Palaeoepidemiological study of the post-medieval Gloucester 13/83 Skeletal Assemblage.

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Dedication:

"To have been loved so deeply, even though the person who loved us is gone, will give us some protection forever." – J.K. Rowling (1997)

Andrew R Martin

1947-2015

“You think the dead we loved ever truly leave us? You think that we don’t recall them more clearly than ever in times of great trouble? Your father is alive in you and shows himself plainly when you have need of him." –J.K. Rowling (1999)

To Jackie, Nicky, Tony, Dean and Jessica

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Abbreviations

Abbreviation	Meaning
13/83	Gloucester site code including GI and SCC.
AMTL	Antemortem Tooth Loss
CO	Cribra Orbitalia
CPR	Crude Prevalence Rate
C-spine (e.g. C1)	Cervical spine (e.g first cervical vertebra)
DA	Dental Abscess(es)
DDD	Degenerative Disc Disease
DISH	Diffuse Idiopathic Skeletal Hyperostosis
GCM	Gloucester City Museum
Georgian period	1721-1837 CE
GI	Gloucester Infirmary
Indet.	Indeterminate
Industrial revolution	1760-1840 CE
L-bone (e.g. L-femur)	Left sided bone (e.g. Left femur)
LEH	Linear Enamel Hypoplasia
LJMU	Liverpool John Moores University
L-Spine (e.g. L1)	Lumbar spine (e.g first lumbar vertebra)
MTC	metacarpal
MTT	metatarsal
OA	Osteoarthritis
OD	Osteochondritis dissecans
PH	Porotic hyperostosis
PO	Periostitis
R/O	Rickets/Osteomalacia
RA	Rheumatoid arthritis
R-bone (e.g. R-femur)	Right sided bone (e.g. Right femur)
S1 – S5	Sacral vertebrae sections 1-5
SBO	Spina bifida occulta
SCC	Southgate Congregational Church
SEM	Scanning Electron Microscopy
SN	Schmorl's nodes
T-Spine (e.g. T1)	Thoracic spine (e.g first thoracic vertebra)

ABSTRACT:

This thesis carries out a palaeoepidemiological study examining the representation of pathological conditions from an 18th-19th Century Gloucester skeletal collection (13/83). This skeletal assemblage contains 82 individuals, including 37 burials from a non-parochial church (Southgate Congregational Church) and 45 burials from Gloucester Infirmary (GI). Biological profiling was carried out to determine sex, estimate age-at-death and stature of individuals to aid in palaeoepidemiological study. This information was compared to the biological information obtained from the 1784-1837 burial register of Southgate Congregational Church (SCC). Significant differences were identified between the known age at death of the individual in the register and the age estimations of the church burials. This may be due to age bias in techniques applied in biological anthropology specifically as there is difficulty in ageing adults over 50 years. There was a significant difference in the numbers of adult males and females between SCC and GI cemeteries. There was also a significant difference age-at-death estimation between the SCC and GI. The high representation of subadults within the church cemetery compared to the Infirmary may contribute to this. Therefore, different cemetery organisation is indicated by these results.

Pathological conditions were categorised into groups for analysis, these were dental and skeletal pathologies (Trauma, congenital, joint, infectious, metabolic and neoplastic conditions). The frequencies of dental and skeletal pathologies were higher in Gloucester Infirmary. However, this was only found to be statistically significant in the dental and traumatic conditions. This was expected due to individuals within Gloucester Infirmary receiving treatment prior to death and suffering general poorer health than individuals from Southgate Congregational Church. Metabolic and neoplastic conditions were found in similar frequencies indicating that these conditions affected the individuals of Gloucester equally. Trends showed increased risk of infectious and metabolic conditions compared to earlier populations. Joint conditions were the most common group of skeletal conditions recorded in the 13/83 skeletal assemblage. The 18th-19th century saw great social economic changes within Britain. This was the also that case in Gloucester, although skeletal analysis indicated that this was less extreme than in larger cities. Access to universal health care and control of infectious disease within the modern population has led to longer life expectancies and therefore different disease prevalence with such as increases in cancer, osteoporosis, diabetes mellitus, and secondary pathologies. These increases are predicted to continue with the emergence of new and old infectious conditions arising as a result of antibiotic resistance and global pandemics.

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Chapter 1: Introduction

This thesis carries out a palaeoepidemiological investigation of a skeletal assemblage housed at Liverpool John Moores University (LJMU). Modern epidemiology studies the process of disease throughout time through the incidence or prevalence rates (Roberts and Manchester, 2010). Therefore, 'palaeoepidemiology' is the study of disease prevalence throughout history (Waldron, 2007). Palaeoepidemiological studies employ an interdisciplinary approach to evaluate how past lifestyles, environment and health affect the incidence of disease (Armstrong *et al.* 2013; Souza *et al.* 2003). This can be achieved by examining the origin and representativeness of skeletal samples, with regards to lesions and disease, as well as the socio-cultural impact on health (Boldsen and Milner 2012). A lesion is defined as the manifestation of a specific disease on an individual tissue (Roberts and Manchester, 2010). Palaeoepidemiological studies can engage with modern medical research to help understand the evolution of various conditions and aid the prediction of the future course of a disease. This can be beneficial when there is an unknown disease aetiology through investigating trends in past populations with application in clinical and archaeological studies (Dageförde *et al.* 2014). Population studies are important in understanding trends in palaeopathology as they give an insight into the health status of specific groups. A holistic approach to the investigation of health and disease is necessary in archaeological populations.

This research examines the palaeoepidemiology of dental and skeletal pathological conditions in an 18th-19th century British skeletal assemblage from Gloucester, coded 13/83. The coding of Gloucester archaeological sites refers to when sequentially during the year it was excavated and the year of excavation. Therefore 13/83 was the site of the thirteenth assigned excavation carried out in 1983. The frequencies and prevalence rates of different pathological conditions are examined in within this skeletal assemblage to enable palaeoepidemiological research.

Approximately 500 burials have been recorded surrounding Southgate Street in Gloucester, including over 300 medieval burials from St. Owen's Church cemetery and later cemeteries (Atkin 1990; Atkin 1991; Atkin and Garrod 1990). The 13/83 skeletal collection is from the cemeteries of Southgate Congregational Church (SCC) and Gloucester Infirmary (GI). This skeletal collection contains unidentified individuals and therefore the age, sex, stature, ancestry and health status of individuals at the time of death is unknown. The burial register for Southgate Congregational Church was located during the process of this research however no attempt to identify individuals within the 13/83 skeletal assemblage has been attempted during or prior to the completion of this thesis.

1.1 Gloucester in the 18th and early 19th Century

Gloucester is a city located in south west England. During the 18th and 19th century the population expanded rapidly due to economic growth both in Gloucester and Britain generally. This led to the migration of large numbers of people from the neighbouring countryside, and to intensive development of the surrounding villages and suburbs. Overcrowding resulted in public health problems including Cholera outbreaks in 1832 and 1834 causing the death of over 200 people (Cox 2005; Herbert 1988; Lewis 2013; Porter 1995). The manufacturing industry around Gloucester grew during the 18th and 19th centuries with pin manufacture listed as the chief occupation in 1735. This industry continued to grow in Gloucester, and in 1802 when the population of the city was around 7500, pin factories employed around 1500 individuals (Cox 2005). Other occupations common in Gloucester during this time included wool stapling and shoe making, with garment production accounting for approximately 50% of Gloucester apprenticeships (Herbert 1988). It is therefore hypothesised that the 13/83 skeletal assemblage will be a higher frequency of conditions related to poor living environments (such as metabolic and infectious disease) than earlier urban populations.

