molar at age five (SK 68). Removing the data for this individual reduces the mean dm1 stage for age five on the figure to look more in line with the general upward trend in wear stage. The decline of mean wear at age nine is probably due to the small numbers of teeth recorded for this age, whilst the second molars scored for age ten and twelve are representative of only one individual in each case. Therefore, although the Gloucester population seems to have quite low stages of wear initially, at later ages (from five years of age) the mean wear stages are higher than those seen at Taunton.

Figure 8.28: Gloucester dental wear mean stages.

8.4.3 Canterbury

Two hundred and twenty-seven teeth (107 dm1 and 120 dm2) from seventy-three individuals were recorded for the Canterbury population. The dental wear stages produce the most even rise in mean dental wear by age of all the sites analysed. In part, this is due to the fact that it was possible to score more teeth for the individuals from this site compared to the others. A gradual increase in mean wear stage is seen from the age of one year up to seven years. After this age the dental wear stages recorded become more similar for the different ages. From the age of seven up to ten the mean second molar wear stage actually reduces. This is probably in part due to one individual (SK 716) with considerable wear (stage 9) in the seven year age group and the slightly smaller numbers of teeth scored for the eight and ten year age groups. Removing the data for SK 716 does not make much adjustment as there is at least one other seven year old with fairly high wear (SK 782). Removing both individuals reduces the dm2 values so they are lower than the eight year olds, but not for dm1; no radical change is seen in Figure 8.29. The first molar stages show more of a gradual rise, with SK 716 causing the rise in mean stage at age seven.

Figure 8.29: Canterbury dental wear mean stages.

8.4.4 All sites comparison

The descriptive statistics in Table 8-33 and Table 8-34 and the graph in Figure 8.30 indicate that, although the dental wear rates increase over time, this can happen at different times for different individuals. This can be seen due to the high standard deviation values for some of the ages, and the wide range of wear stages as shown by the minimum and maximum scores for age. By analysing the mean stages, the first molar seems to pass through wear stages at quite a regular rate. However, this is not so clear for the second molar where stage 2 is not so often seen, and towards the older age ranges there are more eight year olds with higher wear stages than those of age nine year olds. This is likely to be a problem with the small numbers of teeth from these age categories; also analysing the data by yearly age increments will undoubtedly mean that some children may be in the wrong age category.⁴⁸ Figure 8.30 shows that wear stages increase steadily between the ages of two and seven years of age but then flatten off, with the wear stages between the ages of eight and ten being more similar as the deciduous teeth come towards the end of their period of use. The first permanent molar will erupt around the age of six years and this will have an effect on how the deciduous

⁴⁸ This is due to the slight timing differences of eruption and formation between males and females.

teeth are worn. It is likely that the larger surface area of the permanent molar will be involved more in the mastication process from this time than the smaller deciduous molars. Only one individual from Gloucester was recorded that still had a second deciduous molar retained at age twelve (SK 2), and this tooth scored stage 8 wear. This may suggest that the wear stage 9 is probably uncommonly reached even when the molars have been retained in the jaw for the longest possible time. Only three teeth from two individuals (SK 716 and SK 1095), both from Canterbury, showed stage 9 wear. These individuals were seven and nine years of age. This indicates that it is likely to be diet that was a factor in this high wear stage, rather than it being the expected wear stage reached by this age.

Table 8-33: dm1 all sites.

Age (yrs)	N	Median	Mean	St Dev	Min	Max
0	3	0.00	0.00	0.00	0.00	0.00
1	21	1.00	0.95	0.50	0.00	2.00
2	43	2.00	1.81	1.07	1.00	5.00
3	25	4.00	3.44	1.71	1.00	6.00
4	23	4.00	3.96	1.02	2.00	6.00
5	25	5.00	5.00	1.15	3.00	8.00
6	17	5.00	5.12	0.99	4.00	7.00
7	22	6.00	6.18	1.30	4.00	8.00
8	11	7.00	6.73	1.35	5.00	8.00
9	22	7.00	6.73	0.94	4.00	8.00
10	4	6.50	6.50	1.29	5.00	8.00

Table 8-34: dm2 all sites.

Age (yrs)	N	Median	Mean	St Dev	Min	Max
0	3	0.00	0.00	0.00	0.00	0.00
1	14	0.00	0.00	0.00	0.00	0.00
2	43	1.00	1.12	0.91	0.00	4.00
3	25	3.00	2.76	1.45	1.00	5.00
4	27	4.00	3.78	1.09	2.00	5.00
5	28	4.00	4.21	0.88	3.00	6.00
6	23	5.00	4.78	0.90	3.00	6.00
7	23	6.00	6.09	1.31	5.00	9.00
8	14	6.50	6.50	1.34	5.00	8.00
9	26	6.00	6.23	1.11	4.00	9.00
10	15	6.00	6.67	0.98	5.00	8.00
12	1	8.00	8.00	0.00	8.00	8.00

Figure 8.30: All sites dental wear mean stages.

From studying the median and mean for each of the sites some patterns can be seen, but it is not a simple one of a faster or slower rate of wear at a particular site. In the earliest stages of dental wear on the second molar until the age of three years, Taunton shows the lowest wear rates and Canterbury the highest. However, at age three the Taunton children score the highest stage of mean wear and Gloucester the lowest. The Taunton mean wear stage then becomes lower again between the ages of four and eight years, while for Gloucester it is high. By the age of nine years the Taunton wear is once again scoring high and the Gloucester wear lower again in comparison. The Canterbury wear score seems to sit between the other two sites from the ages of three to nine, then become higher at the latest age scored of ten years for the first molar, but lowest for the second molar. It is clear that some of these variations in mean stage are due to the lack of data for some ages and also due to outliers (those with abnormally high wear) having a marked effect on the mean and median stages.

8.4.5 Dental wear by burial location

A Kruskal Wallis test was performed for each of the ages to see if there was any difference between burial location and dental wear, the suggested hypothesis being that lower status burials may have more dental wear, and that lower status burials would be those furthest from the church. Soft textured material such as refined foods and cooked meats create less dental wear than a diet high in grains (Papathanasiou 2005, 388); these types of food would be more likely to be consumed by those of higher status in the late medieval period (Stone 2006, 11; Woolgar *et al.* 2006, 273). Where significance was shown, the data were then tested using the Mann Whitney test for two independent samples to determine between which groups of data the significant difference occurred. Each age in years was tested separately and the significant results are presented in Table 8-35.

Table 8-35: Dental wear scores by age and burial location.

Age	Test	Chi-sq	df	p-value	high wear	low wear
2 year	Proximity by dm1	8.754	2	0.013	<10m	church
	Proximity by dm2	6.444	2	0.040	<10m	>10m
3 year	Proximity by dm1	9.434	2	0.009	>10m	ch, <10m
	Proximity by dm2	8.964	2	0.011	>10m	ch, <10m
4 year	Proximity by dm2	6.116	2	0.047	other	church
6 year	Proximity by dm2	5.981	2	0.050	<10m	>10m
7 year	Proximity by dm1	7.084	2	0.029	<10m	ch, >10m
9 year	Proximity by dm2	6.900	1	0.009	<10m	>10m
1 year	Location by dm1	4.725	1	0.030	south	west
4 year	Location by dm2	7.575	2	0.023	other	church
5 year	Location by dm1	8.106	2	0.017	ch, west	south
9 year	Location by dm1	13.582	2	0.001	west	south

ch = church, other = all other locations tested

The distance that a burial was from the church showed significance in eight instances, three for dm1 and five for dm2, and for the ages of two, three, four, six, seven and nine years. However, the mean ranked scores did not always imply these differences were for the same reason. In five cases those buried in the church had significantly lower scores for dental wear and involved the two, four, six and seven year olds. In two cases those buried more than 10 metres from the church had significantly higher scores, but this was only seen for the three year olds. In the majority of cases (five) it was those buried 10 metres or less from the church that had the higher ranked dental wear scores. Whilst this supports the idea that individuals buried within the church would have lower dental

wear for age due to their higher burial status and therefore possibly dietary status, it does not suggest that those buried further from the church were lower in status than those buried nearer. Burial location around the church showed significance in four cases; three for dm1 and one for dm2. In two cases, for age one and four years, the higher wear stage was seen for those buried south of the church, and the wear of those in the church was low (data for four year old only). Conversely, for the five year olds, those buried within the church and to the west were ranked high and those buried south of the church were ranked low. For the nine year olds those to the west of the church were ranked high and those to the south low.

Although there is slight evidence for lower dental wear scores for those buried within the church in the younger age categories, this is not always the case for the older children. There is no clear pattern of high or low status differences in wear, but part of the problem when looking at the burials from within the church is that the numbers of individuals, and therefore teeth recovered, are very low when compared to the numbers recovered from the graveyards (Table 8-36). This will cause problems in being able accurately to interpret the data.

Table 8-36: Numbers of teeth scored by location and distance from the church.

Location	dm1 number scored	dm2 number scored
1 within church	20	19
2 west	115	129
3 north	8	9
4 south	73	85
Distance		
1 within church	20	19
2 ≤10 m	85	102
2 >10 m	111	121

8.4.6 Dental wear and the potential for use in ageing sub-adult dentitions

As discussed in Chapter Five, deciduous dental wear is rarely recorded, whereas dental wear on the permanent teeth is recorded as standard for all skeletal reports, and is used as a system for ageing adult skeletons. This section will explore whether dental wear on the deciduous teeth may be used as an aid to ageing sub-adult skeletons. This research was carried out as the Taunton excavation produced a large quantity of disarticulated material, which the author hopes to analyse in the future. From initial assessment of the Taunton disarticulated material there would appear to be many sub-adult mandibles. As

discussed in Chapter Seven, the ageing of intact dentitions between the ages of two and six years, without any other bones from the skeleton present, can be difficult without access to radiographic equipment. If the dental wear recorded from the Taunton sub-adults, and the comparison sites, produces any definable age patterning then it is possible that dental wear may help as an aid to ageing those mandibles where eruption only, and not tooth formation, is visible.

To determine whether the data collected might be useful to create a standard ageing chart for deciduous dental wear it was necessary to test whether there was any significant difference in dental wear stages recorded for each age by site. This was done because dental wear is strongly correlated to age, so any difference in the age represented for each site could lead to a false significant difference if all wear stages were tested by site alone. Only two ages when tested separately showed a statistically significant difference by site, five year olds for dm1 (chi-square 6.323, df 2, p 0.042) and the eight year olds for dm1 (chi-square 4.243, df 1, p 0.039). Both involve differences between dm1 for Gloucester and Canterbury, with Gloucester showing significantly higher wear rates than Canterbury. This can also be seen in the mean wear rates in Figure 8.31. This implies that when the ages are analysed separately there is no significant difference between Taunton and Gloucester, even though the mean wear stages for some of the ages have a difference of two stages from each other.

Figure 8.31: Mean wear stages for each population (dm1).

Figure 8.32: Mean wear stages for each population (dm2).

No significant difference was seen between the sites for dm2 (Figure 8.32). The low statistical significance by site is encouraging and suggests that it may be possible to pool the data to create a dental wear chart for the sample as a whole as an aid to comparison with other late medieval samples.

Table 8-37: Suggested dental wear stages for age.

Age (yrs)	dm1 wear stage	Mean	dm2 wear stage	Mean
0	0	0	0	0
1	0-1	1	0	0
2	1-4	2	0-1	1
3	2-6	3	1-5	3
4	4-5	4	2-5	4
5	4-6	5	3-5	4
6	4-6	5	4-6	5
7	4-8	6	5-7	6
8	5-8	7	5-8	7
9	5-8	7	5-8	6
10	5-8	7	5-8	7

Table 8-37 represents the range of dental wear stages and the mean and median wear stages for both the first and second deciduous molar teeth that are likely to be seen for each age (in years) from under one year up to ten years. Although the ranges of dental wear scores are quite wide, this table, along with the dental wear chart depicted in

Chapter Seven, may be of use as a reference to compare to the dental eruption age assigned to a dentition, or as a guide for ageing individual teeth. When looking at the second deciduous molar the wear score at age two years is quite different to that at age five years and may therefore be an aid to ageing more accurately those dentitions with all deciduous teeth present and erupted.

Whilst exploring the dental wear stages recorded on the deciduous dentitions the variance between dm1 and dm2 was explored to see if the rate of wear on the teeth changes over time; the full results are presented in Appendix I. To summarise, these results showed that, initially, dm1 had higher rates of wear compared to dm2; this is probably due to its earlier appearance, with an eruption time around nine months earlier than dm2. However, once three years of age was reached, the wear on dm2 appeared to overtake that of dm1. It may be the greater surface area, and therefore higher use for mastication, that is the causative factor.

8.5 Episodes of Stress

This section tests the hypotheses of questions eighteen to twenty-two outlined in Chapter Seven. The prevalence of each of the stress indicators recorded on the skeletons (cribra orbitalia, periostitis, endocranial lesions, porotic hyperostosis and enamel hypoplasia), are presented in this section, as well as rates for carious lesions. These were explored to see if any difference in prevalence was seen between the sub-adult and adult population at Taunton, and if any relationship was apparent between the presence of different stress indicators, by site, location, proximity to the church, and by age of the individual. Whether the presence of one stress indicator makes an individual more likely to show presence for a different indicator was also tested.

8.5.1 Cribra Orbitalia

8.5.1.1 Taunton population

Table 8-38 shows that more sub-adults had cribra orbitalia present than the adults with 52% presence as opposed to 38%. The adults tended to be scored for grade 1 or grade 3, and the sub-adults for grade 2 or grade 3 (see Figure 7.11 for description of grades). Due to the low counts of data recorded for grade 1 and grade 4 the data could not be statistically tested by grades; when tested using the chi-square test for independence, on presence or absence of cribra orbitalia, no significant difference was seen.

Table 8-38: Cribra orbitalia presence in the Taunton population (by grade).

Taunton	N	1	2	3	4	5	TPR
Sub-adults	50	1 (2%)	9 (18%)	14 (28%)	2 (4%)	-	26 (52%)
Adults	52	7 (13%)	4 (8%)	9 (17%)	-	-	20 (38%)
Total	102	8 (8%)	13 (13%)	23 (22%)	2 (2%)	-	46 (45%)

8.5.1.2 Sub-adults all sites

The percentage presence of cribra orbitalia by site, location and proximity to the church are shown in Table 8-39 to Table 8-41. The incidence is very similar for the sub-adults from the three sites, although the prevalence rate for Taunton is slightly higher. The overall percentage for the three sites with cribra orbitalia present is forty-six percent. No significant difference was seen between the three sites when tested using the chi-square test for independence on the presence or absence of cribra orbitalia.

Table 8-39: Cribra orbitalia presence on sub-adults by grade and site.

Score	N	1	2	3	4	5	TPR
Taunton	50	1 (2%)	9 (18%)	14 (28%)	2 (4%)	-	26 (52%)
Gloucester	42	-	6 (14%)	9 (21%)	3 (7%)	-	18 (43%)
Canterbury	63	1 (1.5%)	10 (16%)	12 (19%)	4 (6%)	1 (1.5%)	28 (44%)
Total	155	2 (1%)	25 (16%)	35 (22%)	9 (6%)	1 (1%)	72 (46%)

Table 8-40: Cribra orbitalia presence by grade and location.

Score	N	1	2	3	4	5	TPR
church	9	-	3 (33%)	5 (56%)	-	-	8 (89%)
west	82	1 (1%)	15 (19%)	22 (27%)	5 (6%)	1 (1%)	44 (54%)
north	21	-	1 (5%)	3 (14%)	1 (5%)	-	5 (24%)
south	43	1 (2%)	6 (14%)	5 (12%)	3 (7%)	-	15 (35%)
Total	155	2 (1%)	25 (16%)	35 (23%)	8 (5%)	1 (1%)	72 (46%)

Table 8-41: Cribra orbitalia presence by grade and proximity.

Canterbury	N	1	2	3	4	5	TPR
church	9	-	3 (33%)	5 (56%)	-	-	8 (89%)
<10 m	72	1 (1%)	7 (10%)	14 (20%)	4 (6%)	1 (1%)	27 (38%)
>10 m	74	1 (1%)	15 (20%)	16 (22%)	5 (7%)	-	37 (50%)
Total	155	2 (1%)	25 (16%)	35 (22%)	9 (6%)	1 (1%)	72 (46%)

The incidence of cribra orbitalia is high for those burials from within the church buildings at 89%, although the numbers available to be scored are low. Due to the low numbers of individuals recorded from within church buildings this could not be tested

statistically. When the chi-square test for independence was used on the data with the church burials removed, significance was seen for cribra orbitalia presence and location of burial (chi-square 8.034, df 2, p 0.018) when tested using all ages together. This difference appears to be between those buried to the west of the church, which had a higher incidence compared to those buried to the north and south⁴⁹. There was no significant difference seen between incidences of cribra orbitalia and proximity of burial to the church for the two cemetery groupings.

When age is explored, the prevalence rates of cribra orbitalia rise for each subsequent age group (Table 8-42). This result is seen as significant using the chi-square test for independence (chi-square 31.216, df 4, p 0.000), with the neonate and age 0 up to 2 year groups having less than expected counts of cribra orbitalia. As the neonate group would not be expected to show any cribra orbitalia (see Chapter Five), when this group was removed from the data for analysis no significance result was attained.

Table 8-42: Cribra orbitalia presence by age and grade.

Score	N	1	2	3	4	5	TPR
c. birth	23	-	-	-	-	-	0 (0%)
0-2 years	22	-	6 (27%)	1 (5%)	-	-	7 (32%)
2-7 years	69	2 (3%)	14 (20%)	17 (25%)	3 (4%)	1 (2%)	37 (54%)
7- 12 years	37	-	5 (14%)	15 (40%)	5 (14%)	-	25 (68%)
12+ years	4	-	-	2 (50%)	1 (25%)	-	3 (75%)
Total	155	2 (1%)	25 (16%)	35 (22%)	9 (6%)	1 (1%)	72 (46%)

⁴⁹ tested using the Mann Whitney test. Results: west and north Z -2.432, p 0.015; west and south Z -1.989, p 0.047.

8.5.2 Non-specific infection - periostitis

8.5.2.1 Taunton population

Both woven and lamellar bone lesions were recorded as evidence for non-specific infection, or periostitis, on the adult population. Of the ninety-seven adults analysed from Taunton twenty had some form of periostitis present; four (4%) as woven bone formation, and sixteen (16%) as lamellar bone. Of the sub-adults, thirty individuals had periostitis in the form of woven or lamellar bone. Woven bone was seen in sixteen individuals (17%) and lamellar in six individuals (6%). No significance was seen statistically between the presence of periostitis on the sub-adults and adults, but a difference was seen in the type of bone formation present, with the sub-adults tending to have woven bone formation and the adults lamellar bone. This could be interpreted that children are more susceptible to die quickly from infection, not reaching the healing lamellar bone stage, but may also reflect the natural process of the growing bone in sub-adults (Lewis 2007).

8.5.2.2 Sub-adults all sites

For the sub-adult population periostitis was recorded as woven bone or lamellar bone growth. Porosity and/or striations were also recorded as these too may indicate non-specific infection (Ribot & Roberts 1996, 70). Eighteen individuals from Taunton had evidence for periostitis on one or more bones (19% of the population), with another nine having porosity or striations present (10% of the population). Nine had evidence for periostitis from Gloucester (14% of the population), with another seven having porosity or striations present (10% of the population). For Canterbury, evidence for periostitis was seen in nine individuals (9% of the population), with another twenty-five having porosity or striations present (24% of the population).

Table 8-43 shows the number of bones affected by periostitis from each site. Where N is the number of bones scored, TPR1 is the true prevalence rate of all lesions (including porosity, striations, woven, and lamellar bone growth), and TPR2 is the number of bones recorded as having evidence of new bone growth in the form of woven and/or lamellar bone only.

Table 8-43: Number of bones affected by periostitis.

Bone	Taunton			Gloucester			Canterbury		
	N	TPR1	TPR2	N	TPR1	TPR2	N	TPR1	TPR2
Parietal L	62	-	-	48	2 (4%)	1 (2%)	82	-	-
Parietal R	63	-	-	47	1 (2%)	-	83	-	-
Occipital	61	1 (2%)	1 (2%)	46	-	-	87	-	-
Temporal L	55	1 (2%)	1 (2%)	45	3 (7%)	1 (2%)	79	-	-
Temporal R	63	1 (2%)	1 (2%)	46	1 (2%)	-	79	-	-
Sphenoid	62	-	-	47	2 (4%)	1 (2%)	77	-	-
Orbit L	48	-	-	41	1 (2%)	1 (2%)	52	-	-
Zygomatic	44	-	-	36	1 (3%)	1 (3%)	45	-	-
Maxilla	52	2 (4%)	-	39	1 (3%)	-	75	3 (4%)	-
Mandible	61	1 (2%)	1 (2%)	51	3 (6%)	1 (2%)	96	2 (2%)	-
Humerus L	54	1 (2%)	1 (2%)	50	2 (4%)	2 (4%)	86	-	-
Humerus R	58	1 (2%)	1 (2%)	46	-	-	88	2 (2%)	-
Radius R	52	-	-	42	1 (2%)	1 (2%)	80	1 (1%)	-
Ulna L	60	1 (2%)	1 (2%)	43	-	-	80	1 (1%)	-
Ulna R	52	-	-	42	-	-	81	1 (1%)	-
set of Ribs	72	1 (1%)	1 (1%)	53	1 (3%)	-	98	-	-
set of Ribs	67	1 (1%)	1 (1%)	50	1 (2%)	-	95	1 (1%)	1 (1%)
Ilium L	59	2 (3%)	1 (2%)	44	-	-	79	-	-
Ilium R	58	2 (3%)	1 (2%)	43	-	-	77	-	-
Femur L	65	6 (9%)	5 (8%)	50	2 (4%)	2 (4%)	77	2 (3%)	2 (3%)
Femur R	63	4 (6%)	4 (6%)	50	2 (4%)	2 (4%)	71	1 (1%)	1 (1%)
Tibia L	61	15 (25%)	8 (13%)	44	3 (7%)	1 (2%)	62	23 (37%)	2 (3%)
Tibia R	58	16 (28%)	10 (17%)	47	3 (6%)	1 (2%)	64	22 (34%)	4 (6%)
Fibula L	57	2 (4%)	2 (4%)	41	-	-	62	8 (13%)	2 (3%)
Fibula R	51	3 (6%)	3 (6%)	42	1 (2%)	-	57	9 (16%)	1 (2%)
Total	1458	61 (4%)	43 (3%)	1133	31 (3%)	15 (1%)	1912	76 (4%)	13 (1%)

Table 8-43 and Figure 8.33 show the different elements that were recorded as showing evidence for bone formation, porosity or striations across the skeleton. It is clear that for this sample of sub-adults it is the bones of the leg that are most commonly involved and the tibia in particular. Porosity and striations were the most common lesions seen with most of these being recorded on the tibia. Woven (new) bone growth is more common than lamellar bone, as would be expected both in growing children, and if the individual did not recover from an infectious episode. The high prevalence of periostitis on the medial side of the tibiae in particular may indicate that this is a sign of normal bone growth. However, the tibia is the bone most often involved in slight trauma due to the anterior portion of the bone having little soft tissue protection.

Figure 8.33: Number of bones affected by periostitis across the skeleton (all sites).

When the presence of woven and/or lamellar bone (TPR2) was tested for individuals by site using the Chi-square test for independence a significant result was obtained (chi-square 7.086, df 2, p 0.029). The prevalence of woven and/or lamellar bone is higher for the Taunton individuals and lowest for those at Canterbury. When tested by two groups, those with new bone growth present (woven and/or lamellar) in one group, and those with evidence of porosity and striations only in the other, a significant result was also seen (chi-square 40.110, df 2, p 0.000). Taunton has a high incidence of woven or lamellar bone recorded, whilst Canterbury has a high incidence of porosity or striations recorded. When all evidence for periostitis is included Canterbury has the highest number of individuals scored and Gloucester the lowest.

Table 8-44 shows the data for periostitis presence by number of individuals by burial location. For all types of lesion the highest incidence (33%) was seen to the south, and the lowest was in the church (27%) and to the west (27%). When only evidence for woven or lamellar bone was analysed the church had the highest prevalence of individuals (20%), then those buried to the west (17%). Those to the north had a prevalence rate of 9%, and those to the south 7%.

Table 8-44: Number of individuals with periostitis by location.

	N	woven or lamellar bone	porosity and/or striations	TPR
church	15	3 (20%)	1 (7%)	4 (27%)
west	143	24 (17%)	15 (10%)	39 (27%)
north	34	3 (9%)	7 (20%)	10 (29%)
south	70	5 (7%)	18 (26%)	23 (33%)
Total	262	35 (13%)	41 (16%)	76 (29%)

Table 8-45 shows the data for periostitis presence by number of individuals and their proximity to the church. When all lesions were included those more than 10m from the church had the highest prevalence rate (33%), then those buried within the church (27%), and for those buried within 10m of the church the rate was 26%. When only the woven or lamellar bone was analysed those buried within the church had the highest prevalence rate (20%), then those buried more than 10m from the church (17%), and those buried within 10m of the church had the lowest prevalence rate (9%). No statistical significance was seen for either location or proximity when presence and

absence data on woven and lamellar bone only was tested using the chi-square test for independence.

Table 8-45: Number of individuals with periostitis by proximity.

	N	woven or lamellar bone	porosity and/or striations	TPR
church	15	3 (20%)	1 (7%)	4 (27%)
<10 m	132	12 (9%)	22 (17%)	34 (26%)
>10m	115	20 (17%)	18 (16%)	38 (33%)
Total	262	35 (13%)	41 (16%)	76 (29%)

Table 8-46 shows the presence of periosteal lesions for each age group by both the number of bones and the number of individuals (number in brackets). The highest prevalence by individual is seen on the seven to twelve year old group (37%), followed by the two to seven year group (33%), and then the birth to two year group (31%). The lowest prevalence is on those over twelve years of age (6%), with the neonate group also scoring a fairly low prevalence (12%).

Table 8-46: Number of individuals with periostitis by age group.

	N	woven or lamellar bone	porosity and/or striations	TPR
neonate	34	3 (9%)	1 (3%)	4 (12%)
0-2 years	42	5 (12%)	8 (19%)	13 (31%)
2-7 years	110	18 (16.5%)	18 (16.5%)	36 (33%)
7- 12 years	60	8 (13.5%)	14 (23.5%)	22 (37%)
12+ years	16	1 (6%)	-	1 (6%)
Total	262	35 (13%)	41 (16%)	76 (29%)

8.5.3 Endocranial lesions

Endocranial lesions were only scored on the sub-adult populations. Gloucester has the highest incidence of endocranial lesions and Canterbury the lowest (Table 8-47). This may be partly due to the fact that the Canterbury skulls had been reconstructed with masking tape, at some point prior to the analysis, which had firmly adhered itself and would have caused damage to the bones on removal; therefore, they could not be completely analysed for lesions. Table 8-48 and Table 8-49 show that no lesions were present on those individuals from within the church; the majority came from the north side of the church, mirroring the high numbers from Gloucester (all those north of the church are from Gloucester). See Figure 7.12 for a description of the grades.

Table 8-47: Endocranial lesions by site and grade.

	N	1	2	3	4	TPR
Taunton	62	2 (3%)	6 (10%)	2 (3%)	1 (2%)	11 (18%)
Gloucester	48	-	9 (19%)	3 (6%)	-	12 (25%)
Canterbury	85	-	3 (4%)	-	1 (1%)	4 (5%)
Total	195	2 (1%)	18 (9%)	5 (3%)	2 (1%)	27 (14%)

Table 8-48: Endocranial lesions by location and grade.

	N	1	2	3	4	TPR
church	14	-	-	-	-	0 (0%)
west	102	2 (2%)	9 (9%)	3 (3%)	1 (1%)	15 (15%)
north	21	-	7 (33%)	2 (10%)	-	9 (43%)
south	58	-	2 (3%)	-	1 (2%)	3 (5%)
Total	195	2 (1%)	18 (9%)	5 (3%)	2 (1%)	27 (14%)

Table 8-49: Endocranial lesions by proximity and grade.

	N	1	2	3	4	TPR
church	14	-	-	-	-	0 (0%)
<10m	91	-	12 (13%)	3 (3%)	-	15 (16%)
>10m	90	2 (2%)	6 (7%)	2 (2%)	2 (2%)	12 (13%)
Total	195	2 (1%)	18 (9%)	5 (3%)	2 (1%)	27 (14%)

Statistical significance was seen for endocranial lesions by site (chi-square 11.748, df 2, p 0.003). Location could not be tested for statistical significance due to low counts of data in some categories. However, there is a high prevalence of lesions from those buried to the north (43%) compared to the other locations; this may be due to the

majority of burials in this area involving young infants, where fibre bone may be part of the normal growth process (Lewis 2004, 94).

Table 8-50 shows the prevalence rates of endocranial lesions by age range. As suggested from the high prevalence seen to the north of the church, a higher incidence was seen in the younger age groups of 38% for the neonate group and 31% for those aged from birth up to 2 years of age.

Table 8-50: Endocranial lesions by age and grade.

	N	1	2	3	4	TPR
neonate	24	-	9 (38%)	-	-	9 (38%)
0-2 years	32	1 (3%)	7 (22%)	1 (3%)	1 (3%)	10 (31%)
2-7 years	85	1 (1%)	2 (2%)	1 (1%)	1 (1%)	5 (6%)
7- 12 years	47	-	-	3 (6%)	-	3 (6%)
12+ years	7	-	-	-	-	0 (0%)
Total	195	2 (1%)	18 (9%)	5 (3%)	2 (1%)	27 (14%)

8.5.4 Porotic hyperostosis

None of the Taunton sub-adults showed evidence for porotic hyperostosis on the skull, even though the incidence of cribra orbitalia was highest here; seven of the adults did, scoring either grade 2 or 3. Both Gloucester and Canterbury had small numbers of skeletons with evidence for the presence of porotic hyperostosis (Table 8-51).

Table 8-51: Porotic hyperostosis by site and grade.

	N	1	2	3	TPR
Taunton	62	-	-	-	0 (0%)
Gloucester	48	-	3 (6%)	2 (4%)	5 (10%)
Canterbury	85	-	1 (1%)	1 (1%)	2 (2%)
Total	195	-	4 (2%)	3 (2%)	7 (4%)

Table 8-52: Porotic hyperostosis by location and grade.

	N	1	2	3	TPR
church	14	-	1 (7%)	-	1 (7%)
west	102	-	1 (1%)	1 (1%)	2 (2%)
north	21	-	1 (5%)	1 (5%)	2 (10%)
south	58	-	1 (2%)	1 (2%)	2 (4%)
Total	195	-	4 (2%)	3 (2%)	7 (4%)

For the sub-adult populations, Gloucester had the highest incidence of porotic hyperostosis, with the majority coming from burials north of the church (Table 8-52); those from within the church showed the next highest incidence.

Table 8-53: Porotic hyperostosis by proximity and grade.

	N	1	2	3	TPR
church	14	-	1 (7%)	-	1 (7%)
<10m	91	-	2 (2%)	1 (1%)	3 (3%)
>10m	90	-	1 (1%)	2 (2%)	3 (3%)
Total	195	-	4 (2%)	3 (2%)	7 (4%)

Table 8-54: Porotic hyperostosis by age and grade.

	N	1	2	3	TPR
neonate	24	-	-	-	0 (0%)
0-2 years	32	-	1 (3%)	1 (3%)	2 (6%)
2-7 years	85	-	3 (4%)	1 (1%)	4 (5%)
7- 12 years	47	-	-	1 (2%)	1 (2%)
12+ years	7	-	-	-	0 (0%)
Total	195	-	4 (2%)	3 (2%)	7 (4%)

For proximity (Table 8-53), the highest prevalence rate came from burials within the church, but numbers are very low. No statistical significance was seen when all ages are tested together for location and proximity to the church. When explored by age group (Table 8-54), prevalence was higher in the younger groups, although no porotic hyperostosis was seen in the neonate group, as would be expected.

8.5.5 Enamel defects

8.5.5.1 Taunton population

For the Taunton population 22, out of 55, adults with dentitions (40%) had enamel defects present on one or more permanent teeth. Twenty-two, out of 45, sub-adults had enamel defects on the permanent teeth (49%), and 12, out of 55, on the deciduous teeth (22%). This is an overall presence of 46% with enamel defects present on either, or both, the deciduous or permanent teeth (29/63). When tested using the chi-square test for independence, on presence and absence data, no statistical significance was seen for enamel defects on the permanent teeth, or when all sub-adult enamel defects were tested.

8.5.5.2 Sub-adults all sites by number of teeth

Two thousand seven hundred and sixty-five teeth were recorded for enamel defects. For the permanent teeth the most common enamel defect was that of hypoplastic lines, whilst on the deciduous teeth lines were rare and defects tended to consist of either single pits or a series of pits in the enamel. Hypoplastic defects appear to be less common on the deciduous teeth. This is because these will be formed whilst the infant is still in-utero and therefore protected to some extent from environmental stresses (Goodman *et al.* 1984b, 26).

Table 8-55: All enamel defects by number of teeth.

	N Dec	Dec TPR	N Perm	Perm TPR	N All teeth	All teeth TPR
Taunton	680	27 (4%)	440	92 (21%)	1120	119 (11%)
Gloucester	212	14 (7%)	252	65 (26%)	464	79 (17%)
Canterbury	757	15 (2%)	424	39 (9%)	1181	54 (5%)
Total	1649	56 (3%)	1116	196 (18%)	2765	252 (9%)

Dec: deciduous teeth; Perm: permanent teeth; All teeth: both deciduous and permanent teeth.

Table 8-55 shows the number of all teeth scored for hypoplastic defects, and includes those where lines on the teeth were recorded as "just discernable". When faint lines are recorded this may inflate the incidence of enamel hypoplasia recorded when compared to sites recorded by another researcher, who may have only recorded clear grooves on the teeth. Table 8-56 shows the same table when only clear lines are recorded. Although only recording the clear defects reduces the overall numbers, in the cases of Taunton and Gloucester by half or more, the comparison of incidence between the sites remains similar. The highest incidence is seen at Gloucester and the lowest at Canterbury.