The treatment of disease in England changed significantly during the Georgian period (1714-1837). Traditionally this was a three-tiered system of physicians, apothecaries, and barber-surgeons. Whereby university trained physicians' diagnosed disease and prescribed treatment. However, this facility was primarily based in London and was only available to the wealthy. During the early 18th century, there were only two qualified physicians listed within Gloucester. Apothecaries met the majority of Gloucester inhabitant's medical needs (Herbert 1988; Porter 1995). Apothecaries learned their trade through apprenticeship, dispensed drugs and advice at a more accessible level to the general population than the physicians (Porter 1995). In 1739, there were at least 10 apothecary shops in and around Gloucester (Herbert, 1988). Barber-surgeons operated under a guild system (from 1540-1745) also trained under apprenticeship. They primarily treated external complaints such as skin conditions, performed simple surgeries including blood-letting, extracting teeth and setting bones. This profession combined barbery (cutting hair) and surgery until the professions separated in 1745 with the establishment of the university educated College of Surgeons (Pelling 1981; Pelling 2014; Porter 1995). The first officially published national medical registers appeared in 1779 and 1783, listing approximately 3000 individuals practising medicine in England (Porter 1995).

In the 18th century, it became common for parishes to pay a fixed sum to contract a local 'general practitioner' who would treat the parochial poor (Porter, 1995). There were very few pauper hospitals under the contemporary Poor Laws. The first established pauper hospital was Bristol Infirmary which was founded in 1735 (Porter, 1995). The decision to build the Gloucester Infirmary (GI) was made in 1755, the chosen location outside the south gate of the city. This institution was to be paid and managed by subscription as a charitable concern. Having previously been housed in a temporary structure, the brick built Infirmary on Southgate Street accepted patients from 1761. This was a significant event in the treatment of disease in Gloucester as surgeons and physicians gave their services for free. The Infirmary was modelled on the Bristol Infirmary paupers' hospital and was intended for individuals unable to pay for their stay or medicine. In 1781, ground was consecrated behind the Independent Chapel (SCC) for burial use by the Infirmary (GI) (Herbert 1988). The excavation records for the 13/83 skeletal collection indicated that the burials located in trenches III and V were from the Infirmary burial ground whereas the burials from trenches I and II were located within the walls of the Independent Chapel which became known as Southgate Congregational Church (SCC). Therefore, this thesis examines the difference in the demographics and prevalence of palaeopathology of these different trench locations and burial provenances. It is therefore hypothesised that there will be different frequencies of conditions found between SCC and GI. As the individuals were receiving treatment within GI prior to burial a higher frequency of conditions such as fractures are expected.

Skeletal data from the Gloucester 13/83 skeletal assemblage will be compared to contemporary collections in addition to skeletal data from other periods. One of these contemporaneous collections is the London parochial church of Christ Church, Spitalfields which was consecrated in 1728 and interred individuals in the crypts from 1729 to 1857 (Molleson and Cox 1993). These crypts were excavated in the 1980s. This is a contemporary sample to the burials of Southgate Congregational Church which built their meeting house on Southgate Street in 1730. This meeting house was built in front of the site of medieval St. Owen's church which had been demolished during the English civil war and close to St. Owen's Cemetery. Burials were carried out by SCC from approximately 1730 to 1860 (Herbert, 1988; Gloucester Archives [online], 2016). There are numerous publications on the skeletal remains from Christ Church, Spitalfields as the collection contains approximately 367 identified individuals (Molleson and Cox 1993; HA Waldron 1991a). Despite the increase in Gloucester's population during this time as described above, the size of the city's population was significantly lower than London (Chalklin, 1983) and other cities during this time period. It is therefore hypothesised that there will be different prevalence rates found between 13/83 and other previously published contemporary skeletal collections. The population from the Spitalfields Crypts were also of a higher socio-economic status than the 13/83 individuals (Connell and Miles 2010; Mant and Roberts 2015) which is hypothesised to indicated differences between discussed populations.

1.2 Pathological conditions

The word 'pathology' within modern practices literally refers to the study of disease processes (Roberts and Manchester, 2010). Therefore, 'palaeopathology' is the study of disease from ancient times which are evident in anomalies present on human skeletal remains (Aufderheide and Rodrıguez-Martin, 1998; Roberts and Manchester, 2010). The study of palaeopathology within the context of past populations enables this palaeoepidemiological study (Boldsen and Milner, 2012). For the purposes of this thesis a 'pathological condition' includes both pathological and pathogenic (disease causing) conditions.

The skeletal remains from the 13/83 skeletal assemblage will be examined for signs of anomalies and pathological conditions. The types of pathological conditions to be examined for prevalence in this study include dental conditions and skeletal conditions such as trauma, congenital, infectious, and joint conditions. An overview of the palaeopathological conditions in the 13/83 Gloucester Skeletal assemblage will provide further information on the health and disease trends in 18th and 19th century post-medieval Britain.

Dental Pathology

Teeth have the highest rate of mineralisation of the body's structures (Larson, 2015; Ogden 2008). Therefore there is a high preservation and recovery rate of dentition which may represent the only surviving element of an individual (Ogden 2008). This makes observation of dental disease important as it enables comparisons between populations.

Dental disease has been known as a significant cause of death throughout time. In 17th century London, 'teeth' were listed as the 5th or 6th leading cause of death according to the Bill of Mortality. Dental pathologies such as dental abscesses continued to have a high mortality rate into the beginning of the 20th century, contributing between 10-40% of the mortality rate (Robertson and Smith 2009). The first English dental school did not open until 1858 (Molleson and Cox 1993), contemporary to the final burials at Southgate Congregational Church (Gloucester archives [online], 2016). Prior to this there is evidence of growth in the dentistry profession and practice by untrained individuals and charlatans including barber surgeons (Molleson and Cox 1993; Pelling 1981). Evidence of restorative dentistry has been observed in the Spitalfields collection and another Georgian British skeletal collection from Kent; both of these examples showed fillings and artificial dentures (Cox *et al.* 2000; Molleson and Cox 1993). It was therefore important to assess the prevalence rate of dental conditions in the 13/83 collection. This study examines the absence and presence of specific dental conditions in retained dentition rather than the severity and location on individual teeth. The conditions assessed are antemortem tooth loss (AMTL), caries, calculus, dental abscesses (DA) and linear enamel hypoplasia (LEH).

Skeletal conditions

Trauma

Trauma can be defined as when living tissue has been subjected to direct or indirect force outside the body's control (Lovell 1997). The study of the location and distribution of trauma on the skeleton can be used as an interpretive tool in bioarchaeology. This aids in understanding the lifestyles of individuals and the potential dangers that the studied populations were exposed to (Larsen 2015; Lovell 1997). Fractures and sharp force injury are types of trauma which will be analysed in the 13/83 skeletal collection.

Studies have been carried out on a number of skeletal assemblages examining trauma patterns in medieval British, Nubian and Danish skeletal populations (Grauer and Roberts 1996; Kilgore *et al.* 1997; Milner *et al.* 2015). Grauer and Roberts (1996) compared the number of long bone fractures from various British medieval cemetery populations including collections from York, Ipswich and Chichester. The authors found that between 4.2-15.7% of individuals in these assemblages had evidence of fractures. The site with the highest rate of fractures was from the medieval Chichester Hospital cemetery site. The fracture rate within the 13/83 collection (including the Gloucester Infirmary burials) is explored in this thesis. This will enable comparison to the medieval Chichester Hospital and evaluate fracture expression in hospital burials from different time periods.

A study by Kilgore *et al.* (1997) of a Nubian medieval population found evidence of fracture treatment. The authors state that the fracture prevalence rate was between 31.9 – 34.5% for both sexes across two populations and 27.1% of these individuals had evidence of multiple fractures. This is an expected difference from the medieval British population as these skeletal collections are remote geographically and different activity patterns would have been present. Both these studies found that the forearm bones (radius and ulna) had the highest frequency of fractures. This is also supported by the findings of a Danish study examining skeletal trauma (Milner *et al.* 2015).

Analysis of fractures on the Spitalfields collection showed a crude fracture prevalence rate of 4.6% in females and 9.4% in males. The most commonly affected area of the skeleton was the ribs, accounting for 34 of the 59 recorded fractures. The second most commonly affected bone was the fibula with a reported frequency of five (Molleson and Cox 1993). Roberts (2000b), examined numerous studies of trauma and fracture patterns in skeletal collections. This highlighted the need for comprehensive and cohesive methods in reporting results and accurate representation which would enable comparison. Roberts (2000) further emphasises the importance of stating the total number of bones present when assessing the actual frequency, the specific type of fracture or pathology in relation to the biological profiles of individuals (if applicable), as this enables the true prevalence of fractures and pathologies to be calculated and permitting comparable analysis. Therefore, during the analysis of the 13/83 collection, the actual representation of trauma and percentage fractures where applicable will be calculated and presented. As stated above, examination of trauma frequencies in the Gloucester collection 13/83 is important. The rate of fractures is expected to be closer to the British studies (Molleson and Cox, 1993; Grauer and Roberts, 1996) than the Nubian (Kilgore *et al.* 1997). Comparison of the medieval (Chichester) and 18th-19th century hospitals (individuals from 13/83) will enable a biocultural analysis of trauma. The comparison between other archaeological sites to Gloucester 13/83 will provide further analysis of fracture patterns in the 18th and 19th century Britain.