Table 8-56: Enamel defects by number of teeth (clear defects only).

	N Dec	Dec TPR	N Perm	Perm TPR	N all teeth	All teeth TPR
Taunton	680	22 (3%)	440	37 (8%)	1120	59 (5%)
Gloucester	212	10 (5%)	252	26 (10%)	464	36 (8%)
Canterbury	757	12 (2%)	424	24 (6%)	1181	36 (3%)
Total	1649	44 (3%)	1116	87 (8%)	2765	131 (5%)

Dec: deciduous teeth; Perm: permanent teeth; All teeth: both deciduous and permanent teeth.

Table 8-57 to Table 8-59 show the different types of defects recorded for each of the three sites on the deciduous teeth, the permanent teeth, and as those defects recorded as clear or gross defects only. When the defects are analysed by number of teeth, it is

Gloucester that has the highest prevalence of defects indicating that defects here are more severe and involve more teeth per individual.

Table 8-57: Types of defects present on the deciduous teeth.

Dec teeth	N	pit	pits	Lin. hypo	thinning	TPR
Taunton	680	14	12	1	-	27 (4%)
Gloucester	212	11	3	-	-	14 (7%)
Canterbury	757	6	-	2	7	15 (2%)

Lin.hypo: linear hypoplasia; thinning: refers to thinning enamel.

Table 8-58: Types of defects present on the permanent teeth.

Perm all	N	pit	Lin. hypo	Lin. hyper	TPR
Taunton	440	3	88	1	92 (21%)
Gloucester	252		65		65 (26%)
Canterbury	424		39		39 (9%)

Lin. hper: linear hyperplasia

Table 8-59: Types of defects (clear only) present on permanent teeth.

Perm clear	N	pit	Lin. hypo	Lin. hyper	TPR
Taunton	440	3	33	1	37 (8%)
Gloucester	252		26		26 (10%)
Canterbur	424		24		24 (6%)

8.5.5.3 Sub-adults all sites by individual

Table 8-60 give details of the rates of enamel defects by site, Table 8-61 by location, and Table 8-62 by proximity to the church. The prevalence of defects scored is the same at Taunton and Gloucester, whilst it is much lower for the Canterbury population. Of the ninety-three individuals from Taunton, 63 had dentitions that were scored for enamel defects. Twenty-nine individuals had one or more enamel defects, with seven on the deciduous teeth only, 17 on the permanent teeth only, and five involving both the deciduous and permanent teeth. This gives a percentage of 46% (29) with at least one enamel defect. If those defects scored as “just discernable” are excluded, the number with defects is 21 (33%). Of the 65 individuals from Gloucester 35 dentitions could be scored for enamel defects. Sixteen individuals had one of more enamel defects, with six on the deciduous teeth, and ten on the permanent teeth. This gives a percentage of 46% (16) with at least one enamel defect. If the “just discernable” defects are excluded, the number is 11 (31%). Of the one hundred and four individuals from Canterbury ninety-two dentitions could be scored for enamel defects. Twenty-four individuals had one or

more enamel defects, with 10 on the deciduous teeth, and 14 on the permanent teeth (26%). If the “just discernable” defects are excluded the number is eleven (18%).

Table 8-60: Enamel hypoplasia prevalence by individual and site.

	N Dec	Dec TPR	N Perm	Perm TPR	N Both	Both TPR
Taunton	55	12 (22%)	45	22 (49%)	63	29 (46%)
Gloucester	30	6 (20%)	24	10 (42%)	35	16 (46%)
Canterbury	85	10 (12%)	65	14 (22%)	92	24 (26%)
Total	170	28 (16%)	134	46 (34%)	190	69 (36%)

Dec: deciduous teeth only scored; Perm: permanent teeth only scored; Both: both deciduous and permanent teeth scored.

Table 8-61: Enamel hypoplasia prevalence by individual and location.

	N Dec	Dec TPR	N Perm	Perm TPR	N Both	Both TPR
church	10	3 (30%)	9	4 (44%)	12	7 (58%)
west	92	16 (17%)	73	33 (45%)	103	44 (43%)
north	9	2 (22%)	5	1 (20%)	10	3 (30%)
south	59	7 (12%)	47	8 (17%)	65	15 (23%)
Total	170	28 (16%)	134	46 (34%)	190	69 (36%)

Table 8-62: Enamel hypoplasia prevalence by individual and proximity.

	N Dec	Dec TPR	N Perm	Perm TPR	N Both	Both TPR
church	10	3 (30%)	9	4 (44%)	12	7 (58%)
<10m	78	10 (13%)	58	17 (29%)	84	26 (31%)
>10m	82	15 (18%)	67	25 (37%)	94	36 (38%)
Total	170	28 (16%)	134	46 (34%)	190	69 (36%)

When enamel defects are tested by site using the chi-square test for independence significance is seen for the permanent dentition (chi-square 9.522, df 2, p 0.009) and for those individuals with any defect from any tooth present (chi-square 8.070, df 2, p 0.018). The highest prevalence of enamel defects are on the dentitions of the Taunton sub-adults and the lowest on those from Canterbury. Due to the low counts for some categories, enamel defects could not be tested statistically by location. No statistical significance was seen for enamel defects and proximity.

8.5.6 Stress Indicators compared with each other

The relationship between the five different stress indicators scored was tested using the Chi-square test for independence. Two tests indicated significance; those carried out on cribra orbitalia by periostitis (chi-square 4.761, df 1, p 0.029), and cribra orbitalia by

enamel hypoplasia (chi-square 7.959, df 1, p 0.005). These results indicate that when a child has cribra orbitalia present on the orbits they are also more likely to have signs of periostitis somewhere on the skeleton, and to have enamel defects. However, when the deciduous and permanent teeth were tested separately by cribra orbitalia, significance was no longer seen, probably due to the smaller numbers of individuals scored as having defects when the different dentitions are tested separately.

8.5.7 Dental disease

8.5.7.1 Taunton population

From the Taunton population 32 adults (55%) had one or more carious lesions out of 58 individuals scored. Only 20 sub-adults (36%) had one or more carious lesions present out of 55 individuals scored. The difference in scores was not statistically significant.

8.5.7.2 Sub-adult population all sites

Thirty-nine individuals out of 200 (20%) with at least one recordable tooth had carious lesions on one or more teeth. Where individuals did not have the full set of teeth recovered on excavation, this will have an effect on the frequencies presented as they may have had caries present on unrecorded teeth. Three individuals had caries present on their permanent teeth only, 35 individuals had caries present on their deciduous teeth only, and one individual had caries present on three deciduous and one permanent tooth. Table 8-63 shows the presence of caries by individual for each of the sites.

Table 8-63: Caries rates by individual for each site.

	N	caries present	TPR %
Taunton	65	22	34
Gloucester	39	2	5
Canterbury	96	15	16
Overall	200	39	20

Taunton has the highest number of caries and individuals with caries by site, and that for Gloucester the number is very low. When the number of caries present for each individual is tested using the Kruskal Wallis test the difference in presence of caries on the deciduous teeth by site is significant (chi-square 15.169, df 2, p 0.01). The Mann Whitney test for two independent samples confirms that Taunton has significantly higher rates of caries than the other two sites, and also that Gloucester has significantly

lower scores than the other sites⁵⁰. This may suggest different diets at these sites, and also different levels of oral hygiene.

Statistical significance was seen for the presence of deciduous caries when tested by burial location using the Kruskal Wallis test (chi-square 9.295, df 3, p 0.026), with the mean ranks indicating the prevalence of caries is high in the west compared to those buried elsewhere. The Mann Whitney test for two independent samples confirms this significance⁵¹ for burials within the church and to the south. When the presence of caries was tested using the Chi-square test for independence by the presence of other stress indicators no significance was seen for any of the indicators.

Table 8-64 shows the presence of caries by the number of teeth scored for each of the sites. As for the presence of caries per individual, the prevalence is highest for Taunton and lowest for Gloucester on the deciduous teeth. The lack of any caries on the Canterbury permanent teeth may be because no individuals over the age of 12 years of age were analysed. However, of the four individuals with permanent caries one was aged as nine and one as ten years of age. The other two were in the 12+ year age category.

Table 8-64: Presence of caries by tooth for each site.

	N	Deciduous	TPR %	N	Permanent	TPR %
Taunton	683	49	7%	385	3	1%
Gloucester	220	1	0.5%	216	1	0.5%
Canterbury	767	22	3%	329	0	0%
Total	1670	72	4%	930	4	0.4%

Table 8-65 shows the position of the carious lesion for each tooth where caries were recorded. These were mostly seen on the interproximal surface of the tooth.

⁵⁰ Taunton and Gloucester Z -3.382, p 0.001; Taunton and Canterbury Z -2.711, p 0.007; Gloucester and Canterbury Z -1.96, p 0.050.

⁵¹ Church and west Z -1.962, p 0.050; west and south Z -2.295, p 0.022.

Table 8-65: Position of caries by tooth (all sites).

	Deciduous	Permanent	Total
Occlusal caries	9	3	12
Interproximal	36	1	37
Interproximal and onto occlusal	24		24
Most of tooth	1		1
Labial caries	1		1
Lingual caries	1		1
Total	72	4	76

8.6 Growth and Development

8.6.1 Long bone lengths

Growth was explored by comparing long bone length by age for each of the sites. The mean value for each age was used to create a growth chart for each site and these are plotted separately for each long bone (see Figure 8.34, Figure 8.35, Figure 8.36, Figure 8.37, Figure 8.38 and Figure 8.39). Left side bones were used where possible, with right bones being used when the left was missing or broken. In the event of no bones being complete, but at least one that could be reconstructed accurately, the left side was used where possible. The number, mean, median, standard deviation, minimum and maximum values for the long bone lengths for each age in years are presented in separate tables for each site (see Appendix I), and as a collation for all sites. The measurements from all sites were depicted on a scatter plot with an added regression line to give an indication of overall growth rate for the individuals analysed (presented in Appendix I).

Eighty-nine maximum femoral lengths were measured, 29 for Taunton, 18 for Gloucester, and 42 for Canterbury. For most of the ages the measures are similar, with the highest discrepancy (51mm) between Canterbury and Taunton at age eight years. For Taunton, Figure 8.34 shows a slight rise at age five and then a decline at age eight and ten. This is probably just an effect of the small numbers involved.

Seventy-four tibial lengths were measured, 25 for Taunton, 13 for Gloucester, and 36 for Canterbury. For most of the ages the mean values for all the sites are similar, with the widest variation seen for the seven year olds between Gloucester and Taunton (45.25mm).

Figure 8.34: Femoral lengths plotted against age for each site.

Figure 8.35: Tibia lengths plotted against age for each site.

Figure 8.36: Humeral lengths plotted against age for each site.

Figure 8.37: Radius lengths plotted against age for each site.

Figure 8.38: Ulna lengths plotted against age for each site.

Figure 8.39: Fibula lengths plotted against age for each site.

Ninety-seven humeral lengths were measured, 31 for Taunton, 13 for Gloucester, and 53 for Canterbury. The mean humeral lengths are similar for most of the ages, with the largest variance of 24.67mm seen at age seven years between Canterbury and Taunton.

Sixty-two radius lengths were measured, 21 for Taunton, 10 for Gloucester, and 31 for Canterbury. Canterbury shows a gradual even rise for radial lengths by age, whilst Taunton shows a sudden rise at age five but then a decline at six years to match the other sites. The Gloucester data are lacking in radial lengths but, where there are data, this seems to mirror the Canterbury data. The greatest discrepancy in the mean ages from the sites is at age seven between Gloucester and Taunton (15.77mm).

Seventy-five ulna lengths were measured, 22 from Taunton, 12 from Gloucester, and 41 from Canterbury. The growth chart for ulna length depicts quite an even gradual rise for all the sites with not very much variation between them; the widest variation between the mean lengths for each age is between Gloucester and Taunton at age seven (16.92mm).

Forty-one fibula lengths were measured, 15 from Taunton, four from Gloucester and 22 from Canterbury. The number of fibulae that could be measured are quite small, hence the gaps on the growth chart (Figure 8.39). Again, the Gloucester data quite closely matches that of Canterbury; the highest discrepancy in the means is between Gloucester and Taunton at age seven (30mm).

To test if there was any statistical significance in long bone lengths between the three sites, five age groups were created; 1 and 2 years, 3 and 4 years, 5 and 6 years, 7 and 8 years, and 9 and 10 years. The data were tested by two yearly age groups together due to the small numbers of data in each yearly group. The long bone lengths were tested by site using the ANOVA test for each group. None of the results showed significance; therefore, although differences up to 51mm in length for the femur are present between two children of the same age, the data in general for long bone length are similar between the sites.

8.6.2 Stature

Figure 8.40 shows each of the mean stature estimates for age (years) plotted for each of the three sites; descriptive statistics are presented in Appendix I. Due to the higher number of individuals being present from estimating stature, as opposed to creating the

figures using single long bone measurements, the lines for each site fall closer together and there are also less missing data⁵². This figure shows that the three sites have fairly similar means for all the ages. As with the long bone lengths, the largest discrepancy between the sites appears at age seven, where the mean for Taunton is somewhat less than that for the other two sites (a difference of 10.89cm). For age 0 years there is a difference of 9.41cm between Taunton (high value) and Canterbury, and for age 10 years a 7.65cm difference for the means from Canterbury (high value) and Taunton. When stature was tested using ANOVA by site in the five age groups (as defined above) no statistical significance was seen.

Figure 8.40: Stature plotted against age for each site.

⁵² Only age 9 years is missing for Gloucester, whereas the Taunton data goes up to age 10 years, and Canterbury age 11 years.

Figure 8.41: Estimated stature for all sites.

Figure 8.41 is a scatter plot of all data points for stature for the three sites with a trend line added (Taunton $R^2 = 0.88$, Gloucester $R^2 = 0.92$, Canterbury $R^2 = 0.89$). Whilst the mean statures of the Taunton individuals appear to start off slightly higher in the early years, after six years of age the trend is for statures to become shorter than those of the other two sites. The lines of fit for the other two sites are remarkably similar.

Figure 8.42 shows the comparison of the late medieval data (the mean statures of the three sites combined) plotted against modern US data (Maresh 1970) and modern British data (Tanner *et al.* 1966). From the age of three years the modern statures are consistently higher than the medieval estimated statures.

The unexpected high values for the medieval data during infancy are probably due to a discrepancy in the way the two datasets have been collected. For the Maresh (1970) data a child at age x is actually x years and no months whereas for the medieval data an age of x could be anywhere between age x and no months and age x and 11 months. This explains the higher values for the ages of 0 and 1 years of age, because for the archaeological data the remains are going to represent at least 0 or 1 year of age rather than measured at exactly 0 or 1 year.

Figure 8.42: Medieval stature plotted in comparison to modern stature.

Figure 8.43: Medieval stature plotted in comparison to modern stature.

Figure 8.43 shows the same data for the medieval stature but plotted against the measures taken on US and British children at x years and 6 months of age. This plot appears to show a similar stature in infants for both periods, but as the children get older the modern children are clearly outgrowing the medieval ones, with the difference tending to increase as they get older. The British and US stature for age is very similar, with the US children very slightly taller than their British counterparts. This supports

the use of the Maresh (1970) datasets as a modern comparison with British archaeological skeletal material.

8.6.3 Burial location and stature

Stature was tested statistically against burial location and proximity to the church using ANOVA in the five age groups, as noted above. No significance was seen for stature and proximity to the church.

For burial location by stature the 3 and 4 year age group showed significance in the statures estimated from humerus length, but not in the overall mean stature⁵³, (F 4.004, df 2, p 0.036). The Tukey test identified that the mean difference of 6.27 was significant at the 0.05 level between those buried to the west and those to the south of the church; the higher mean stature was associated with those buried to the west. The highest mean stature was, however, associated with those buried within the church buildings: the non significance here is attributable to the low numbers (N=3) for this group. However, three outliers were identified for this group when tested for normality, and when these were removed no significance was seen.

The 7 and 8 year group also showed some significant results by location and stature (see Table 8-66). Due to the small numbers involved the post hoc Tukey test could not be performed to determine the mean difference of the significance. T-tests were performed to determine between which groups the significance was falling. When the west and south were tested against each other, they showed significance for all the bone lengths and stature estimations listed in Table 8-66. For the humerus length and stature, significance was also seen between the church and the south (T -3.654, p 0.035). In both instances the mean values of those buried south of the church were higher than those buried west of the church, or within the church. This is in contrast to the difference seen for the 3 and 4 year group. The mean stature values for those buried to the south also tend to be higher than those from within the church, also in contrast to the 3 and 4 year age group.

⁵³ The numbers of individuals with mean stature calculated will be higher and therefore the dataset will be slightly different.

Table 8-66: Significant values of age 7 and 8 years for stature by burial location.

	ANOVA			T-Test	
	F	df	p	T	p
Femur	3.733	3	0.045	-2.702	0.021
Tibia	5.991	2	0.022	-3.164	0.011
Humerus	5.267	2	0.025	-3.053	0.011
Ulna	5.910	2	0.023	-4.737	0.001
Mean stature	5.139	3	0.010	-3.911	0.001

The 9 and 10 year age group also showed significance for stature by burial location, but only for the tibial estimation of stature; $F 4.048$, $df 2$, $p 0.048$. No post hoc Tukey test could be performed in this case, but the mean values of those individuals buried within the church were considerably higher than for the other groups. The T-Test confirms that the significance is between those buried within the church and those buried to the west ($T 3.204$, $p 0.019$). The mean values are higher for the church group, indicating a taller stature for those buried within the church.

8.6.4 Stature and stress

The number of stress indicators present on each individual was explored to see if there had been any effect on bone growth, in terms of long bone length and stature. Figure 8.44 shows the number of stress indicators recorded for each individual plotted against estimated stature; the plots for long bone length for each long bone are given in Appendix I.

Figure 8.44: Estimated stature by age and stress indicators present.

There is no clear indication that any of the stress indicators had an influence on growth in terms of estimated stature. An ANOVA test was performed on mean stature by the number of stress indicators present; no significance was seen. Each site was also tested separately and no significance was seen. Statistical tests were then performed on the different stress indicators by stature; the significant results are presented below.

8.6.4.1 Separate stress indicators Independent T-Test results

Initially the data for stature for all ages and sites were tested against each of the stress indicators recorded. Four significant results were seen for mean stature.

- Cribra orbitalia (CO) presence ($t=5.648$, $df=119$, $p=0.000$). The mean stature for those with CO was higher, at 104.32 ($N=59$), than for those without, at 82.38 ($N=66$). At this stage the data tested were not separated into age groups and this higher stature may indicate that it is the older children that are more likely to have CO as opposed to taller children. Because the number of individuals with and without CO in each age group is not equal it may be a few individuals that are creating the higher mean, such as the one 14 year old with CO but no individuals of that age without.
- Enamel hypoplasia (EH) presence on the permanent teeth ($t=-3.781$, $df=102$, $p=0.000$). The mean stature for those with EH on the permanent teeth was higher than those without, 116.94 ($N=38$), as opposed to 104.60 ($N=66$). Again, this may be indicating that older children are more likely to have EH; as younger children will not have fully completed crowns for the permanent teeth, this is highly likely. When the one and two year old data were removed, there was still significance seen ($p=0.006$), but when the three to five year old data were also removed (permanent teeth begin to erupt at age six) there was then no significance, indicating that the significance was due to age, and not stature or long bone length.
- Caries presence on the deciduous teeth ($t=-6.751$, $df=71$, $p=0.000$). The mean stature for those with caries was higher at 113.03 ($N=30$) than for those without at 94.35 ($N=100$). However, the older the child is, the more likely they are to have caries.

- Endocranial lesions (t 6.846 df 36 p 0.000). In this case, the mean stature for those with the lesions was less 72.17 (N = 19) than for those without, 98.00 (N = 133). Here, it is the fact that these lesions tend to be seen on younger rather than older children that is causing the significance.

Therefore, in all these data it appears that age may be the contributing factor to significance. When the presence of each of these stress indicators is tested by age they are all statistically significant.

- Cribra orbitalia presence (t -2.037, df 127, p 0.044). There is a higher mean age for those with CO 5.28 (N = 71) than those without 4.12 (N = 58).
- Enamel hypoplasia presence on the permanent teeth (t -5.289, df 130, p 0.000). There is a higher mean age for those with EH present 8.49 (N = 45) as opposed to those without 5.57 (N = 87).
- Caries presence on the deciduous teeth (t -8.049, df 72, p 0.000). There is a higher mean age for presence of caries 7.23 (N = 35) than those without 3.83 (N = 131).
- Caries presence on the permanent teeth (t 2.579, df 129, p 0.011). There is a higher mean age for those with caries 11.33 (N = 3) than those without 6.49 (N = 128).
- Endocranial lesions (t 3.255, df 164, p 0.001). There is a lower mean age for those with endocranial lesions 2.33 (N = 18) than those without 5.13 (N = 148).

This indicates that in the four examples, where stress indicator by stature gives a statistically significant result, it is the age of the individuals that is significant and not stature in all of the cases. The effect of age on the presence of enamel hypoplasia on the permanent teeth, and caries on the deciduous and permanent teeth, is an expected result as young children will not have the permanent teeth fully formed until a certain age, and caries are more likely to appear as the child's teeth become older. The higher age for those with cribra orbitalia is more interesting; in the first months of life infants would not be expected to have an iron deficiency due to stores from the mother. However, this only lasts about six months (Lewis 2007, 113), so it appears that infant diet may have

been adequate to stave off deficiency, but in later childhood nutrition may have become poorer. Endocranial lesions conversely tend to be more common on the younger rather than the older children. This is not surprising as in children under two years of age these lesions can be fairly common and may represent normal growth processes (Lewis 2004).

Due to the biasing effect that age will have on stature, each of the stress indicators were tested against stature separately for each age group. The numbers for each yearly age group was too small to test, so the ages were grouped into the two year age groups as described above: 1 and 2 years, 3 and 4 years, 5 and 6 years, 7 and 8 years, and 9 and 10 years. Statistically significant results for stress indicator presence and stature for five separate age groups were obtained.

- Cribra orbitalia presence by mean stature ($t -2.523$, $df 13$, $p 0.025$). Statistical significance was seen in the 3-4 year age group. Eta squared is 0.33 which equates to 33% of the variance, or a large effect (see Pallant 2005, 209). Those with CO have a mean stature of 94.66 cm, whilst those without have a mean of 88.74 cm.
- Enamel hypoplasia presence on the deciduous teeth by fibula length and estimated stature ($t -2.683$, $df 5$, $p 0.044$). Statistical significance was seen for the one and two year age group. Eta squared is 0.59 which equates to a large effect. Those with EH have a higher mean stature 90.03 ($N = 5$) as opposed to those without 79.05 ($N = 2$). However, it may be the pooling of the ages that has created a significant result as enamel hypoplasia is only present on those individuals who are two years of age, and they would therefore naturally have greater long bone lengths than those aged as one year olds.
- Enamel hypoplasia presence on the deciduous teeth by humeral length and estimated stature ($t -2.485$, $df 18$, $p 0.023$). Statistical significance was seen for the three and four year old age group. Eta squared is 0.26 which equates to a large effect. However, the sample size is quite small with 17 individuals with no EH present having a mean of 91.21, and only three with EH having a mean of 99.33. Three outliers were present when the data were tested for normality, but the result was still significant when these are removed ($t -2.538$, $df 17$, $p 0.021$).

- Caries presence on the deciduous teeth, by tibial length and estimated stature ($t = 2.414$, $df = 11$, $p = 0.034$). Statistical significance was seen for the nine and ten year old age group. Eta squared is 0.35 which equates to a large effect. The mean of those with caries is higher than for those without 123.32 ($N = 7$), as opposed to 117.41 ($N = 6$).

In all four cases those with stress indicators are taller than those without. This is not necessarily the result that would be expected.

8.6.5 Development

8.6.5.1 Fusion of the skull

Fusion was recorded for the bones that make up the occipital bone as unfused, fusing or fused. These data were then plotted against the dental ages of the individual skeletons to determine the fusion timing. The results closely match the fusion ages for the bones in Scheuer and Black (2000b) and Schaefer *et al.* (2009), where the fusion of pars lateralis to squama is recorded as occurring between one and three years of age, and the fusion of the pars basilaris and pars lateralis between five to seven years of age. Figure 8.45 indicates that the lateral part of the occipital begins to fuse to the squama from the age of one year; it may still be unfused at age four, but all individuals showed complete fusion by five years of age.

Figure 8.45: Fusion of pars lateralis to squama of the occipital
sq-lat UF: the squama and pars lateralis are unfused; FS: are fusing; F: are fused.

Figure 8.46 shows that the pars basilaris begins to fuse to the pars lateralis from the age of three years; this area can still be unfused until six years of age and is recorded as still fusing as late as eight years of age. Both figures show that the occipital bones can be fusing for a slightly longer period than determined in the literature.

Figure 8.46: Fusion of the pars basilaris

bas-lat UF: the squama and pars basilaris are unfused; FS: are fusing; F: are fused.

8.6.5.2 Fusion of the vertebrae

The fusion of the vertebrae was recorded for each of the separate areas which fuse during childhood; the following list gives the regions involved and the fusion timing for these events from Scheuer and Black (2000b):

1. the fusion of the posterior part of the neural arches; one year for the thoracic and lumbar region, complete by two years for the cervical region, three to four years for the axis, and four to five years for the atlas.
2. the fusion of the neural arches to the centrum, or the anterior part for the atlas; three to four years for the cervical, thoracic and lumbar vertebrae, five to six years for the axis and atlas.
3. the fusion of the dens to the neural arches; three to four years.
4. the fusion of the dens to the centrum; commences four to five years, and by five to six years fusion is complete.

For both the cervical and thoracic vertebrae, posterior fusion of the neural arches occurs between the ages of birth and two years, although one individual is present that still has an open posterior synchondrosis at age three. For the lumbar vertebrae no individuals have an unfused posterior synchondrosis past the age of two years, although incomplete fusion was seen in two individuals aged four years and six years. The fusion occurs between the ages of one and three years for the axis,

although two individuals were recorded with the posterior synchondrosis still unfused at the ages of seven and fifteen. In contrast to the suggested ages of fusion, the majority of the recorded fusion of the posterior part of the atlas were fused by the age of one, with only one unfused as late as three years. The fusion of the anterior arch of the atlas appears to be occurring between the ages of two and six years (Figure 8.47).

Figure 8.47: Fusion of the atlas.

ant-na UF: anterior arch to neural arch is unfused; FS: is fusing; F: is fused.

For the atlas the fusion of the neural arches to the centrum occurred between two and six years of age, beginning earlier than suggested by Scheuer & Black (2000b). For the cervical vertebrae the fusion was occurring between the ages of two and six years (Figure 8.48). For the thoracic and lumbar vertebrae (Figure 8.49 & Figure 8.50) this started slightly earlier at the age of one year in the case of two individuals and, although the majority of fusion was complete by age seven, some elements were still recorded as fusing up to eleven years and nine years respectively. However, the elements were recorded as fusing when the parts were separate, but it could be seen that the bones had begun to fuse together, and when the bones were fused together, but a distinct fusion line was still obvious between the two elements.

Figure 8.48: Fusion of the cervical vertebrae.

Figure 8.49: Fusion of the thoracic vertebrae.

Figure 8.50: Fusion of the lumbar vertebrae.

The fusion of the dens to the neural arches occurred around two to six years of age, with one individual vertebra still in the process of fusing at age nine. The fusion of the dens to the central part occurs around four years of age until about nine years, with a few individuals still fusing at age ten, and one at age fourteen years.

8.6.6 Non-metric traits

Cranial non-metric traits were scored for the sub-adults from the three sites and some of the traits which showed presence are presented in Table 8-67 and Table 8-68.

Table 8-67: Cranial non-metric traits (midline).

Taunton	N	present	absent	% present
metopic suture	39	10	29	26
apical bone	20	0	20	0
Inca bone	40	1	39	3
Gloucester	N	present	absent	% present
metopic suture	35	17	18	49
apical bone	13	0	13	0
Inca bone	29	0	29	0
Canterbury	N	present	absent	% present
metopic suture	53	11	42	21
apical bone	45	8	37	18
Inca bone	68	1	67	1

N: number of individuals scored; apical bone also known as ossicle at Lambda.

The appearance of many non-metric traits is related to age and therefore some traits such as the metopic suture and sutura mendosa will always be present in young children, whereas some will not be seen. The majority of metopic sutures scored were in young individuals around two years of age. The metopic suture was still present in two six year olds, one seven year old and two nine year olds; it was scored as absent in children as young as one year of age.

The apical bone appears to be present early on in the development of the individual; it was scored as present in children from the age of one up till nine years. Therefore, it seems that the presence of this extra skull bone is not related to age. The presence of one or more lambdoid ossicles appears to have no relationship to age, with individuals showing presence between the ages of one and fifteen years.

Frontal grooves also seemed to have no age relationship and were scored in individuals ranging from birth to ten years, and neither did the supraorbital foramen or notch

(although presence is more subtle in young children than in adults), with ages scored as present ranging from birth to nine, and one to eleven years respectively. The presence of more than one zygomatic facial foramen was present in individuals from one to fifteen years.

Only three individuals had more than one mental foramen present, their ages being one year, two years and fifteen years. The sutura mendosa is related to age with it being present in all young infants and being a trait, like the metopic suture, that can persist into adulthood. All the individuals scored for this trait were four years or younger.

Table 8-68: Cranial non-metric traits (sided).

Taunton	N Left	P Left	% Left	N Right	P Right	% Right
frontal grooves	22	8	36	19	6	32
supraorbital foramen	25	3	12	26	2	8
supraorbital notch	23	6	26	25	5	20
zygomatic foramen	43	15	35	43	11	26
lambdoid ossicle	8	5	63	8	5	63
sutura mendosa	13	2	15	9	2	22
mental foramen >1	48	1	2	45	1	2
Gloucester	N Left	P Left	% Left	N Right	P Right	% Right
frontal grooves	23	4	17	21	4	19
supraorbital foramen	26	1	4	24	2	8
supraorbital notch	26	3	12	24	2	8
zygomatic foramen	32	14	44	28	8	29
lambdoid ossicle	5	4	80	5	3	60
sutura mendosa	21	9	43	19	8	42
mental foramen >1	39	0	0	36	0	0
Canterbury	N Left	P Left	% Left	N Right	P Right	% Right
frontal grooves	32	3	9	35	2	6
supraorbital foramen	37	2	5	34	3	9
supraorbital notch	39	6	15	37	4	11
zygomatic foramen	44	8	18	41	13	32
lambdoid ossicle	22	11	50	18	9	50
sutura mendosa	24	6	25	32	5	16
mental foramen >1	76	0	0	79	1	1

N: number scored; P: presence of trait; %: percentage present (true prevalence rate).

Table 8-69: Postcranial non-metric traits.

Taunton	N Left	P Left	% Left	N Right	P Right	% Right
third trochanter	50	4	8	49	4	8
tibia sq. facets medial	7	0	0	7	0	0
tibia sq. facets lateral	8	5	63	6	2	33
septal aperture	41	2	5	39	1	3
supracondyloid process	48	0	0	43	0	0
preauricular sulcus	48	0	0	50	0	0
vastus notch	8	0	0	11	0	0
Gloucester	N Left	P Left	% Left	N Right	P Right	% Right
third trochanter	46	0	0	43	1	2
tibia sq. facets medial	3	0	0	3	0	0
tibia sq. facets lateral	3	0	0	3	0	0
septal aperture	35	1	3	32	1	3
supracondyloid process	44	1	2	39	0	0
preauricular sulcus	37	2	5	39	2	5
vastus notch	1	0	0	0	0	-
Canterbury	N Left	P Left	% Left	N Right	P Right	% Right
third trochanter	68	4	6	61	2	3
tibia sq. facets medial	4	0	0	5	0	0
tibia sq. facets lateral	3	0	0	4	0	0
septal aperture	67	1	1	61	0	0
supracondyloid process	74	0	0	74	0	0
vastus notch	7	1	14	5	0	0

N: Number scored; P: presence of trait; %: percentage present (true prevalence rate).

Some of the postcranial non-metric traits (Table 8-69) appear to be related to age whilst others do not. A third trochanter was present on 12 individuals ranging from age two up to age 14 years. This therefore appears to be an early appearing trait. In contrast squatting facets do not appear until an individual is of an older age. Only lateral squatting facets scored as present in five individuals, all from Taunton. All were at least eight years of age, and this is due to the development of the distal tibia preventing the scoring of this area until around this age.

A septal aperture was present in five individuals, with the youngest aged between five and eight years from bone maturation. The rest were all 10 years or over. Only one supracondyloid process was seen in an eight year old from Gloucester. A preauricular sulcus was scored in two individuals, again both from Gloucester, and aged six and eleven years. This trait can be used as an aid to sexing (Buikstra and Ubelaker 1994), although the presence of this trait is seen in children and occasionally in male

individuals (Dawson 2004), and therefore suggests it should not be relied on without other evidence. Bruzek (2002) has noted that the morphology of the sulci present on males and females is different, the former relating to general skeletal robusticity and the latter to obstetrical trauma, and has created three steps of visual recording to aid in a more rigorous method of identification of sex using this trait.

A vastus notch was seen in one individual a ten year old from Canterbury. Most patellae present were of individuals aged seven or over, although two were from children under two years old. No atlas with a double articular surface was seen and no posterior or lateral bridges were present on any, this may indicate that these traits appear with age. Another trait which was not present was sacral accessory facets, indicating that this trait may also appear with age.

8.7 Other pathologies

A few other pathologies, not recorded as stress indicators, were noted on analysis and are presented below. Very little pathology was seen on any of the sub-adult skeletons, and the lack of lesions indicates that the types of diseases that led to the majority of children's deaths were probably rapid and therefore the disease present could not be expressed on the skeleton by the time of death.