Congenital conditions

Congenital abnormalities and conditions are present at birth. These developmental anomalies occur prior to birth for several reasons and can affect both soft and skeletal tissue. The aetiology of many congenital conditions and abnormalities is unknown. A combination of genetic, extrinsic and intrinsic factors may contribute to the prevalence of congenital conditions. An example of conditions caused by single gene and chromosomal disorders is Down Syndrome (Aufderheide and Rodrıguez-Martin 1998; Barnes 1994; Barnes 2012). Congenital conditions are important for palaeoepidemiological research and are being considered within this thesis as diet, environment and genetics contribute towards the frequency of these conditions (Boldsen and Milner, 2012; Roberts and Manchester, 2010). Therefore, presenting information on the prevalence rates within 13/83 will enable comparison to previous findings and provide additional information to aid future medical and bioarchaeological research. These conditions may also influence the frequency of other pathological conditions, which will be assessed during the research process.

A study by Mckeown and Record (1960) compared the survival rate of children born alive both with and without signs of congenital anomalies. This study showed a survival rate of 51.3% in the affected compared 95.7% of the unaffected at 5 years old. This may be attributed to a number of reasons including an increased risk factor in the affected. These factors included infection, the co-morbidities of Down Syndrome with congenital heart disease; and concurrent cleft palates and neurological conditions (McKeown and Record 1960; Roberts and Manchester 2010; Sture 2001). The skeleton was affected in 40% of congenital conditions in live births between 1960 – 1980 (Aufderheide and Rodrıguez-Martin 1998; Manchester 1983; Roberts and Manchester 2010). Therefore, the observation of congenital conditions in archaeological remains is problematic due to the majority affecting soft tissue which is not commonly preserved. Additionally, subadult remains are rarely preserved intact which may obscure the diagnosis of congenital conditions.

Spina bifida is the most common developmental condition found archaeologically (Roberts and Manchester, 2010). This is a neural tube condition which involves incomplete fusion of the neural arch of the vertebrae. Spina bifida occulta (SBO), involves unfused neural arches of the sacrum and is asymptomatic (Waldron 2009). Spina bifida cystica and aperta are serious conditions which additionally involve the protrusion of the spinal cord and/or meninges through the opening of the malformed vertebrae and epidermis. These more severe conditions would have likely been fatal perinatally due to infection, and therefore less likely to be observed archaeologically than SBO (Roberts and Manchester, 2010). In a 2013 study Armstrong *et al.*, examined spina bifida in a pre-Columbian Cuban population. Using palaeoepidemiological methods the authors analysed gene frequency and diet in the expression of SBO. They concluded that the combination of genetic predisposition and insufficient folic acid dietary intake contributed to spina bifida aetiology. Spina bifida occulta was found in 22 individuals from Spitalfields, a prevalence rate of 2.3%. This along with another congenital condition, spondylolysis showed a lower prevalence rate than observed in other studied populations (Molleson and Cox, 1993). This study will examine the representation of spina bifida along with other conditions such as vertebral border shifts (lumbarisation and sacralisation) and spondylolysis within Gloucester 13/83. Although dietary and genetic analysis is not included in this study, this may be possible for future work on spina bifida and other congenital conditions. The expression rate of congenital conditions can be compared with other 18-19th century skeletal collections as well as those separated in time and geographical origin, to further the understanding of these pathological conditions.

Joint conditions

Evaluation of the prevalence of joint conditions is extremely important in palaeopathological studies as they cause pain and disability. This could have created burden and hardship on the population similar to that of the modern aging population (Rogers 2000) and are therefore of interest in palaeoepidemiological research (Waldron 2007). Joint diseases in addition to traumatic and dental conditions can provide the most information about past populations (Roberts and Manchester, 2010). There are numerous conditions affecting the joints and the most common joint condition are degenerative joint diseases which include osteoarthritis (Jurmain and Kilgore 1995; Ortner 2003).

Joint diseases were found to affect 1-5 % of US citizens under the age of 45 and between 15-85% of individuals over 45 years old (Cotran *et al.* 1989; Roberts and Manchester 2010). Osteoarthritis (OA) is a degenerative joint condition involving inflammation of the articular surface of a joint, loss of the articular cartilage which results in deterioration of the joint and osteophytic lipping from direct contact between bones (Felson, 2000; Larsen, 2015; Waldron, 2009). Ortner (2003) states that osteoarthritis (OA) has a high prevalence rate in Western populations with an estimate of over 50% of individuals being affected over the age of 60 and nearly all individuals over the age of 65 have evidence of osteoarthritis in the cartilage surrounding the articular surface. However, not all these joint changes will be evident in archaeological skeletal remains as the criteria commonly applied uses the macroscopic joint changes present in osteological analysis (Waldron, 2009). The high prevalence of osteoarthritis within skeletal populations has also been reiterated by other authors such as of Aufderheide and Rodrıguez-Martin (1998); and (Waldron 2007; 2009). The prevalence of osteoarthritis was assessed in the adults from Spitalfields which found that the shoulder (including the acromioclavicular joint) and vertebral facets had the highest frequencies (Molleson and Cox 1993; HA Waldron 1991a). These studies examined the prevalence rate in adult skeletal remains only and found that the rate increased with age which supports other studies. Rogers *et al.* (1987) stated that whilst joint diseases such as OA are uncommon in subadult remains and Diffuse Idiopathic Skeletal Hyperostosis (DISH) is unlikely to be found in individuals under 45 years it is important to include them in the sample. This study aimed to examine all palaeopathology found within the 13/83 skeletal collection and therefore subadults were included within the analysis of joint conditions.

The prevalence of gout and rheumatoid arthritis (RA) was assessed in the Spitalfields collection. However, no evidence of either these conditions were identified in that collection. This was unexpected as gout is known to have had a high prevalence rate during the 18th and early 19th centuries (Molleson and Cox 1993; Porter and Rousseau 2000). Diagnosis of rheumatoid arthritis is problematic in archaeological remains as complete skeletal remains are rarely recovered, and diagnosis requires the involvement of symmetrical joints and commonly affects the bones of the hands and feet (Rogers *et al.* 1987).

Joint conditions that will be assessed in the 13/83 skeletal collection also include spondyloarthropathies such as Diffuse Idiopathic Skeletal Hyperostosis (DISH), Degenerative Disc Disease (DDD) and Schmorl's Nodes (SN) in addition to osteoarthritis (OA) and other non-spinal specific conditions. Degenerative Disc Disease is another condition which is frequently discovered in archaeological skeletal remains and it was found in 115 adult males and females from Spitalfields with the cervical and lumbar vertebrae being most commonly affected (Molleson and Cox 1993; T Waldron 1991a).

Infectious conditions

Infectious conditions were one of the highest causes of mortality in the 18th and 19th centuries (Molleson and Cox, 1993). However, the skeleton is not always affected as the result of exposure to infectious pathogens. Modern clinical data indicates that between 5-20% of chronic infections show skeletal evidence (Ortner 2003; Ortner 2008). This can be problematic as palaeopathological assessment can be a major source of past cultural analysis.

Infectious conditions in palaeopathology refer to conditions caused by a specific infection such as treponematosis (syphilis) and tuberculosis (TB); or non-specific infection such as osteomyelitis and periostitis. Osteomyelitis is caused when an infectious agent enters the medullary cavity of a long bone possibly as the result of trauma (Roberts and Manchester, 2010).