8.7.1 Congenital conditions

Skeleton 2068, from Area 4 of the Taunton cemetery, has a bifurcated first rib (see Appendix I, Figure I.26). Bicipital ribs consist of two ribs that have fused together to form one rib, but they still retain two proximal articulations (Mann & Hunt 2005, 115); bifurcated ribs have one proximal articular end. Skeleton 2010 from the same area has an axis with a lack of fusion of the posterior synchondrosis (see Appendix I, Figure I.27) and the atlas, although fused, has a deep pit in the same area. Skeleton 1620, from Area 1 of the Taunton cemetery, has a very small right auditory meatus with thickening of the bone of the inferior portion (see Appendix I, Figure I.28). There is no evidence of any bone growth indicating infection, and it is possible that this is a congenital condition. The reduced size of the external auditory meatus may have led to a hearing impairment in this individual in the right ear; the left side is normal. Skeleton 914, a child burial from within the nave of the church at Taunton, has a reduction in size of the first rib, which is very thin and small for the age of the child.

Congenital conditions seen at Gloucester mostly involve the spine. Skeletons 129 and 42 both have sacralisation of the fifth lumbar vertebra (see Appendix I, Figure I.29). Skeleton 171 has an extra lumbar vertebra which has also sacralised. Sacralisation is where the most inferior lumbar vertebra (usually fifth) is fully or partially fused to the sacrum. Skeleton 346 has a lumbarised twelfth thoracic vertebra. Lumbarisation is where the first sacral element has shifted cranially in development and therefore resembles a lumbar vertebra (Mann & Hunt 2003, 117).

At Canterbury, SK 25 has a small rib associated with the first lumbar vertebrae. Skeleton 42 has fusion of the middle and distal foot phalanges, as well as lumbarisation of the first sacral vertebra. Skeleton 253 has sacralisation of the fifth lumbar vertebra. Skeleton 286 has an atlas with the anterior arch in two portions which have not yet fully

fused in the middle. Skeleton 269 has a manubrium that consists of three segments; two of these are fused together with the third unfused (see Appendix I, Figure I.30).

8.7.2 Trauma

Only one fracture was recorded at Taunton that of a greenstick fracture to the right fibula in SK 2028, aged 15 years of age (see Appendix I, Figure I.31). Skeleton 346, from Gloucester, around 16 years of age, has collapse and kyphosis of the thoracic spine involving five thoracic (T) vertebra (T6-T10 see Appendix I, Figure I.32). The bodies of T7-T9 are fused together as are the neural arches of T8-T9. T6 shows extra sclerotic bone on the inferior side of the body, and T10 on the superior side. Most of the bodies of T8-T9 have been destroyed either by a lesion or possible fracture. There are several possible diagnoses including Potts disease, caused by tuberculosis. However, there is no evidence of any lytic lesion, but there is near complete destruction of vertebrae T8 and T9. Scheuermann's disease causes kyphosis of the spine but would not tend to cause the destruction seen in the vertebral bodies. This deformity tends to develop in adolescence and the curvature usually affects the area of the eighth to tenth thoracic vertebra (Ortner 2003, 463). The underlying cause is thought to be due to extrusion of the nucleus pulposus material of the intervertebral disk, followed by a narrowing of the disk space, leading to growth disturbance of the end plate of the centrum (*ibid*, 464). The most plausible diagnosis is a compression fracture. The sclerotic bone may be evidence of healing and some changes can also be seen to the ribs. Three of the rib ends on the left side, and two on the right have thicker and wider articular ends than is normal, and it is likely that these ribs are those that relate to the affected area. The thickening of the rib ends may be in response to changes in loading due to the changes in the spine. Slight schmorls nodes are also present on four of the lumbar vertebrae.

8.7.3 Long bone deformities (possible rickets)

Skeleton 310, assigned as two years of age, may have suffered from rickets. Only subtle changes were noted which involve slight bowing of the long bone shafts, flaring of the metaphyses (longbone ends)⁵⁴, and flaring and porosity of the sternal rib ends. This individual also has dental defects on the deciduous canines and on the second deciduous molars (see Appendix I, Figures I.33 and I.34).

⁵⁴ No frayed appearance of the growth plate was observed on the radiograph taken (see Appendix G).

Six individuals from Canterbury have slight bowing of various long bones. None of these cases are diagnosed as definite rickets as they are all slight, and therefore a description is all that is attempted here. Skeleton 32: left humerus, SK 121: both humeri and femora, SK 184: left femur, SK 214: both ulnae, SK 631: both femora and tibiae, with a marked medial flare present on both distal tibiae, and SK 716: right femur.

8.7.4 Possible cases of tuberculosis

Skeleton 2077, from Taunton, a child aged four years old, has a circular lytic lesion on the right parietal bone at the posterior medial corner, close to where the sagittal and lambdoidal sutures meet (Figure 8.51). The lesion penetrates through both inner and outer tables as a circular hole, 10mm in diameter. Ectocranially the hole has a smooth edge and some porosity surrounds the area. The inner surface also has a larger circular area of bone destruction, 16mm in diameter with a sharp edge. This indicates that the lesion has formed from the inside. Both the larger lesion internally and the lack of reactive bone suggest this lesion to be associated with tuberculosis (Ortner & Putschar 1985). One differential diagnosis to consider is Langerhans cell histiocytosis. In the three expressions of this disease only one produces solitary lytic lesions, eosinophilic granuloma (Kaufman *et al.* 1997, 208), but, these tend to have more irregular margins (Barnes & Ortner 1997). The occipital bone exhibits resorptive endocranial lesions along the area of the occipital sulcus, covering 45mm length and 12-15mm width (Figure 8.52). These types of lesion have been associated with tuberculosis (Hershkovitz *et al.* 2002), and infections of the meninges, of which tuberculosis could be a possible cause (Lewis 2004). There are destructive lytic lesions present on the visceral surface of three rib fragments and a small area of periostitis present on one (Figure 8.53). Both lytic lesions (Ortner & Putschar 1985, 162; Mays *et al.* 2002b) and periostitis (Kelley & Micozzi 1984; Roberts *et al.* 1994; Roberts *et al.* 1998; Santos & Roberts 2001; Santos & Roberts 2006) on the visceral rib surface are seen to have an association with tuberculosis. Very similar scalloped rib lesions can be seen on SK 121, from the cemetery of the hospital of St James and St Mary Magdalene, Chichester, and these have been attributed to a respiratory infection, most likely tuberculosis (Lewis 2008, 184). There are also very slight lesions on the atlas, on the superior edge of the posterior rim, and on the axis, on the inferior edge of the lamina. Slight patches of woven bone were also recorded on both femora, posterior midshaft on the left and anterior proximal shaft on the right.

Figure 8.51: SK 2077 lytic lesion on parietal.

Photo by H. Dawson

Figure 8.52: SK 2077 lesion on occipital.

Photo by H. Dawson

Skeleton 1620, a child aged as five years old, has a lesion present on the frontal bone, just above the nasion (Figure 8.54). The affected area is circular with evidence for healing present in the form of rounded nodules of bone within the central portion. A single pinprick perforation penetrates both the inner and outer table, and on the

endocranial surface there is some concavity. This is the same individual mentioned earlier that exhibits an unusually small opening to the auditory canal, with thickening of the bone on the inferior side. There is no evidence for any active infection.

Figure 8.53: SK 2077 pathology on ribs.

Figure 8.54: SK 1620 lesion on frontal bone.

The lesions on the skeletons of both SK 2077 and SK 1620 may represent new evidence of tuberculosis within children from the late medieval period. Previous cases have been described by Stroud (1993), involving rib lesions (2 individuals); Conheaney (1997),

involving lesions of vertebral bodies (one individual), and Mays (2007), involving periostitis on the ribs and leg bones and resorptive lesions on the occipital (one individual). The latter example has also tested positive for the presence of *Mycobacterium tuberculosis* DNA (Mays *et al.* 2002b); although this was only one of four sub-adults with similar rib lesions to prove positive. Care therefore needs to be taken with any diagnosis of tuberculosis from rib lesions, in both young children and adults, as the cause may be due to other respiratory disease. For SK 2077 tuberculosis does seem to be the most likely cause for the range of lesions seen on this skeleton. The diagnosis for SK1620 is far more tentative as no postcranial lesions are present.

Skeleton 796, from Canterbury, aged eleven years old, has destructive lesions present on the fourth and fifth lumbar vertebrae; with no collapse (see Appendix I, Figure I.35). There is a “scooped out” lesion present on the anterior of the body of L4; no trabecular bone remains visible within this deep pit. A second smaller lesion is also present on the right side of the anterior portion of the body but the area is damaged. Most of the anterior portion of the centrum is damaged on L5, but a similar shallow scoop can be seen on the right anterior portion which survives. No other lumbar vertebrae are present. The rest of the remaining ribs and the thoracic vertebrae are normal. The destructive nature of the lesions could be indicative of tuberculosis, but as only two vertebrae survive and no other lesions are present across the body it may be that some type of localised infection (abscess?) caused the lesions present.

8.7.5 Activity related lesions

Three individuals from the Taunton cemetery, SK 122 and SK 1637 from Area 1 and SK 2020 from Area 4, have lesions on the distal portion of the metaphysis of the posterior side (see Appendix I, Figure I.36). These are termed distal cortical excavations and are thought to be linked to repeated pulling stresses or acute trauma to the gastrocnemius muscle (Mann & Hunt 2005, 173).

Four individuals from Taunton have a deep pit on the inferior side of the clavicle at the area of attachment of the costoclavicular ligament. Two involve both sides, for SK 327 and SK 2023, whilst SK 101 and SK 2007 only have the right side affected (see Appendix I, I.37). Sometimes called the rhomboid fossa it has been classed as a normal anatomical variant but may be aggravated by activity of the dominant hand or arm (Mann & Hunt 2005, 138).

Four individuals from Canterbury have pits at the costoclavicular area on the clavicle. Skeleton 201 has a small pit on both left and right clavicles, SK 607 a deep pit on both clavicles, and SK 23 and SK 26 have marked pits on the right clavicle. Skeleton 389 has a prominent area of bone on the left clavicle. Skeleton 960 has a prominent area of bone on both femora at the site of the lesser trochanter. Skeleton 801 has a markedly more robust right humerus than the left, and a marked deltoid attachment area (see Appendix I, Figure I.38). Two individuals, SK 716 and SK 1095, have markedly robust mandibles for their age and both also have severely worn teeth.

8.8 Summary

This chapter has presented the results under several section headings, each related to a different aspect of evidence available from the analysis of the skeletal remains and the funerary context. Chapter Nine will follow on to discuss the interpretations of these results and how they can contribute to the understanding of the status of late medieval children, in terms of burial practice, and of the health and growth of sub-adults from the populations analysed.

To summarise, children are an important portion of the populations from all three cemetery sites. The demographic profiles for Taunton and Canterbury are similar, whilst at Gloucester many more preterm and neonate burials were recovered. Adults were more likely to be buried within church buildings, but young children were often buried close to church buildings.

The position of sub-adult skeletons is very uniform and more so than that of adult burials, but some subtle variations are seen, both within and between the three sites. Sub-adult graves tend to be slightly shallower than those of adults, and neither group tended to be laid to rest with grave goods or within coffins.

The preservation of infants is very good from all three sites, and the sub-adult burials are as well preserved, if not better, than the adult burials from Taunton. The presence of on-site specialists appears to contribute to the recovery of more small bones, and therefore possibly the recognition of more infant bones. Burials situated closer to the church were more likely to be partial, having been inter-cut by later burials, and this may cause problems if, as suggested at Taunton and Gloucester, infants are more likely to be buried here.

Deciduous dental wear is an unexplored piece of information, both in terms of children's diet and as a potential method to aid with assigning age. The low rates of wear on the church burials indicate that the rich may have had a less coarse diet, whilst the higher rates, in general, from Gloucester may indicate that coarser foods were more common in the earlier part of the period.

Data on the stress indicators suggest, contrary to some other studies (Bennike *et al.* 2005; Pechenkina & Delgado 2006; Craig & Buckberry 2010), that it may be the higher status sub-adults that tend to have a higher presence of stress indicators, such as cribra orbitalia, enamel hypoplasia and periostitis (in the form of woven or lamellar bone growth). However, as Wood *et al.* (1992) have discussed, these results are not that unexpected. It may be the advantaged group (in terms of status) that often survive the stresses of childhood illness and therefore go on to exhibit the lesions associated with stress. The less advantaged children may die quickly from childhood stress or illness before the skeleton has had the time to acquire any pathological lesion; '*better health makes for worse skeletons*' (Wood *et al.* 1992, 356). Sub-adults also tend to have higher prevalence rates of stress indicators than the adult population. Growth does not appear to be adversely affected by the presence of stress indicators, and little evidence was forthcoming that lower status individuals may have reduced rates of growth. Pathological conditions were rare on the sub-adult population in comparison to the pathology present on the adult populations (Dawson & Robson Brown in prep.). Two individuals indicate tuberculosis; it is likely that infectious disease would have been common in the past and that many children probably would have died from some type of infectious disease which did not have the time to make its mark on the skeleton.

Chapter 9 : Discussion

9.1 Introduction

The aim of this thesis has been to explore the status of children in late medieval English society. The approach has been mainly an osteoarchaeological one, used in conjunction with an analysis of the funerary context alongside a review of previous works, by both archaeologists and historians, on the role and status of children. The importance of using all of these sources to progress a discussion on late medieval children has been made clear throughout this thesis. The skeletal remains that we recover on archaeological excavation are the closest link that we have to the people that lived and died in the past. These remains were once the living children that experienced life in the period, and the information that we can glean from them is invaluable to further our knowledge on how they lived, and how they were treated by society when they died at a young age. Exploring how they were treated after death, from the burial archaeology, will give us an insight into the medieval mind, and how parents, the church, and society in general felt about the death of these children who, in an ideal world, should have had the opportunity to become adults. The three sites analysed by the author have provided a wealth of new information, and a review of other published cemetery sites has been used to put the author's results into context. Historical documents of the period are numerous, and although records relating to children, especially children of the ordinary working people, may be scarce, the research undertaken in this field (Demaitre 1977; Hanawalt 1977; Shahar 1990; Gordon 1991; Finucane 1997; Orme 2001) has shown how, in essence, children in late medieval society were not that different to children today. Details of children depicted on burial monuments, and the passionate pleas of parents to Saints when death or injury occurs, have also shown that parents undoubtedly loved their children, although being able to care for them adequately may have often been hard. The following discussion will begin with a short review of the previous chapters and will then bring together some of the ideas and interpretations that have materialised whilst researching the subject.

9.2 Chapter Review

In Chapter Two it was posited that to undertake research into the status of late medieval children the skeletal remains of those children need to be analysed alongside the evidence for burial practice. Ideas about what constitutes a child were discussed and how "childhood", although generally associated with being a child, is a fundamentally

different concept. Reference was made to ethnographic examples which indicated the universal development of children as well as the different roles and responsibilities that children from different cultures and societies are assigned.

In Chapter Three the role of children in late medieval society was explored through a range of sources, from archaeological to historical, from burial monuments to works of art. Children could be found in many sources, and the conclusion from this research is that they were not neglected in the medieval mind, nor were they merely perceived as small adults, as Ariès (1996) had postulated. The stages that were assigned to children in medieval writings were outlined in this chapter. These stages were later chosen for the presentation and exploration of the data collected from the three sites analysed by the author. There appears to be no standard method used by researchers for assigning age ranges to sub-adult remains; different osteoarchaeologists use different groupings and, as can be seen in Appendix A, this can make it difficult to compare data between sites analysed by different authors. For the late medieval period in Europe there are historical writings which define different stages in a child's life and link these with the age of the child. Therefore, as the premise was to discover information about the status of children in late medieval society, it made sense to use these age ranges when presenting and analysing the data, as these ranges may already have some connection with how children were viewed in the past. For other periods, especially prehistoric ones, it may be more difficult to decide on a set of age ranges deemed applicable. Studies on the funerary context, especially the placement of grave goods or position of burial, may suggest the possible stages in children's lives assigned by different cultures at different temporal locations. Stoodley (1999; 2000) reviewed the artefacts found in children's graves in the early medieval period, which led him to suggest age thresholds; when the child reaches a certain age they have a different set of grave goods. These thresholds could relate to different stages in a child's life as defined by their society. It would be useful to future studies if osteoarchaeologists reviewed the evidence on age differences from archaeological and historical sources and presented their age data in a more contextually specific way. Gowland (2006) has suggested using a "life course" approach when analysing age within skeletal populations, to allow for more fluid shifts in identity and status over time. However, she concedes that age ranges still need to be assigned to sub-adults for data analysis, and she uses the same age ranges for her work

on late Romano-British (Gowland 2001) and early Anglo-Saxon children (Gowland 2006).

Chapter Four discussed the evidence for past populations both in terms of the palaeodemography of late medieval cemetery populations and historical sources for family size. The problems inherent in any study which aims, to elucidate meanings about the living population from the dead were discussed, alongside the problems that taphonomic and excavation biases can lend to interpretations of the data. Archaeological and historical evidence for burial practice within the period, particularly relating to children, was explored, suggesting subtle variation in traditional Christian practice. This may translate to ideas about the afterlife not necessarily adhered to by the Church, such as the placing of objects with the body.