Treponematosis is an infectious chronic condition caused by a specific bacterium producing debilitating and unsightly physical manifestations prior to the implementation of antibiotic treatment in the 20th century. There was a rise in the prevalence of this disease in late medieval

Britain (Roberts and Manchester 2010; Walker *et al.* 2015). In their 2015 study Walker *et al.,* state that venereal syphilis has three distinct phases which if it progresses to the third stage (about 20-50% of cases) produces characteristic bone lesions. In their study of the medieval British hospital and priory cemeteries of St. Marys Spital, approximately 0.5% of their skeletal assemblage (25 out of 5387 individuals) had evidence of treponematosis affecting both sexes and age groups equally. This study found that the condition commonly affected the tibiae, ulnae, humeri, frontal and parietal bones supporting the previous findings of Aufderheide and Rodrıguez-Martin, 1998. The authors conclude their study stating the importance of comparative British studies and emphasising the need to record the location of treponemal lesions on skeletal remains to establish trends. Syphilis was also prevalent in the 18th and 19th centuries, analysis the Spitalfields collection which was excavated from a site close to the St Mary's Spital, found two possible cases of treponematosis (Molleson and Cox, 1993).

Tuberculosis (TB) was another leading cause of mortality during this period. This was likely due to population growth and environmental factors leading to increased exposure to pathogens (McKeown and Brown 1955; Molleson and Cox 1993; Roberts 2016). Skeletal TB was only observed in two individuals from Spitalfields, both of which were subadults. The low frequency of TB in skeletal remains was attributed to the infection rarely spreading to the skeleton (Molleson and Cox, 1993).

Non-specific infections which affect the skeleton, such as periostitis and osteomyelitis can have multiple aetiologies. Periostitis is a reaction of the periosteum of the bone which is less severe than osteomyelitis or osteitis. It is caused by an inflammatory reaction resulting in new bone formation. This can be induced by trauma or localised infection/ disease (Larsen, 2015). In a case study by Roberts (2016), periostitis was observed in an individual affecting the internal rib surfaces indicating evidence of lung disease.

In the 18th and early 19th centuries, the importance of segregating infectious patients was neither understood nor implemented, therefore individuals admitted to hospital had an increased risk of contracting a fatal infection (McKeown and Brown, 1955). This is an important factor when assessing the individuals from the infirmary (GI) as they would have been exposed to infectious pathogens prior to death.

Metabolic conditions

Metabolic conditions are caused when there is an absence of specific nutrients (e.g. malnutrition) or when an individual is unable to absorb nutrients for example age-related osteoporosis and diabetes (Ortner, 2003). The most common metabolic bone diseases in the modern population are osteoporosis and Paget's disease of bone (Mays 2008).

The type of metabolic conditions found in the 18th and 19th centuries included deficiencies in vitamins C (scurvy) and D (rickets/ osteomalacia). These conditions are important in biocultural analysis as they are indicators of diet and lifestyle (Mays, 2008). Scurvy has been observed in past populations where there has been deprivation of fresh vegetables and fruit, which could have arisen for numerous reasons such as famine, sea travel and war (Ortner, 2003). The skeletal manifestation of scurvy varies by age group. Infantile scurvy is more likely to be observed in subadults between the ages of 6 and 12 months. Subabults under this age might exhibit symptoms if the mother is deficient in the vitamin as prior to weaning they received maternal vitamin C. Scurvy and malnutrition were significantly prevalent during the mid-nineteenth century in Ireland due to the Potato Famine which saw mass migration from the country (Geber and Murphy 2012). In their study, Geber and Murphy assessed a large number of individuals from an Irish workhouse observing the location of skeletal lesions in different age groups. They found an overall prevalence of approximately 52%. Skeletal scorbutic lesions included porosity, hyperostosis, and new bone formation with the skull only showing definitive variables.

Vitamin D deficiency is known as rickets in subadults and osteomalacia in adults. This condition typically affects the weight-bearing bones. Vitamin D is required for calcium metabolism and can be acquired with exposure to sunlight in addition to dietary Vitamin D (Roberts and Manchester, 2010). Rickets affects subadults who are rapidly growing with children over four being infrequently affected. Skeletal evidence of childhood rickets deformity is evident in approximately 10-25% of those affected in later life due to healing of the deformity (Mays, 2008). Rickets mainly affected the more affluent in the 17th and 18th centuries compared to earlier generations as children were more likely to be kept indoors compared to the rural and poorer children who still had more interaction with the land and daylight. Living conditions changed during the Industrial Revolution within poor urban dwellings as exposure to sunlight became limited. This rise in prevalence continued to the early 20th century was an estimated 90% of infants and young children living in industrialised western countries being affected (Gibbs 1994; Loomis 1970; Mays 2008). Osteomalacia which shows different manifestation in adults has been found in several studies of 18th and 19th century British populations. These included seven adult individuals from St. Martin's Church, Birmingham (Brickley *et al.* 2007), 12 individuals from Spitalfields and two individuals from Broadchurch, London (Brickley *et al.* 2005; Brickley *et al.* 2007; Molleson and Cox 1993; White 1987).

Porotic hyperostosis (PH) and Cribra Orbitalia (CO) are porotic lesions which affect the cranium. Multiple aetiologies for these conditions have been proposed such as anaemia in a studied prehistoric population (Angel 1966) and the effects of poor living conditions during the 18th and 19th century (Molleson and Cox, 1993; Larsen, 2015) including population density, pathogen load and poor nutrition (Stuart-Macadam 1992). These conditions are also symptomatic of metabolic disturbances including vitamin C and D deficiencies (Geber and Murphy 2012; Ribot and Roberts

1996). Therefore, for the purposes of this thesis CO and PH will be included as metabolic conditions. This is in line with recent palaeopathological studies which have analysed their presence as a sign of general metabolic stress rather than directly related a specific condition such as anaemia (Cessford 2015; Connell and Miles 2010; Ribot and Roberts 1996; Steyn *et al.* 2016; Walker *et al.* 2009).

Observation of metabolic conditions within the 13/83 skeletal collection aids in the understanding of diet and lifestyle in 18th and 19th century Gloucester, providing supporting information and comparative analysis to previously published data. Observation of metabolic and stress indicators on the skeleton were assessed and presented in this thesis.

Neoplastic conditions

A neoplasm refers to an abnormal growth of new tissue (Roberts and Manchester, 2010). Neoplastic conditions include benign (i.e. non-cancerous) and malignant (i.e. cancerous) growths (Brothwell 2008). Malignant conditions are rarely seen archaeologically due to the frequency of these conditions being higher in the elderly and age at death was lower in past populations (Molleson and Cox, 1993). The rise in cancer may be a modern occurrence following the industrial revolution and as a consequence of changes in the environment which affects health in addition to longer lifespans, other genetic and epigenetic factors (Roberts, 2016). Brothwell (2012) states that distinctive osteolytic lesions caused by malignant neoplasms are often misinterpreted as post-mortem damage and that under macroscopic analysis these may appear very similar. As with congenital and joint conditions as stated above, the inclusion of these conditions in this thesis is relevant for palaeoepidemiological and bioarchaeological research. The frequencies of neoplastic conditions can be compared to other populations and modern clinical data.

Metastases of prostate and breast cancer to the bone occurs in 75% of individuals affected. The differentiation between primary cancers and metastases is difficult. This can be aided by examination of historical medical records combined with dry-bone analysis. However, this facility is rare in archaeological remains. (Brothwell, 2008). Examination of documented skeletal collections found evidence of prostatic carcinoma in a 59-year-old individual from St. Brides, London who died in 1834. The author was able to identify the metastatic progression of the disease (T Waldron 1997). There was one individual from Spitalfields with evidence of neoplastic conditions, this was in a 75-year-old female with possible metastatic breast cancer (Molleson and Cox, 1993). Breast cancer has been observed and recognised in individuals from prehistoric times. During the 18th and 19th centuries, there was a change in the understanding of the disease progression. The changes in surgical techniques during this time led to the development of surgical techniques reducing recurrence rates to around 6% following excision of breast tissue (Sakorafas and Safioleas 2009; 2010). Osteomas are the most common neoplasms found in archaeological remains, these are normally found on the cranium and are benign. There has been no significant difference found between the occurrences in male and female remains (Brothwell 2008; 2012). Whilst assessing neoplastic conditions in the 13/83 collection, it was important to consider the treatment and understanding of these conditions at the time.