In Chapter Five, the types of pathologies that can be recognised on the skeletal remains of children were discussed, and how these may relate to periods of stress through lack of required nutritional needs and episodes of infectious disease. The aetiology of these markers is not always clear but it is agreed that some type of stress, whether in the form of nutritional deficiency, infectious or parasitic disease, appears to be the cause. The dentition was also discussed in terms of how dental wear rates and caries may also aid in our interpretations of diet and status.

In Chapter Six information about the three cemeteries and the towns within which they were located were presented, along with details of the excavations and the plans of the sites. The socio-economic status of the towns and how this may relate to the status of the cemeteries was also noted. To elucidate the status of a particular burial ground, or even areas within that burial ground, is not necessarily a simple endeavour. Whilst burial within the church is obviously reserved for those of high status, who can afford such a privilege, the location of higher status areas within cemeteries does not appear to be so clear cut. The area to the north of the church has traditionally been seen as a low status area, on the dark side of the church, but, burial close to the church may be more desirable than burial in a southern location further away. Some excavations including that at St Oswald's priory in Gloucester have produced high numbers of infant burials from the north side; however, other cemetery excavations (St Helen-on-the-Walls) have not. It is clear from the cemetery plans presented in Chapter Six that children are located in all the available excavation areas and are dispersed alongside the adult members of

the community. As members of the Christian Church all were seen to be equal in death, and it should not therefore surprise us, in theory, if children and adults received the same burial treatment.

Chapter Seven focused on the methods used for this analysis, and why certain methods were chosen over others. The revised method, created by the author, designed for recording dental wear on the deciduous teeth was described in detail. The encouraging results from intra and inter observer tests (Appendix C), suggest that this method could have the potential to be adopted by other researchers in the future. It is a method that is simple to use and does not require the use of any equipment or additional software. It is precisely this simplicity that could lead to the regular recording of deciduous dental wear on sub-adult remains, which could be included as part of the standard data collected for general human remains reports produced by archaeological units.

In Chapter Eight the results from this study were presented, and for the remainder of this chapter a discussion of these results will follow to expand upon some of the ideas and interpretations suggested previously.

9.3 Interpretation of results

Twenty-five research questions were outlined alongside proposed hypotheses in Chapter One. The interpretation of each of these questions using the results presented in Chapter Eight will be discussed in this section.

9.3.1 Demography

Question 1: Is there a difference between the distribution of sub-adult and adult burials by site?

H_0 : The number and distribution of sub-adult and adult individuals are equal across sites.

H_1 : The number and distribution of sub-adult and adult individuals are not equal across sites.

For the Taunton population from the 2005 excavation there is a fairly equal distribution (93 sub-adults and 97 adults) of sub-adult and adult burials. The 1977 excavation recovered fewer sub-adult burials but more adults (58 and 96 respectively); the overall ratio of the recovered skeletons from both excavations is 1: 1.3. At Gloucester the adults also outnumber the sub-adult burials recovered (76 sub-adults and 151 adults), for every sub-adult there are two adults (a ratio of 1: 2). At Canterbury from the excavation of the church and cemetery 316 sub-adults and 929 adults were recovered, a ratio of 1: 2.9. From all three sites the number of adult burials recovered is higher than those of sub-adult individuals. The difference is small from the Taunton 2005 excavation with nearly equal numbers of sub-adults and adults, but including the 1977 data gives a ratio of 1: 1.3 sub-adults to adults. The difference in distribution is large at Canterbury with nearly three adult skeletons recovered for every sub-adult. In general H_1 appears to be true, the number and distribution of sub-adult and adult individuals are not equal across sites. The data collected from other published sites (Appendix A) agrees with this statement. However, the difference in sub-adult to adult ratio from the two separate excavations at Taunton shows that different results can be obtained from partial excavations of the same cemetery.

Question 2: Is there a difference between the distribution of sub-adult age ranges by site?

H_0 : The number and distribution of sub-adult age groups are equal across sites.

H_1 : The number and distribution of sub-adult age groups are not equal across sites.

As seen in Chapter Eight (Figures 8.6 to 8.8) the distribution of the sub-adult age ranges for Taunton and Canterbury are very similar with the two to seven year age range showing the highest percentage rate. The same can be seen at the sites of Wharram Percy and St Helen-on-the-Walls, Yorkshire, and at St Mary Magdalene, Chichester (see Appendix A). However, if the individuals aged between 12 and 20 years had been analysed at Canterbury the percentage of this age group would have been much higher than at the other two sites (see Figure 8.5). At Gloucester there are a much higher percentage of infants present who died around birth, and therefore lower numbers of older children. Therefore H_1 appears to be true, the number and distribution of sub-adult age groups are not equal across sites.

Question 3: Is there a difference between the distribution of preterm and neonate burials by site?

H_0 : The number and distribution of preterm/neonate individuals are equal across sites.

H_1 : The number and distribution of preterm/neonate individuals are not equal across sites.

Three times the number of preterm and neonate burials were recovered from Gloucester, than were recovered from Taunton or Canterbury, mostly from an area to the north of the church. They account for 32% of the sub-adult remains analysed from Gloucester. Taunton also has a fairly high percentage of preterm or neonate infants recovered (6% of the sub-adult population), at Canterbury this group makes up 7% of the sub-adults analysed, but if individuals over 12 years of age are included they would only be 2%. Of the published sites in England with at least 50 sub-adult individuals recovered, listed in Appendix A, Wharram Percy has the highest percentage of neonates (10%), whilst for the other sites where this data is available the number tends to range between 1-3%. H_1 appears to be true, the number and distribution of preterm/neonate individuals are not equal across sites.

The nature of archaeological excavation dictates that not all of the areas of a cemetery will usually have been excavated. If young infants tended to be buried in close proximity to each other, it may be that this area was excavated at Gloucester, but was not uncovered at Taunton or Canterbury. Both priory churches at Taunton and Canterbury had other buildings extending to the north of the church, so this area could not have been used for burial. It is therefore not the lack of excavation in this area at

Taunton and Canterbury that is causing the contrast between Gloucester and the other two sites.

One reason that Gloucester infants were in higher numbers could be due to better preservation at this site. Although this has been shown to be true, all of the sites were seen to have good preservation of very young infants and is, therefore, not the reason for the higher numbers recovered here. Both the cemeteries at Taunton and Canterbury have a great deal more inter-cutting of graves than appears to be seen on the plans from Gloucester. This heavy use of the cemeteries would undoubtedly cause disturbance to infant burials which may have been buried in slightly shallower graves. The majority of the preterm and neonate skeletons from Gloucester were recovered from a single context (described as a pit); it is likely that this pit of burials was dug deeper than a grave for a single infant inhumation. This may explain the low numbers of infants at Taunton and Canterbury if burials tended to be single, rather than multiple, for stillbirths.

When an adult grave is disturbed, a portion of the body will often remain intact, even if this is only the lower legs, and the individual will still be identified as an articulated burial on excavation. If an infant grave is disturbed, the whole skeleton will most likely become disarticulated and therefore be less likely to be identified and recovered or, if recovered, it will be less likely to be reported,⁵⁵ leading to a reduction in the numbers of infants for each site. The disarticulated material from Taunton is still awaiting analysis, but, from the authors knowledge of the excavation and curation of the remains, it is known that there is a great number of sub-adult remains, including infant bones, within this collection.

The majority of the Gloucester burials are thought to be slightly earlier in date than those of Taunton and Canterbury (see chapter Six for dating of the burials), and it may be that burial practices had changed over time, and that burial of very young infants may have been carried out with more care in the earlier period. Geographical differences may also play a part in different burial traditions and, although all burials

⁵⁵ disarticulated material can get neglected, and often never makes it into the final published report for a site.

are of homogenous Christian practices, local communities may have retained some influence from traditional practices.

There are records that unbaptised children, and therefore those that died at birth or were stillborn, may not have been buried within consecrated ground (Shahar 1990; Orme 2001). This could account for the small numbers of preterm/neonate burials at Canterbury and Taunton. The higher numbers at Gloucester may indicate a more lenient religious house, or the illicit burial by the members of the local community. The fact that many of these individuals were located together in pits may suggest the latter, although communal burial for neonates may have been practiced for other reasons. Scott (1999) notes that some modern cemeteries, in use today, have a special burial ground for stillborn infants; at Milton cemetery, Portsmouth they are buried six to a grave. This example sounds not dissimilar to a communal burial pit for the Gloucester infants. The evidence for infant burial outside cemeteries is also almost non-existent, implying that this is unlikely to be a reason for a lack of infant burials, unless other disposal methods were in use such as exposure.

The majority of preterm/neonate burials are in the range of 38-40 weeks gestation at both Gloucester and Taunton. At Canterbury there is a higher percentage of burials that fall with the 41-43 week age range. The numbers are however small and could merely indicate the coincidence of excavating infants from overdue births, or they may indicate that the life of the newborn was more precarious in Canterbury than at the other two sites.

Question 4: Is there a difference between the distribution of sub-adult and adult burials by burial location?

H_0 : The number and distribution of sub-adult and adult individuals are equal by burial location.

H_1 : The number and distribution of sub-adult and adult individuals are not equal by burial location.

This question was tested for the Taunton population where some statistically significant differences were seen. Adults were more likely to be buried within the church, whilst sub-adults were more likely to be buried within the 10m proximity zone to the church than adults. On excavation it was noted that there were few children buried within the church, and that a majority of children were seen in the area directly to the west front of

the church. The other two areas excavated, slightly further from the church to the west, showed similar numbers of children and adults distributed across these areas, with slightly more children present to the north of this area. However, the only burials recovered from beyond the extent of the supposed boundary ditch of the cemetery were of adult males (see Figure 6.11). As noted in Chapter Four, burial outside the cemetery area is often cited as a place for unbaptised infants, the excommunicated, and suicides. It is interesting to wonder why these three individuals were buried here; one of these was SK 2203 who was covered by a charred plank. Whether this was a high status coffin burial, the incorporation of a reused piece of wood for a cheaper coffin, or a marker so the grave was not disturbed, is open to interpretation. The use of a marker may have been required so that the grave was not disturbed, possibly due to a sudden strange death, or as a means of warning against some infectious disease such as the Black Death; the liminal situation also suggests exclusion for some reason. Therefore H_1 appears to be true, the number and distribution of sub-adult and adult individuals are not equal by burial location

The comparison of the 1977 Taunton excavations to the data collected for the 2005 excavation shows many differences. The 1977 excavation focused on an area to the south of the 2005 excavation, where no preterm or neonate burials were recovered. The majority of children recovered were in the two to seven year age range, as they were for the 2005 excavation. However, many older children, over 12 years of age, were recovered. Males and females were found in more equal numbers than from the 2005 excavation. This area had much less disturbance from inter-cutting burials and may therefore be suggested to be a less desirable place of burial, compared to the areas excavated in 2005; it is also further from the church. However, it may be that it is a later area of burial brought into use once the area near the church had become too crowded; no evidence for burial prior to AD 1350 was recovered from this excavation.

Question 5: Is there a difference between the distributions of sub-adult age ranges by burial location?

H_0 : The number and distribution of sub-adult age groups are equal by burial location.

H_1 : The number and distribution of sub-adult age groups are not equal by burial location.

The question of whether the age range within which a child was assigned had any influence on location of burial was explored by grouping the children in a way that mirrored the evidence of how child stages were assigned in the late medieval period. It was seen that infants (including neonates and those up to two years of age) tended to be buried close to the church at both Taunton and Gloucester; this is in agreement with the observations at other church excavations (Boddington 1996; Mays 2007). The older age ranges tended to be located further from the church, beyond the 10m zone. However, at Canterbury the reverse was seen, with infants more likely to be recovered from over 10m away from the church, and the older children within the 10m zone.

The high number of preterm/neonate burials at Gloucester came from the area to the north of the church, this area at Taunton and Canterbury was occupied by other priory buildings. Mays (2007) states that sub-adults were more likely to be buried to the north of the church, and in close proximity, than adults but, at St Helen-on-the-walls the north-west area contained high status adult burials and the sub-adults tended to cluster to the south-west (Dawes & Magilton 1980). The evidence suggests that H_1 is true, the number and distribution of sub-adult age groups are not equal by burial location.

When trying to study the burial practices of different communities, although closely linked by time period, religious institution, and socio-economics, it cannot be assumed that these communities will have the same practices; local traditions will undoubtedly be deep rooted and play a role. Therefore, some differences in burial practice between different communities within England during the period should be expected. The fact that the cemetery at Canterbury was closely associated with the nearby hospital, and appears to have had a policy of free burial for the poor, may indicate a slightly different dynamic in burial location for certain sectors of this community.

No attempt was made to assign sex to the sub-adult remains for this research, and no standard well tested method is yet available using metrical or morphological criteria. The historical records and burial monuments discussed in Chapter Three, gave contradictory information on the number of male and female children present in families. The records all refer to many more boys than girls, whereas a basic count on the brasses recorded for Gloucestershire had slightly more female than male children depicted. However, as discussed previously, boys, like men, were probably more likely to be written about and mentioned in records than girls or women. The depictions on

brasses probably give a more representative account of the male to female ratios amongst offspring, albeit from wealthy families. The ratios of the adult males and females from the three sites show a higher ratio of males at all of them; this is seen at many cemetery excavations of this period (see Appendix A). The reason for this difference in sex ratios in the skeletal remains recovered is hard to determine. Most of the sexually dimorphic features of the skull are based on robusticity, the male being more robust. However, coarse diets will generate more robust skulls, and post-menopausal women tend to become more robust in the facial area (Mays & Cox 2000: 125). Therefore, some females, especially older females, may be being mistakenly sexed as male, when analysing partial skeletons means the whole suite of sexing methods can not be used. Those skeletons classed as indeterminate or of undetermined sex may also be more likely to be females. Although this may account for some of the missing females from excavated cemeteries of the period, it does probably not account for them all. As discussed in both Chapters Three and Four, there is no real evidence that infanticide was practiced in the period. However, the fact that males were probably cosseted more than females, possibly leading to the neglect of female children over their brothers, is indicated in some of the historical sources, such as earlier weaning of female children (Demaitre 1977). This is something that could be tested using isotope analysis if, in the future, sub-adult remains could be accurately sexed.

9.3.2 Funerary Context

Question 6: Is the placement of the body for burial similar for sub-adults and adults?

H_0 : There is no difference in the placement of the body for burial between sub-adults and adults.

H_1 : There is a difference in the placement of the body for burial between sub-adults and adults.

Some differential treatment between the burial of adults and children was seen. The most common burial position for sub-adults from both Taunton and Gloucester was to be laid supine with arms placed by the sides (position A). This also appeared to be the case for Canterbury, but the lack of full plans for the skeletons meant that the accuracy of arm placement was uncertain. For adults, from Taunton, the majority were laid with their arms across the stomach area of the body (position C). This subtle variation does suggest a possible link in arm position to status. Young infants also tended to have their

legs slightly flexed, in what appears to be a more natural position. None of the sub-adults from Taunton had their arms across the chest area, whilst seven adults did. One seven year old from Gloucester (SK171) had their arms laid across the chest; they were buried within the church. H_1 appears to be true; there is a difference in the placement of the body for burial between sub-adults and adults.

Three double burials were excavated at Taunton, and one from Canterbury; none were recorded at Gloucester. None involved adults, and these four examples also tended to involve children of similar ages, the only exception being the oldest child involved, aged ten years, buried with a five year old. The reasons for placing two children together in a single grave may be for monetary reasons, involving less cost. It may also have been easier emotionally for parents of the same community, possibly friends or relations, to bury two children together if they died around the same time. They could also represent siblings who had both died of the same disease; this could be resolved by testing for any surviving DNA in the bones.

Question 7: Is the presence of evidence for coffins similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for coffins between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for coffins between sub-adults and adults.

The burial of the three year old child, within the church at Taunton, in a coffin indicates that even young children could be deemed of sufficiently high status to receive such a burial; only one other sub-adult was buried within a coffin from Taunton. However, only 13 adults had definite evidence for coffined burial at Taunton so, although more adults would have been buried within a coffin, the majority of both children and adults would have been buried in a simple shroud. At Gloucester six sub-adults had evidence for coffin burial, whilst no solid evidence was seen at Canterbury. The presence of coffin evidence could not be tested statistically and it is therefore more problematic to decide which hypothesis best fits the data in this case, adults are probably more likely to be buried within a coffin, but most individuals, both sub-adults and adults, appear to have received an uncoffined burial and H_0 is therefore more likely.

Question 8: Is the presence of evidence for grave goods similar for sub-adult and adult burials?

H_0 : There is no difference in the presence of evidence for grave goods between sub-adults and adults.

H_1 : There is a difference between the presence of evidence for grave goods between sub-adults and adults.

Grave goods were sparse at all sites, as would be expected. Fourteen sub-adult individuals from Taunton had some evidence for copper alloy artefacts associated with them in the form of the metal itself, or staining on the skeleton, compared to 24 adults. No other grave goods were noted with the sub-adults and few were seen with the adults. Any difference between the presence of grave goods for sub-adults and adults could not be tested statistically and therefore H_0 appears the most likely hypothesis from the evidence presented for Taunton.

Two ash burials, and two burials involving charred planks, were seen for adults at Taunton. At Gloucester one charcoal burial involved a two year child, and another had some charcoal around the stomach area of an eight year old. Thirty-one charcoal burials of adults were seen at Gloucester, but the majority were dated to AD 900-1120 (Heighway & Bryant 1999); those associated with children are therefore late examples of this practice. At Canterbury one burial, of an elderly male, was associated with a portion of burnt wood at the foot end, but this may have been a burnt piece of wood reused for a coffin. The ash burials from Taunton and the charcoal burials of Gloucester appear to be related to two different rites (Gilchrist & Sloane 2005, 120). Charcoal burials tend to be the earlier rite and involve lining the grave cut with black charcoal, as is seen at Gloucester. The ash burials tend to be associated with coffins, with the ash being placed in the base of the coffin. There is also a difference in the type of material that goes into the grave or coffin, with that of charcoal burials tending to be "clean" (Holloway 2010, 87), whereas, the ash burials from Taunton involved inclusions of animal bones, grains and pottery. Gilchrist (2008, 145) suggests that these ashes represent the rakings of domestic hearths and that they range in date from the late thirteenth to the mid fifteenth century. Functional explanations for both charcoal and ash have been suggested such as being used to absorb bodily fluids (Hadley 2001, 99), perhaps indicating a delay in burial. It may have been believed that the charcoal or ash would prevent further decay or, in the case of charcoal on the top of burials, that it would act as a marker to avoid inter-cutting of burials; the charred plank over SK 2203

from Taunton may be for this reason. Links have also been made to the symbolic association of ash with penitence (Hadley 2001; Holloway 2010). Daniell (1997, 158) even suggests that the charcoal or ash may form a kinder resting place than the cold earth. In general, due to the extra effort involved, most authors see charcoal or ash burials as high status (Heighway & Bryant 1999; Daniell 1997). However, their quite high occurrence in the East Smithfield Black Death cemetery may indicate a more practical or symbolic use associated with disease (Grainger *et al.* 2008). Some disarticulation of one of the ash burials at Taunton and a partly disarticulated burial from the East Smithfield cemetery may support the association with absorbency needed for delayed burial. More work into the details of such burials in England is needed to determine the likelihood of the reasons given for such burial inclusions.

Question 9: Does depth of burial differ for sub-adults and adults?

H_0 : There is no difference in the depth of burial between sub-adults and adults.

H_1 : There is a difference in the depth of burial between sub-adults and adults.

When depth of burial was tested statistically (for the Taunton population only) the result showed that the sub-adult individuals were recovered from significantly shallower depths than the adult individuals (see Table 8-17). Therefore, H_1 is true for the Taunton population; there is a difference in the depth of burial between sub-adults and adults.

9.3.3 Preservation

Question 10: Is there a difference in preservation and completeness of the skeleton between sub-adult and adult skeletons?

H_0 : The preservation of the remains are equal for sub-adults and adults.

H_1 : The preservation of the remains are not equal for sub-adults and adults.

The remains from the Taunton cemetery show that the adults and sub-adults have equal preservation; sub-adult remains from all sites were generally described as good and hypothesis H_0 is accepted.

Question 11: Is there a difference in preservation and completeness of the skeleton by site?

H_0 : The preservation of the remains are equal across sites.

H_1 : The preservation of the remains are not equal across sites.

All sites had high proportions of sub-adult remains recovered, although Gloucester had a significantly higher proportion of preterm and neonate skeletons than the other two sites. Significantly more skeletons were recorded as good preservation from Gloucester than the other two sites. However, no difference was seen for the percentage of the skeleton recorded as complete between the three sites. Therefore, in the case of the somewhat subjective recording of preservation as good, medium or poor, H_1 appears to be true, the preservation of the remains are not equal across sites. When analysing the completeness of the skeletons H_0 is accepted, the completeness of the remains are equal across sites.

Question 12: Is there a difference in the percentage of elements recovered from each skeleton by site or burial location?

H_0 : The percentage of elements recovered are equal across sites, and by burial location.

H_1 : The percentage of elements recovered are not equal across sites, and by burial location.

When all the skeletal elements (bones) present were tested for the three sites no difference in preservation was seen. However, when only the smallest bones in the skeleton were chosen (ear ossicles, hyoid bone, carpals and tarsals, metacarpals/tarsals, hand/foot phalanges, manubrium, sternum and patellae) a significant difference was seen. This difference showed that a higher number of small skeletal elements had been recovered from the Taunton (2005) excavation, and a lower number from Gloucester. As already proved earlier the preservation at Gloucester was very high, therefore, it is likely that it is the recovery on excavation that was not as rigorous at this site compared to that at Taunton. Hypothesis H_1 is accepted and this suggests that the presence of excavators trained in the identification of human remains will ensure that more bones are recovered on excavation than may otherwise be the case.

Question 13: Is there a difference in surface erosion on the skeleton by site or burial location?

H_0 : The surface erosion recorded on each skeleton is equal across sites, and by burial location.

H_1 : The surface erosion recorded on each skeleton is not equal across sites, and by burial location.

Overall evidence for surface erosion on the skeletons analysed was slight, however Gloucester had significantly less higher graded scores than the other two sites, once

again indicating the good preservation of the remains from this site. H_1 is accepted, the surface erosion recorded on each skeleton is not equal across sites, and by burial location.

Question 14: Is there a difference in preservation and completeness of the skeleton by age?

H_0 : The preservation of each skeleton is equal across age ranges.

H_1 : The preservation of each skeleton is not equal across age ranges.

It has been suggested that infant remains may not preserve as well as older sub-adult and adult remains (Walker *et al.* 1988; Paine & Harpending 1998). The results for this study show that neonatal remains tend to be scored as good preservation significantly more often than older children. The percentage completeness of neonatal remains was also good compared to the other age groups analysed, with only the seven to twelve year category scoring higher for recovery. This suggests that if infant remains are present and have not been disturbed in the past, then there is no reason why they should not be recovered as easily as adult remains, or those of older sub-adults.

Skeletons in the birth to two year age group were more poorly preserved than the other age groups, excluding the 12+ years category, which was the least well preserved but not recorded for Canterbury. This is in agreement with the studies on bone mineral density (BMD) cited in Chapter Four, which found that BMD tended to drop after birth and did not reach the same level until the age of two years. This could account for the lack of skeletal remains of those under two being recovered, but does still not explain the lack of recovery of preterm or neonatal remains from cemetery sites in general. As suggested earlier, this is probably more closely associated with differential burial practice, area of excavation, and even experience of the excavation team. Therefore, H_1 appears to be true, the preservation of each skeleton is not equal across age ranges. Although the highest level of preservation amongst the neonatal group and the lowest amongst the 12+ year age group is not what would be expected.

Question 15: Is there a difference in preservation and completeness of the skeleton by burial location?

H_0 : The preservation of the remains are equal by burial location.

H_1 : The preservation of the remains are not equal by burial location.

The results for the completeness of the skeleton, depending on proximity of burial to the church, may give some indication as to why infant remains are not found in higher quantities. At both Taunton and Gloucester the majority of infant remains were located close to the church buildings. However, proximity to the church did have a significant effect on the completeness of the recovered skeletons, with those located close to the church tending to be less complete than those located further from the church. Therefore, H_1 is accepted, the preservation of the remains are not equal by burial location. This is probably due to the preference of burial close to the church, and therefore a higher likelihood of disturbance. As already mentioned, if infant remains are disturbed, they would no longer be recognised as an articulated burial on excavation, even if the bones still survived, and this could lead to the lower prevalence figures for infants recorded from some late medieval cemeteries. Closer examination of the disarticulated remains, if recovered and retained, may determine if this may be part of the reason for a lack of recognisable infant burials.

As mentioned above, the smallest elements of the skeleton were often missing from the Gloucester skeletons and this is undoubtedly because they are harder to excavate due to their size, many infant bones, especially those of the hands and feet can look like small stones to the untrained eye, and poor excavation techniques and post excavation processing may lead to substantial losses of these small bones and therefore compromise the final dataset prepared by the osteoarchaeologist.

9.3.4 Dental Wear

Question 16: Is there a difference between dental wear scores recorded and burial location?

H_0 : The dental wear score of same age children is equal across burial locations.

H_1 : The dental wear score of same age children is not equal across burial locations.

Some evidence that rates of dental wear may be influenced by burial status was seen when analysing the difference between church and cemetery burials. For five of the ages analysed, the teeth of individuals buried within the church had significantly lower rates of wear for age than those buried in the cemeteries. Hypothesis H_1 is accepted, that the dental wear score of same age children is not equal across burial locations. However, the distance that the individuals were buried from the church did not appear to play a major part in the rates of dental wear. In general it appears that the Gloucester children

may have had a slightly coarser diet and the Taunton children a softer one. Most of the dentitions analysed from Gloucester are of a slightly earlier period than those of Taunton, so it is possible that it is a temporal difference in diet that is being observed. Richards *et al.* (2002) found evidence that children between the ages of four and eight had a diet containing fewer animal products than older children. If their diet tended to consist of coarsely ground grains then this might explain the sudden rise in dental wear at Taunton soon after weaning age. It may also explain the reduction in the rate of dental wear seen around the age of seven years, when the wear rates of older children become more similar. If meat becomes a more regular part of the diet then slower rates of dental wear may be expected. In Chapter Three it was suggested that once a child reached seven years of age they would be expected to do more tasks; entering an apprenticeship, the beginning of schooling, or helping out at home. This may suggest that from this age they were thought to need higher protein foods, such as meat and dairy products.

Question 17: Is there a difference between dental wear scores recorded and site?

H_0 : The dental wear score of same age children is equal across sites.

H_1 : The dental wear score of same age children is not equal across sites.

Deciduous dental wear was explored both as a method for determining possible dietary differences and as a potential method to aid in more accurately ageing individuals between the ages of two and six years. The deciduous molars from the dentitions of the late medieval children analysed appear to wear at similar rates for all sites. A statistically significant difference was seen between the sites at the ages of five and eight years of age, but this only involved the first molar. Therefore, for the second molars at least, H_0 is true, that the dental wear score of same age children is equal across sites.

It is therefore suggested that when comparing dental wear scores between individuals from different sites, recording the wear on the second deciduous molars is preferable to that of the first. This may be due to the larger surface area of the second deciduous molar and therefore higher involvement in the mastication process. The similarity between wear from the three sites indicate that it may be possible to use dental wear scores as an aid to ageing children, but further work needs to be carried out. When the

disarticulated material from Taunton is analysed, this method will be used to determine if it helps when ageing mandibles. Even though as an ageing tool the method may be limited, as a way of recording wear on deciduous teeth that is simple for other researchers to use, it may have the potential to encourage osteoarchaeologists to record deciduous dental wear as part of their standard methodology, something which is automatically done for the permanent teeth of adults.

9.3.5 Episodes of Stress

Question 18: Is there a difference between the presence of stress indicators, or caries, between sub-adults and adults?

H_0 : The presence of stress indicators, or caries, recorded is equal between sub-adults and adults.

H_1 : The presence of stress indicators, or caries, recorded is not equal between sub-adults and adults.

The sub-adults from Taunton had a slightly higher presence of cribra orbitalia, periostitis, and enamel defects than the adults, but the results were not statistically significant. As would be expected there was a higher presence of carious lesions on the adult dentitions than those of the sub-adults, but the results were not statistically significant. Therefore H_0 is accepted, and the presence of stress indicators, or caries, recorded is equal between sub-adults and adults. Evidence from the sites listed in Appendix A also suggests that sub-adults tend to have a slightly higher prevalence of cribra orbitalia than adults (St Mary Graces, London, Wharram Percy and St Andrew Fishergate, Yorkshire). This confirms Stuart-Macadam's (1985) view that the lesions of cribra orbitalia are related to episodes of stress during childhood, even when recorded on adult individuals. In contrast, where separate prevalence rates were recorded (see Appendix A), enamel hypoplasia and periostitis prevalence tends to be higher on adults than sub-adults (East Smithfield Black Death Cemetery and St Mary Graces, London).

Question 19: Is there a difference between the presence of stress indicators, or caries, recorded by site?

H_0 : The presence of stress indicators recorded is equal across sites.

H_1 : The presence of stress indicators recorded is not equal across sites.

There is a considerable difference in the rate of caries between the sub-adults from the three sites. Taunton has a high rate, with 35% of individuals having one or more carious

lesion. At Canterbury the rate is 16% and at Gloucester it is only 6%. The Gloucester rate seems fairly low and is interesting that this coincides with the highest dental wear of the three sites. It may be postulated that it is this higher rate of wear that is helping to reduce the rate of caries in the sub-adult population by changing the topography of the occlusal surface, creating less undulations in which food could become trapped; in contrast Rogers (1999, 235) notes that for the post-medieval children the rate of caries is high (40%), whilst the Anglo-Saxon children have no sign of carious lesions. The rate of adults with carious lesions at Taunton was 55%, only slightly higher than the average, seen across late medieval sites from Britain, of 53% (Roberts & Cox 2003, 259); at Gloucester the rate of adults from the Norman and late medieval period was around 22% (Rogers 1999, 236). These results may suggest differing diets at the three sites, or differences in oral hygiene. For caries presence H_1 is accepted, the presence of caries recorded is not equal across sites.

There is also a statistically significant difference in the presence of individuals with enamel defects between the three sites, with Canterbury having low prevalence (26%) compared to the other two sites (both 49%). Enamel hypoplasia rates vary across sites, from the information from those sites listed in Appendix A, 76% prevalence was seen at St Andrew Fishergate, Yorkshire (Stroud 1993, 204), but only 12% at St Mary Graces Abbey, London (MOLAS 2007). At Gloucester enamel defects tend to involve higher numbers of teeth and be more severe. For enamel defects H_1 is accepted, the presence of stress indicators recorded is not equal across sites.

No statistically significant difference was seen for cribra orbitalia prevalence by site or the presence of periostitis in the form of new bone formation or porosity and striations, and H_0 can be accepted, the presence of stress indicators recorded is equal across sites. However, there was a difference in the manifestation of periostitis between Canterbury and Taunton, with a higher incidence of bone formation present on the Taunton individuals. Whether the appearance of porosity and striations occurs prior to the new bone formation of periostitis, or whether it represents a milder form of infection, or even the normal growth process in sub-adults needs further research. This difference might relate to the possibility that lower status individuals (the association with the hospital and free burial for the poor) are potentially being buried at Canterbury and, therefore, they may be dying before the bone formation associated with periostitis has

had time to manifest. The low numbers of porotic hyperostosis presence and the problems in recording endocranial lesions on the Canterbury skeletons mean that the prevalence rates for these indicators could not be accurately tested statistically.

Question 20: Is there a difference between the presence of stress indicators recorded by burial location?

H_0 : The presence of stress indicators recorded is equal by burial location.

H_1 : The presence of stress indicators recorded is not equal by burial location.

The higher prevalence of stress indicators appears to be associated with the higher status burial areas in the populations analysed. Prevalence rates for cribra orbitalia, enamel hypoplasia and periostitis were all high on those burials from within the church buildings, and were statistically higher for those buried to the west of the church. Therefore, H_1 is accepted, the presence of stress indicators recorded is not equal by burial location. Most of the burials to the west come from the Taunton population, but as they appear to come from a well used part of the cemetery it may be postulated that they are of a higher status proportion of the population, at least when compared to the burials from the main south cemetery at Canterbury. The statistical differences calculated often appear to fall between those to the west (majority are Taunton) and to the south (Canterbury); the fact that the Canterbury cemetery was attached to a local hospital, to which the priory was obliged to allow free burial for the sick, may suggest that some of these sub-adults fall within this category. Referring back to the summary of Chapter Eight, Wood *et al.* (1992) have suggested that it may be the advantaged groups in society that are more likely to survive a stress assault and therefore survive long enough for a skeletal lesion to become visible. It is possible that the most stressed individuals actually died when a stressful assault occurred, thereby not surviving for long enough for the skeletal manifestations to be seen. This could explain why a higher prevalence of stress was seen in the assumed higher status burial areas. However, to determine the status of burial areas without the presence of certain high status elements such as coffins is difficult. The presence of one ash burial, and one burial on a charred wooden plank (if these can be interpreted as high status),⁵⁶ may indicate that the burial

⁵⁶ the silver coin with the cemetery ash burial, and the presence of a comparable ash burial within the church may suggest this is a fair assumption.

area from the Taunton 2005 excavations is a high status one. The prevalence of stress indicators from the area excavated to the south in 1977, which is further from the church buildings, is much lower, although only crude prevalence data is available. To have been able to analyse the fifty-eight sub-adults and ninety adults from this collection would have been really useful for this study, and potentially could have helped to answer the question of whether the area close to the west of the church was of a higher status. Sadly this was not possible due to the reburial of these remains in the past, and that none of the original skeleton recording forms appeared to be held in any archive, meaning that the raw data on these remains has been lost.

Question 21: Is there a difference between the presence of stress indicators recorded by sub-adult age grouping?

H_0 : The presence of stress indicators recorded is equal by age group.

H_1 : The presence of stress indicators recorded is not equal by age group.