1.3 Limitations of Study

There are multiple limitations in the analysis of ancient human remains, some of these relating to palaeopathology have been mentioned above and will be further addressed throughout this thesis. Some of the general issues which arise include general extrinsic and intrinsic factors.

Extrinsic factors

Waldron (2007) states that there are four main extrinsic factors which affect the palaeoepidemiological research on a skeletal assemblage such as the 13/83 skeletal collection. These are (a) the proportion of the dead which are buried at a site compared to the general population, (b) the proportion of dead individuals lost due to poor preservation and disturbance surviving until discovery, (c) the proportion of buried individuals discovered, and (d) the proportion of individuals recovered during excavation (Waldron, 2007). When the above statements are directly applied to the 13/83 skeletal assemblage the following limitations can be inferred:

(a) The individuals buried in both Southgate Congregational Church (SCC) and the Gloucester Infirmary (GI) burial ground do not necessarily represent the overall population of Gloucester or Britain at the time. These differences will be further explored during this thesis and form part of the research rationale.

(b) Due to poor preservation and disturbance of buried human remains (i.e. taphonomy), not all the individuals buried at SCC or GI were recovered. This may have been due to the robusticity of individual bones, secondary burial practices, soil type and acidity, groundwater damage and a number of other factors (Baxter, 2004; Manifold, 2012). In-depth analysis of these factors on 13/83 will not be addressed within this thesis as they are currently the subject of on-going research being conducted at LJMU. However, the general preservation and retention of skeletal elements will be discussed to enable analysis of observed skeletal pathological conditions for palaeoepidemiology.

(c) Not all of the skeletal remains buried by SCC and GI were discovered during the 13/83 excavation and are contained within the 13/83 skeletal assemblage. This is likely as the SCC building was extended in 1851 and demolished in 1981 (Herbert, 1988) which may have obscured the burial ground. Further excavations of the site were carried out in 1989 (Atkins, 1991), which uncovered more skeletal remains including individuals most likely originating from either SCC or GI burial grounds. These issues will also be explored within this thesis.

(d) Not all of the individual burials and skeletal remains from were successfully excavated during the 13/83 excavation. This may have been due to the fragility of the remains *in-situ.* The available contemporaneous archaeological excavation records will be examined where possible for comparison to the skeletal material housed at LJMU. Skeletal material from the 13/83 skeletal assemblage may have also been lost between excavation in 1983 and its current storage at LJMU. This issue will also be discussed further during this thesis.

Waldron (2007) further states that in the majority of palaeoepidemiological studies it is rarely possible to estimate the proportion of burials recovered. As mentioned previously in this chapter, the burial register for Southgate Congregational Church between 1786-1837CE has been located. Therefore, it may be possible to estimate the proportion of individuals reported. However, this will not be possible for Gloucester Infirmary burial ground.

Intrinsic Factors

The main intrinsic factor affecting palaeoepidemiological research is that a skeletal collection is not the same as a living population. This makes comparison with modern epidemiological research is problematic therefore care needs to be taken to avoid bias (Waldron, 2007; 2009). Some of these factors include changes to the (a) demography of the populations (such as age and sex), (b) the time scale of which burials were occurring, and (c) the sample size (DeWitte and Stojanowski, 2015; Roberts and Manchester, 2010; Waldron, 2007; Woods *et al.,* 1991). Therefore, some of these limitations when applied to 13/83 and the following statements can be stated:

(a) Analysing the demographics of a skeletal assemblage is essential in order to interpret palaeoepidemiological studies and understand past populations (Waldron, 2007; Walker *et al.,* 1988). The life expectancy of past populations is expected to be different to the modern developed world and therefore clinical epidemiological studies. The reduction in mortality during the 19th century in Britain (McKeown and Record, 1962; Waldron, 2007) signified a change in the demographics between studied past populations. The 13/83 skeletal collection may therefore have similar demographics to modern Britain, this will be further explored in this thesis. However, there are problems in the methodology used for estimating age-at-death in some osteological remains (especially in 'old adults') and sex determination of subadults. These issues will be discussed in relation to 13/83 throughout this research. The sex ratio of adults will be assessed in line with Waldron's (2007) recommendation to check for anomalies as modern epidemiology require 'balanced' samples.

(b) The length of time a burial ground or cemetery was in use may also create bias; the amounts of burials over time may have varied due to higher prevalence of disease (DeWitte and Stojanowski, 2015; Waldron, 2007; Woods *et al.,* 1991). Due the availability of the burial register for SCC, it will be possible to examine the number of burials by year and to look for trends. However, as the individuals within the 13/83 skeletal assemblage are unidentified specific dates of death of individuals are not achievable within the scope of this research.

(c) The 13/83 collection is small compared to other skeletal assemblages, therefore all the appropriate skeletal remains will be utilised.

Overall, there are multiple issues with affect palaeopathological and palaeoepidemiological research. Therefore, the 13/83 skeletal assemblage is a sample of individuals from SCC and GI rather than a population and in order to produce the best results care will be taken to reduce bias within the sample, and to address any specific factors found with the 13/83 skeletal assemblage.

1.4 Aims and Objectives

The overarching aims of this research is to conduct a palaeoepidemiological study into the different pathological conditions present in a specific 18th and 19th century urban British skeletal sample and to examine the differences between individuals buried by Southgate Congregational Church and Gloucester Infirmary. This will enable further understanding of health and disease in late Georgian Britain.

The specific aims of this research are:

1. To investigate the original excavation records and compare with the material housed at LJMU.
2. Documentation of the burials from the Gloucester 13/83 site as there was no published literature regarding these excavated burials and explore burial provenance, which were believed previously to be medieval.
3. To understand and separate the individual skeletal remains within the 13/83 skeletal assemblage between burial locations of Southgate Congregational Church and Gloucester Infirmary.
4. To investigate any contemporary information about SCC and GI which can give historical information about the skeletal sample, for example the burial register of Southgate Congregational Church.
5. To examine the demography of the 13/83 skeletal assemblage.
6. To identify and discuss any identified sample bias.
7. Examine individual skeletal remains within 13/83 for signs of pathological conditions.
8. Present information relating to the palaeopathological conditions found in the 13/83 skeletal assemblage.
9. To compare the demographics and frequency of conditions found between individuals from Southgate Congregational Church and Gloucester Infirmary.
10. Compare the frequency and prevalence of pathological conditions in 13/83 with published data from other skeletal assemblages and modern disease prevalence.
11. To use the information which will be gained from the above aims in order to contextualise the pathological conditions found 13/83, how they relate to post-medieval Gloucester, other British populations and what these conditions can infer about health status.

The above specific aims will be achieved by the following objectives:

- Due to the amount of time that has elapsed between excavation and this investigation, the archaeological records will be examined. These will be compared to the skeletal material housed at LJMU to ensure that the results presented and discussed in this thesis are accurate.
- The information about the collected about the 13/83 skeletal assemblage will be presented within this thesis for publication in order for future research to be conducted.
- The information about individual buried at SCC and GI will be presented separately in addition to 13/83 in general to provide understanding into the similarities and differences.
- Examination of the historical background of SCC and GI will aid understanding of the population sample. This was also give evidence on the demographics, occupation and health issues occurring in Gloucester at the time. Analysis of the SCC burial register will give specific information about the individuals buried within the church and how they are representative of Gloucester at the time.
- The demography of the 13/83 skeletal assemblage will be assessed by creating biological profiles. This will be achieved by using standard anthropological methods (described in Chapter 2) to assess biological sex, age-at-death, and stature.
- When biological profiles have been created, it will be possible to evaluate if there is a bias in the sample in relation to age-at-death and sex ratios. If bias is found this can be further discussed.
- A palaeopathological assessment will be carried out on each individual skeleton within the 13/83 skeletal assemblage using predetermined diagnostic criteria (see chapter 2).
- These will include any condition discovered within the skeletal assemblage. The pathological conditions recorded will be used for palaeoepidemiological research to understand how they are representative of disease trends within the collection and throughout time. Some of the conditions which are expected to be found have been discussed earlier in this chapter.
- Comparison between SCC and GI in terms of both demography and palaeopathology will include statistical analysis.
- Palaeopathological studies usually examine human remains on an individual basis of may look for a single pathological condition in multiple skeletal remains (Waldron, 2007). This palaeoepidemiological study seeks to contextualise palaeopathological analysis within bio-cultural and archaeological setting along with modern clinical data.

Chapter 2: Materials and Methods:

2.1 Materials and site history

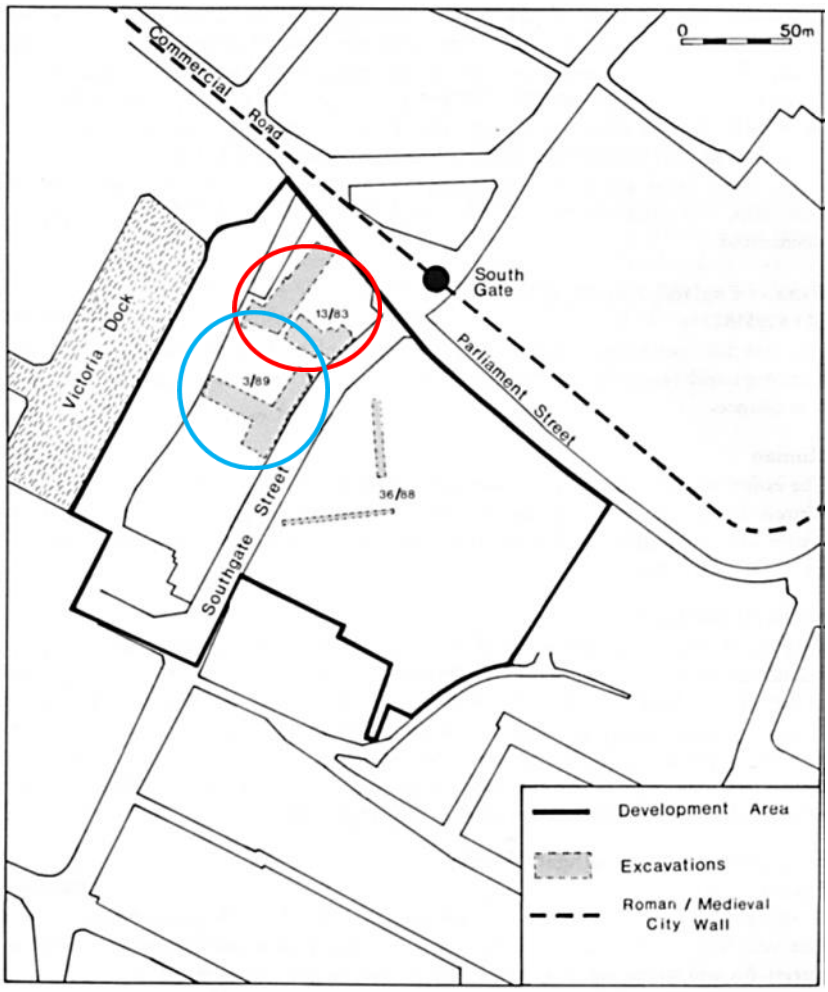


Figure 1: The location of excavation trenches and sites on Southgate Street Gloucester between 1983-1989. The red circle indicates the 13/83 site and the blue circle represents the excavation (after Atkins, 1990)

The archaeological record for site 13/83 and 3/89 excavations of Southgate Street (*Figure 1*) show occupation over multiple periods including Saxon huts, Roman masonry and civil war defensive ditches, as well as the site of St. Owens and the Gloucester Independent church. (Gloucester Archaeology, 1995; Atkins and Garrod, 1990). The church of St. Owen's was demolished in 1648 prior to the siege of Gloucester, the land was then leased to an Independent Chapel (SCC) (Herbert, 1988). This supports the information that the burials recovered from the excavations in 1983.

The Gloucester 13/83 collection consists of the skeletal remains of approximately 90 individuals. A total of 82 skeletons were utilised in this study as the burials in Trenches I, II, III and V (Table 1) could be accurately phased as 18th – 19th century. The remaining burials in Trench IV were from St. Owen's church and medieval in origin forming the test trench for the 3/89 excavation and therefore excluded from analysis. The physical location of individuals in trenches I, II, III and V can be identified from the archaeological plans (Figure 2).

Table 1: Location of trenches and the number of individuals in each trench and location.

Location	Trench Number	Number of individuals
Southgate Congregational Church (SCC)	I	1 (Skull only)
	II	36 (including 5 skull only)
	Total	**37**
Gloucester Infirmary Burial Ground (GI)	III	40 (including 7 Skull only)
	V	5 (skulls only)
	Total	**45**

The skeletal remains from 13/83 were transferred from Gloucester City Museum to LJMU and these contained both the articulated burials and disarticulated remains. Research carried out in separate research at LJMU included curation of these remains and separation of individuals from the disarticulated remains. Within these remains were several of the skull or crania only burials (Table 1). Information in relation to the 13/83 excavation from Gloucester City Museum was recovered. These included the context register and sheets, excavation plans, and photography (including the majority of skeletons *in-situ*). This information enabled cross checking with the original information and the materials housed at LJMU. This was important due to the amount of time which elapsed between excavation and analysis. Figure 2 (©Gloucester City Museum) is an example of an archaeological site plan which was recovered from Gloucester City Museum, clearly illustrating the site, the location and phases of the church as well as the separation of church burials from those in the other trenches. A proportion of the excavated burials are included on this plan. This plan shows that the burials from trenches I and II are within the walls of the 1851 church, with some of the trench II burials being located between the walls of the 1730 and 1851 buildings.

The terminology used for the skeletons in this collection is the trench number (in roman numerals) followed by assigned the skeleton/ context number e.g. I103, referring to entry 103 in the context register and was excavated from Trench I. These have been used throughout data collection. This was in-line with the methodology used by Gloucester excavations (Bryant and Heighway 2003).