In agreement with other authors (Bennike *et al.* 2005; Grauer 1993) the higher prevalence of some stress indicators (cribra orbitalia and enamel hypoplasia) was associated with older children. Whilst the enamel hypoplasia result is related to the fact that the younger children in this sample will not yet have their permanent dentition erupted, there is no such explanation for the presence of cribra orbitalia. It may be that infants and young children were buffered against the causes of cribra orbitalia, whereas older children were not. It may also be that older children are more likely to have had previous stressful assaults in the past before they died. For cribra orbitalia and enamel defects H_1 is accepted, the presence of stress indicators recorded is not equal by age group. It was younger children that were more likely to show manifestation of endocranial lesions, but this could not be tested statistically due to the low counts of data.

Question 22: Is there any relationship between the presence of two different stress indicators?

H_0 : There is no relationship between the presence of two different stress indicators.

H_1 : There is a relationship between the presence of two different stress indicators.

When cribra orbitalia presence was tested against the other stress indicators there was a significant relationship seen with periostitis and the presence of enamel defects.

Therefore H_1 is accepted and there is a relationship between the presence of cribra orbitalia and two other stress indicators. This result indicates, as suggested in Chapter Five, the probable relationship between infectious disease, nutritional deficiency, and the cessation of growth of enamel in sub-adults.

9.3.6 Growth and development

Question 23: Do the remains of similar age individuals from the three different sites have a similar stature?

H_0 : There is no difference between stature for similar age individuals for the three sites.

H_1 : There is a difference between stature for similar age individuals for the three sites.

No statistical significance was seen for stature or long bone length measurements for the three sites, therefore, H_0 is accepted, there is no difference between statures for similar age individuals for the three sites.

Question 24: Does burial location have any effect on stature in similar age individuals?

H_0 : There is no difference between stature for similar age individuals and burial location.

H_1 : There is a difference between stature for similar age individuals and burial location.

In the three instances where growth showed statistical significance in relation to burial location, contrasting results were obtained for different age children. In the first case those buried to the west had the higher stature, in the second it was those buried to the south, and in the third case those within the church had the higher stature. However, the small dataset, when an age cohort of two yearly increments was assigned, undoubtedly has led to individuals of unusually small or tall stature for age having a large effect on the statistical tests, and therefore possibly biasing the results. This was seen for the three and four year age group where, when the identified outliers were removed, significance was no longer seen. Skeleton 2038, a seven year old from Taunton buried to the west, has the lowest stature estimate (102 cm) for this age (very short). Their long bone lengths are small for age, and bone maturation is also slightly delayed compared to dental eruption and formation. In contrast the individual with the greatest estimated stature (128 cm) for the same age is SK 716, buried to the south at Canterbury. It could be that extreme cases like these can affect the results; however, in this case neither of these individuals was recognised as an outlier when tested for normality. Because of the

contrasting results it is safest to accept H_0 , that there is no difference between stature for similar age individuals and burial location.

Question 25: Does the presence of stress indicators have any effect on stature in similar age individuals?

H_0 : There is no difference between the presence of stress indicators and stature for similar age individuals.

H_1 : There is a difference between the presence of stress indicators and stature for similar age individuals.

In the four instances where the presence of stress indicators appeared to have a statistically significant effect on stature and/or long bone length the individuals with stress indicators were taller. This, like the higher prevalence of stress indicators on potentially higher status individuals, is not the result that would naturally be expected, although as Wood *et al.* (1992) have suggested it may be the healthier individuals who exhibit skeletal lesions and therefore it is not so unexpected that they would be taller than those individuals without lesions. It has been suggested that catch up growth, after the stress assault was overcome, will remove any evidence for stunted growth due to stress (Mays 1985, 217), it may also be possible that this growth could lead to taller individuals for age if nutrition was good after the recovery period. This may complement the results that it is the higher status children, who may potentially be taller, that are able to survive these assaults for a longer time than the lower status children, who may be shorter, and who may succumb quickly leaving no skeletal manifestation. However, as mentioned above, no clear result was seen when stature was tested by burial location. To really be able to answer questions about the relationship between stress and growth, a large cohort of data would need to be gathered from late medieval skeletal collections across the country, and this would make a useful study for the future. Therefore in some cases H_1 appears to be true and there is a difference between the presence of stress indicators and stature for similar age individuals, but in the majority of cases H_0 should be accepted.

Chapter 10 : Conclusions

10.1 Research Aims

The main aim of this research was to try and uncover information about the lives, and deaths, of children living in the late medieval period in England. A biocultural approach was chosen which involved an osteoarchaeological analysis of the skeletal remains of children from the period, alongside an exploration of the funerary context from the archaeological evidence. Analysing the skeletal remains of a cemetery population is the best way of getting close to the actual individuals who lived and died in the past, and from which we can obtain information such as, their age at death, whether they had suffered from stressful episodes in their lives (ill health or malnutrition), and how these episodes may relate to their growth and development. To place this research into the cultural context of the time, as well as exploring the archaeological evidence associated with the burial of children, reference was made to the research of various historians who have analysed written documents of the period in search of information about the lives of children, and the attitudes of adults towards those children. The importance of this thesis is that the author has attempted to bring these strands of evidence together to create a more holistic view on the life and death of children in late medieval England.

During the course of this research the author discovered the potential for the analysis of wear on the dentitions of sub-adult individuals. Wear is commonly recorded on the permanent teeth of adult individuals but there appears to be no published research which has focused on the wear on the deciduous dentition of skeletal populations of any period within the British Isles, and only two papers were located which focused on the deciduous teeth from prehistoric populations from Europe (Skinner 1997) and the US (Bullington 1991). Dental wear is a worthy subject for study in association with status, as the main cause of this wear will be the type of diet being consumed, and this may vary between individuals and populations of differing status. In adult dentitions wear is also commonly used as a tool for ageing (Miles 1963; Brothwell 1981; Drier 1994), but this is something that has not been explored for sub-adults using the deciduous dentition. To determine whether the rate of dental wear on the deciduous molar teeth could be useful as an aid to other developmental ageing methods for sub-adults became a further aim of this research.

10.2 Summary of findings

The evidence from the historical and archaeological evidence cited in this thesis indicates that children did have an identity separate to that of adults in late medieval England. This identity was not merely perceived as a dichotomy between adult and child, but, for scholars of the period at least, it was understood that the age and development of the child was an important factor in how they should be cared for and in the types of roles and responsibilities that they could undertake. The stage of *Infantia* lasted until the age of seven and was believed to be a period when children needed nurturing and not have the demands of work tasks placed upon them. However, as the reports from the Coroners records (Hanawalt 1977) and the accounts of Saints miracles (Gordon 1991; Finucane 1997) attest this did not mean that children were well nurtured (according to our modern concepts) and it appears that very young infants would be left alone for considerable periods of time whilst their parents were working. It was not until the stage of *pueritia* beginning at seven years of age that children were expected to have an understanding of the correct modes of behaviour, and to begin on the road toward adulthood in the commencement of formal schooling or apprenticeship. This age coincides with the eruption of the permanent dentition and indicates that the developmental stages of children may have been seen as important markers in the stages of life. Whilst children from the age of seven may have begun to help out their parents with adult work it was probably not until the late stages of *pueritia* or the beginning of *adolescentia* that true apprenticeship began, a stage Dyer (1989) refers to as the "life cycle servants". In fact rather than being seen as adult workers from this age (at around 12 years) they would live with their employers, and be regarded as part of the family, with many children actually being placed with relations or close family friends. It is not until the end of the stage of *adolescentia* (around 20 year of age) that individuals appear to "come of age" (Hanawalt 1993, 57), or have the right to hold land (Razi 1980, 43).

The presence of these different stages in the life of a child, recorded in the writings and illustrations contemporary to the period, were therefore used to create the age ranges for the data analysis in this thesis. This was done to enable the data to be explored in a more meaningful way, in relation to the perceptions of the adult population that will have been responsible for the burial of deceased children. The way in which age data for sub-adults is presented, as a series of age groupings, by osteoarchaeologists often appears to be quite random and probably somewhat dependant on the ageing method used. If

evidence for different stages in children's lives, for the specific population under study, were explored prior to data analysis the interpretation of results may become more meaningful, and aid in the understanding of how different populations both temporally and spatially perceived childhood. Just as to ignore the lives of women in archaeological interpretations will be neglecting 50% of the adult population, neglecting the lives of children will be ignoring at least 22% of the living population and probably nearer 40-45% (Department of Economic and Social Affairs 2007), if comparisons with modern child to adult ratios are made.

The review of the literature and evidence for how children were perceived, depicted and treated after death by the adults in society clearly indicate that they were an important part of late medieval society. Children and adults appear to receive very similar rites of burial, although in some ways they were treated differently. Burial positioning appears more standardised for children than adults, and they are less likely to be buried within church buildings. However, the evidence from Taunton shows that young children were more likely to be buried in favourable places close to the church (in this case the west front) than adults; children were also present in good numbers in this location from Gloucester and Canterbury, although numbers were not explored in comparison with the adults from these sites. At Gloucester and other sites, for example Wharram Percy (Mays 2007), it has been noted that infant burials were more likely to be recovered close to the north side of the church and this has been interpreted as being the less favourable side for burial. Both children and adults could receive high status burial practice such as coffined burial (SK 914 from Taunton) or charcoal burial (SK 113 from Gloucester). Grave goods were sparsely found with both adults and sub-adults at the three sites analysed here, although as mentioned in Chapter Four, small finds interpreted as talisman have been recovered with several sub-adult burials across England.

Most of the sub-adult skeletons analysed for this study were of good preservation and the preterm or neonatal remains had a statistically higher preservation than sub-adults in some of the other age ranges. This suggests that where general skeletal preservation is good there should not be a problem in recovering sub-adult remains. However, the depth of burial at Taunton was statistically shallower for the sub-adults than the adults and this will have implications on the possibility of post-burial disturbance. The higher recovery of small bones from the Taunton (2005) excavation, where several

osteoarchaeologists were present, also suggests that the experience of the excavation team will undoubtedly play a part in the recovery of infant bones. Lower bone mineral density has been seen in skeletal remains of humans between the age of birth and two years (Trotter & Hixon 1974; Rauch & Schoenau 2001) and this may be the reason that there was lower preservation seen for the skeletons within this age range at the three sites analysed.

The creation of a chart and photographs for the use of recording deciduous dental wear, and the results obtained from the data have wide implications for the study of sub-adult remains. The low rate of wear seen on the dentitions from the high status sub-adults buried within the church buildings indicate that wear rates may have a relationship to diet, with higher status diets containing softer foodstuffs. The similarity of wear stage attainment, by age, for the three sites, suggests that this method may also be useful as an aid to assigning age to skeletal remains, where the formation of each tooth cannot be recorded, for example when a mandible has all the deciduous teeth present and erupted. It is hoped that this research will lead to others considering the potential of recording deciduous dental wear as a matter of course when analysing sub-adult remains.

It is apparent that further work needs to be carried out to enable a clearer picture of some of the relationships between status in terms of burial location (the funerary context), and status as defined by the growth rate and presence of stress indicators on individual skeletons (the osteoarchaeological analysis). A review of the literature on status and stress indicators show that the underlying assumption is that the lower status children in societies will show greater evidence for stress on their skeletons. This does not appear to be the case for the remains analysed here. In fact the high incidence of stress indicators seen on the highest status burials, those from within church buildings, suggests the opposite. This finding is more in line with the suggestions of Wood *et al.* (1992) as it appears to be the higher status individuals, the more advantaged in society, that are surviving a stressful assault long enough for recordable lesions to appear. The less advantaged in society are likely to die before any recognisable lesions manifest. The problem with low numbers, in some of the data cohorts, means that in most cases this is an observation only, and not statistically testable. However, if one assumes from the available evidence, presented in Chapters Six and Eight, that Taunton in general is a higher status site than Canterbury, the results do show significantly higher stress

indicator prevalence on the Taunton children, as opposed to the Canterbury children. Although stress appears to have had little effect on the growth profiles of the three sites in the cases where a statistically significant result was obtained those with stress indicators appeared to be taller in estimated stature (have greater long bone lengths) than those without. This also agrees with the idea of the more advantaged (taller) individuals being more likely to show signs of stress on the skeleton.

10.3 Limitations

As with any study that tries to elucidate information about living people from the past by analysing the remains of the dead there will be many limitations (Waldron 1994). When dealing with sub-adult remains we are able to glean information from an individual who was a child at the time that they died, enabling their growth, development, wear and enamel defects on the deciduous dentition, and the presence of any signs of pathology to be recorded. However, all those children that reached adulthood in the past will not be available to study for growth and developmental changes, and many signs of stress or illness from childhood will no longer be visible. There are of course some exceptions, with enamel defects on the permanent teeth having the potential to survive, as long as the adult retains their teeth without severe dental wear, and cases of cribra orbitalia present on adults potentially being a record of stress during childhood (Stuart Macadam 1985).

The skeletal remains recovered from the three sites analysed are of course not representative either of the complete population that was buried within the cemetery or of the population living at any one point in time. The long span of use of most late medieval cemeteries, in the case of the three sites analysed for this study from the twelfth to the mid sixteenth centuries, means that within each skeletal population we may have individuals that lived four hundred years apart. At Gloucester the majority of burials analysed fall within the late twelfth and early thirteenth century, whereas at Taunton it is likely that most are later than the thirteenth century. Therefore some of the differences seen between the sites, for example the low rate of caries at Gloucester compared to Taunton, may relate to temporal differences, in this case in diet, as opposed to geographical ones.

Some of the findings presented within this thesis, especially relating to growth, are in many ways tentative due to the problems of small cohorts of data for each age range.

Although the total number of skeletons analysed was a good sample (262), when these individuals are placed into yearly age groupings, necessary for data analysis when looking at attributes related to age, for example long bone length, the number of individuals in each group becomes much smaller, and in some cases was too small to be tested statistically.

Women and men would have lived very different lives in the late medieval period and this must have also been the case for girls and boys. This research can only refer to children as the sex of the individual skeletons cannot be ascertained. Chapter Two referred to work that has been undertaken in assigning sex through differences in the morphology of the bones and teeth of sub-adult remains, but no reliable method has yet been found. Whilst DNA analysis of bone can determine sex the method is expensive and not without its problems. Unless the excavation of skeletal remains is carried out under forensic conditions (to minimise the contamination of the bone with DNA from the excavation team) the likelihood of obtaining an uncontaminated sample is low (White & Folkens 2000, 444). Therefore to obtain a good sample of sub-adults, which could be assigned sex using DNA analysis, research questions and methods would need to be present prior to excavation, something that is unlikely to happen when most cemetery excavations in England are development led and carried out by commercial archaeological units.

10.4 Future Research

The role of diet and status has been touched upon in relation to the work carried out to create a new method for recording wear on the deciduous molar teeth. The results for the potential of this method have been encouraging and this is another area that could use further exploration and refining in the future. Several authors have used isotope analysis to determine the presence of animal or fish proteins within the diets of medieval populations (Barrett & Richards 2004; Muldner & Richards 2005; 2007; Richards *et al.* 2006), with the main focus being on the status of adults, and the differences in the isotope values between the sexes. This method could be used to look at differences in diet between children and adults, and also between children from different age groups, as has been done for nitrogen levels on the sub-adults from Wharram Percy (Richards *et al.* 2002). At Taunton, at least, the dental wear rates indicate a soft diet for infants and young children but then a possible sudden change to coarser foods from the age of three years. This may indicate a quicker move to a more

adult diet at this site than is seen from the more gradual increase in wear rates at Canterbury and Gloucester.

The cemetery at Gloucester had child burials present for the Roman, Anglo-Saxon and post-medieval periods, as well as the late medieval period studied here. To record the dental wear on the whole cemetery population, and compare the results across time periods, could inform us about changes to diet over time, and would also be a good test to see how well the suggested age for dental wear stages presented in Table 8-37 perform on dentitions of other periods. This is another study that the author believes has potential for the future, especially if carried out with stable isotope analysis.

The association of stress indicator prevalence, burial location and status could be explored further both utilising published skeletal data, for example from sites such as St Helen-on-the-Walls (Dawes & Magilton 1980; Lewis 2002a) and Wharram Percy (Lewis 2002a; Mays 2007), and by looking at more recently excavated and as yet unpublished sites, for example St Peter's, Leicester where 1340 burials were discovered, a good proportion of them sub-adults (Buckley 2007, 23). One of the useful aspects to the creation of a database by the author, designed to answer specific questions, is that further information can be added to it over time to create a large cohort of data and, that the same queries can be run to see if data from different sites provides different answers.

The study of children in the past has often been neglected maybe because the burial archaeology does not appear as exciting as that for adults or, that the range of recordable pathologies is less than on adult individuals. However, Lewis (2007) has recently reviewed the potential for studies of childhood pathology. This study has shown the potential for the types of questions that can be addressed through exploring in detail both the skeletal remains and the funerary context in conjunction with each other, to provide a fuller window onto both the lives of individual children, and the practices employed in dealing with these children when they died. It is hoped in the future that some aspects of recording information from sub-adult skeletons will become standard in archaeological reports, such as long bone lengths, possibly alongside estimations of stature, and deciduous dental wear. It is also hoped that more researchers will become interested in exploring the relationship between diet, age, and dental wear on the deciduous teeth, and will find the methods employed in this thesis of use.

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