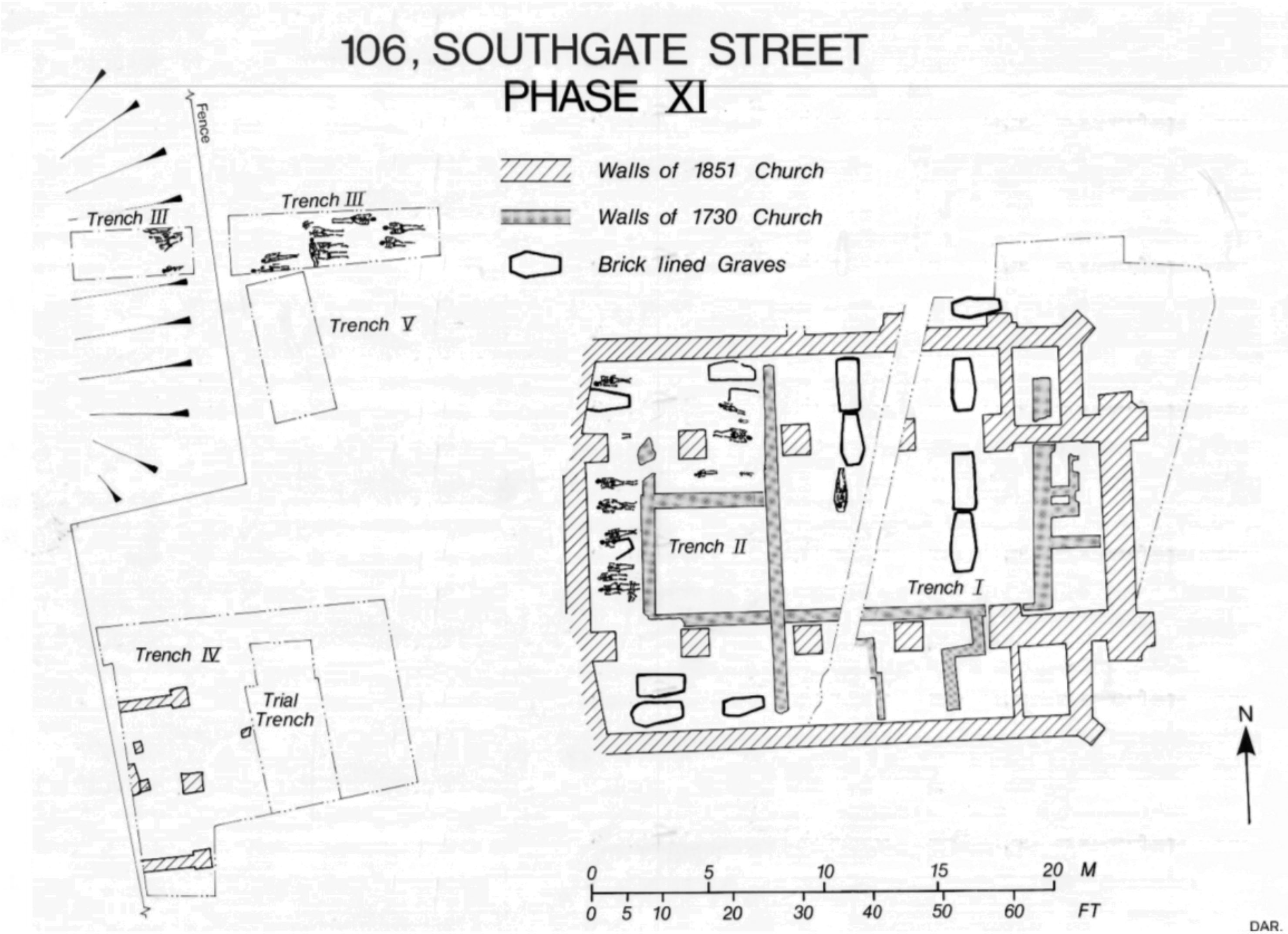


Figure 2: Plan of 13/83 archaeological site. Image ©Gloucester City Museum

Figure 3: 1851 Southgate Congregational Church building which was demolished in 1981 (Herbert, 1988)

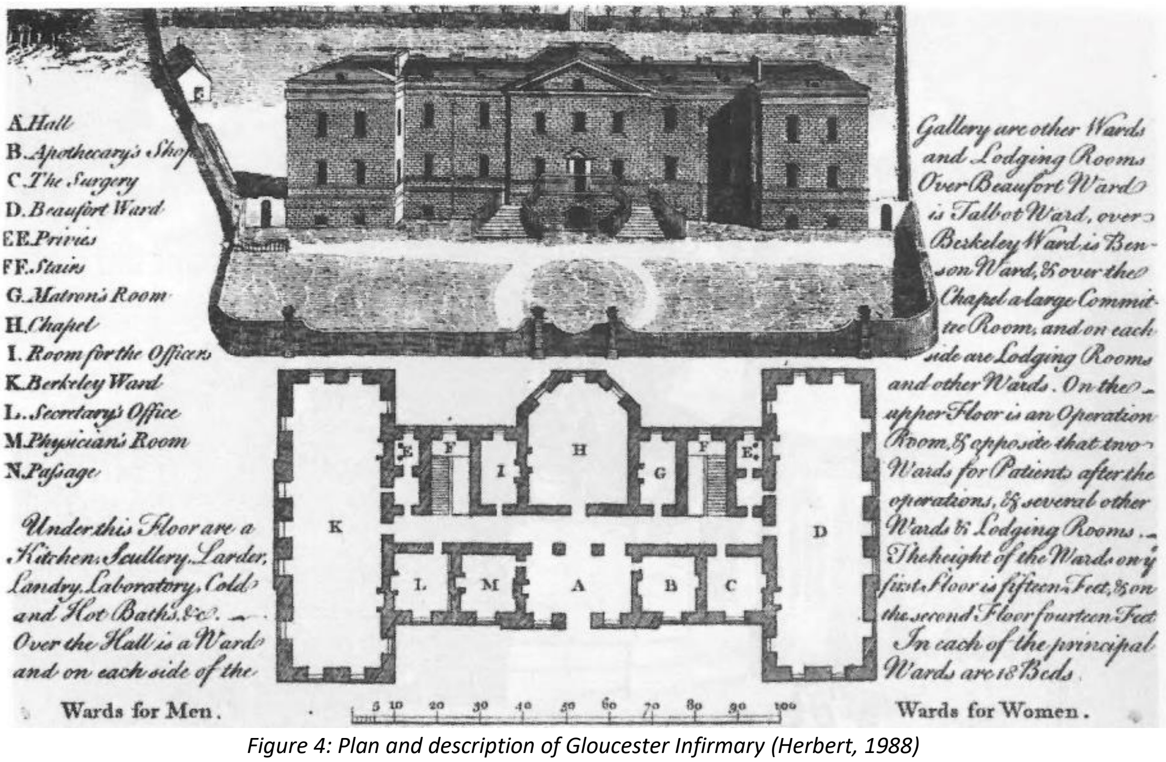


Figure 4: Plan and description of Gloucester Infirmary (Herbert, 1988)

The burial positions found within 13/83 (*Figure 2*) were mainly in east-west alignment, this was consistent with standard burial practices at the time and in earlier time periods including the medieval period (Daniell, 2005). However, there were burials which diverted from this position which will be discussed later in this thesis. The information contained within the archaeological records obtained from Gloucester City Museum (appendix 3) referenced accompanying coffin fitting with some of the burials. These fittings and associated finds are not contained within the material housed at LJMU. A combination of shrouded and coffin burials is indicated by the burial positions of the skeletal remains. Excavations carried out in 1989 (3/89), primarily containing burials from the medieval church of St. Owens also uncovered lead lined coffin burials believed to be from Southgate Congregational Church (Atkin and Garrod, 1990). These have not been examined as part of this study as they are not included in the 13/83 skeletal assemblage.

Southgate Congregational Church

Southgate Congregational Church was an Independent (non-parochial) church in Gloucester (Figure 3) established in 1730. Trenches I and II were located within the church (*Figure 2*). The church attendance declined in the late 18th century. However, the attendance of the church increased under the ministry of Rev. William Bishop (1797-1832), who carried out charitable outreach to the surrounding villages (Herbert, 1988). This information is supported by the church burial register presented below. The non-conformist churches pioneered the Sunday Schools movement providing education to the lower classes and impoverished. Southgate Congregational Church opened a Sunday school in 1812, and the schoolrooms were enlarged in 1830. The popularity of the church continued to grow necessitating a rebuild of the church in 1850 and re-opening in 1851 (Gloucester Archives (online), 2016; Herbert 1988). The Ordnance Survey map of 1880s Gloucester states that Southgate Congregational Church seated 850 people (National Library of Scotland, 2016). A religious Census of Gloucester was carried out in 1881. This found that over half the number of individuals attending church went to non-conformist institutions (Herbert, 1988).

Gloucester Infirmary

As stated in the introduction the Gloucester Infirmary (*Figure 4*) was an important landmark in the management of health and disease in Gloucester. The subscriptions for the infirmary were collected by the Bishop of Gloucester for the poor from the gentry and prominent residents as a matter of civic pride. Gloucester Infirmary was independent from the Workhouse Infirmary which was established later in a different area of the city (Herbert, 1988). The Infirmary burial ground was consecrated in 1781 and was located behind Southgate Congregational Church (Herbert, 1988). The locations of trenches III and V (Figure 2) have been identified belonging to this burial ground.

2.2 Methodology:

To carry out this research, a biological profile (sex, age at death, and stature estimation), as well as a palaeopathological assessment was completed for each individual in the Gloucester skeletal assemblage 13/83. These were carried out in-line with British Association for Biological Anthropology and Osteoarchaeology (BABAO) guidelines (Brickley and McKinley 2004). Data collection sheets included skeletal inventory and visual recording forms which were utilised to document the completeness of the human skeletal remains (appendix 2). This is important for bioarchaeological research and for palaeoepidemiological study (Brickley and McKinley 2004; Buikstra and Ubelaker 1994). Therefore, the methods most applicable to this ancestry were used. Data was compiled into an excel spreadsheet and analysed using IBM SPSS 23. Where applicable normality testing was carried out prior to data analysis. Photography of pathological conditions was carried out by myself unless otherwise stated.

Demography of Southgate Congregational Church from the burial register

One of the aims of this research is to explore contemporary and historical information about the burials occurring from both Southgate Congregational Church and Gloucester Infirmary in order to aid understanding the sample. Therefore, the SCC burial register was analysed to examine this. The demography of Southgate Congregational Church was established using the 1784 - 1837 burial records from of the church (appendix 1). These were made available through online National Archives and downloaded via an online genealogy service (findmypast.com, 2016). The records were then transcribed from the original handwritten scanned text to an electronic database (Microsoft Excel 2016) and used for data analysis. All the results are given as per the original record. However, interpretation of some entries was problematic due to the cursive handwritten style of the original document. Therefore, these entries have been classed as 'unknown', or the text has been transcribed as directly quoted in the burial register.

This enabled further analysis of the demography using IBM SPSS 23. Sex was recorded based on the names of the individuals and age were as given in the register. Individuals who were not definable were coded as 'unknown'. The ages of individuals were coded the same as those used in the biological profiling of the 13/83 skeletal collection except for those older than 60 years where additional age grouping was possible from the burial records.

Sample Preservation

Some of the issues which affect the preservation of bone have been addressed in chapter 1 (1.3). These include taphonomic changes and damage, in addition to successful recovery of human skeletal remains. Fragmentation and completeness of human remains was recorded in-line with BABAO guidelines (Brinkley and McKinley, 2004; Mitchell and McKinley, 2017). This was achieved using the inventory sheets which can be seen in appendix 2. This enabled the preservation of individual skeletal elements for the 13/83 collection in addition to the total number of burials was assessed. The presence and absence of skeletal elements were examined in addition to the occurrence of pathological conditions and lesions. The total number of skeletal elements present are presented in chapter 4. The majority of skeletal elements present were well preserved and the bone surface assessable for signs of pathological conditions. This was for the purposes of frequency analysis and some individual bones were grouped together. Fragmentation of remains was high in some of the individuals, this was especially true for the ribs, cranium and the bones of the hands and feet. This formed part of the rationale for grouping these bones together. Due to time constraints within this study, the collected data was simplified for the purposes of statistical analysis. The bones grouped together using collected raw data were the bones of the cranium, right and left ribs, right and left hands and foot bones, and the cervical, thoracic and lumbar spine. Future research could use all the collected raw data of skeletal elements on this collection. However, other research being currently conducted at LJMU is aimed at addressing the preservation of the skeletal remain including the 13/83 skeletal sample.

The exception to this was in congenital conditions which were primarily located on the spine in 13/83 which were analysed at each relevant spinal level (e.g. L5). Bones were scored as present regardless of the level of preservation. If individual bones were fragmented or partially complete, it was illustrated on the skeletal diagram. This was to enable analysis in the distribution of skeletal lesions in the 13/83 skeletal collection in this thesis and enable further analysis in future research.

Biological profiles of 13/83 skeletal collection:

Establishing a biological profile (sex determination, age-at-death and stature estimation) was essential to this research as it enables understanding of the demography of the skeletal collection and enables palaeoepidemiological study. The data collection sheets (Appendix 2) included specific methods for creating a biological profile and a list of the pathological conditions which were recorded can also be seen here. The selection of methods are in-line with anthropological standards (Buikstra and Ubelaker, 1994; Brinkley and McKinley, 2004; Mitchell and Brinkley, 2017). The use of up-to-date and current methodology has been stated as desirable, rather than relying solely on more established methods (Buckberry. 2015). For that reason, care was taken that the most appropriate methods were selected within this study. These methods are specified in this section.

Sex determination

Sex determination is not currently accurately achievable in subadult skeletons (Brickley and McKinley 2004; Mitchell and Brickley2017), and therefore was not be attempted in this research. Methods used for sex determination included the use of morphological traits on the pelvis, such as the sub-concavity, ventral arc, medial aspect of ischiopubic ramus (Klales *et al.* 2012; Phenice 1969), pre-auricular sulcus presence (Bruzek 2002), the greater sciatic notch (Walker 2005) and subpubic angle (Bass 2005; Ferembach *et al.* 1980). The curvature of the sacrum has been observed as a determinator for sex, as it is straight in females and curved in males (Anderson and Munro 1962; Bass 2005). Skull morphological traits were also used for sex determination, these included the supra-orbital ridge, mastoid process, nuchal crest, and mental eminence (Buikstra and Ubelaker, 1994).

Metric methods of various articular surfaces were also be used for sex determination such as humeral vertical head diameter, glenoid fossa height of the scapula, femoral vertical head diameter and bicondylar width (Bass 2005; Stewart 1979).

The majority of these deteminators were scored on a scale of 1-5, with 1 being female and 5 being male. The Klales method (Klales *et al.* 2012), which is an adaption of Phenice (1969) was selected for this purpose. A code of 6 was given to subadults and individuals where sex was not assessable (*Table 2*). These were placed into general sex categories of adult female (codes 1 and 2), adult male (codes 4 and 5), indeterminate (code 3) and subadult (code 6). These general sex categories were used for analysis of pathological condition frequencies.

Table 2: Classification codes and summary method for sex determination.

Sex	Code	Methods
Female	1	Innominate traits Sacral curvature Cranial and mandibular features Metrics
Probable Female	2	
Indeterminate	3	
Probable Male	4	
Male	5	
Not assessed	6	*For subadults and where methods are not applicable

Age estimation

Age estimation is one of the key components in creating a biological profile (Brinkley and McKinley, 2004; Mitchell and Brinkley, 2017). One of the main limitations with estimation age at death is the differences in chronological (time since birth/ conception) and the biological (physical) age of an individual (Mitchell and Brinkley, 2017). The biological age of an individual may not be the same as the chronological age.

The terms relating to 'childhood' chronological age may be described as an 'infant' (which is between one and five years) or juvenile (I and II) depending on the literature (Lewis, 2007). This can be confusing in bioarchaeological studies where exact chronological age is unknown. Consequently the term 'subadult' has been widely applied to encompass individuals under 18 years of age (Lewis, 2007; Mitchell and Brinkley, 2017). Lewis (2007), suggested that the term subadult has negative connotations and that the term 'non-adult' be applied instead. As both these terms are now both used synonymously within current literature (Mitchell and Brinkley, 2017), the term subadult has been selected for this study (with no negativity intended).

One of the fundamental necessities in comprehensive research into past populations requires the ability to compare datasets (Buckberry, 2015). There is inconsistencies within the bioarchaeological text between the age ranges which account for age-at-death categories, in many cases depending on the authors' interpretation (Buckberry, 2015; Merritt, 2017). It is therefore important to state which biological age groupings (*Table 2Table 3*) are being used in this research (Buckberry, 2015; Mitchell and Brinkley, 2017). However, there are usually divided into subadult/ non-adult, young adult, middle adult, and old adult. The majority of studies classify 'old-adults' as over 50 years although the end of the 'young-adult' range differs widely with the 'middle adult' category depending on the other two classifications (Buckberry, 2015). Within this study, the individuals were aged into five general categories (*Table 3*); Sub-adult (0-17 years), Young Adult (18-29 years), Mid-adult (30-49 years), Old adult (50+), and unassessed adult (this was only applied when exact aging was not possible). These were selected due based on aging techniques. These broad age categories were then divided into more specific age ranges (see below) to enable better comparison between the results of this study and other publications. For this study, the age of individuals was estimated using a combination of methods. The age categories used for biological profiles were also used for analysis of the burial register in chapter 3.

Age assessment of subadults

Age estimation is reliant on changes that occur to the skeleton due to maturation and size changes in ontogeny (White and Folkens, 2005). It is widely accepted that age estimation in most accurate in individuals which are still growing (i.e. subadults) (Franklin. 2009). These changes include dental development and eruption (Alqahtani *et al.* 2010), and observation of skeletal development and size (e.g. long bone diaphyseal length) and epiphyseal closure (Schaefer *et al.* 2009). These developmental changes occur in a predictable sequence within younger individuals and can therefore indicate more a precise age-at-death than following growth cessation (Buckberry, 2015). Considerable research has been conducted and complied to create reference texts containing age specific ranges of measurement (using an osteometric board), development rates (e.g. epiphyseal closure) for archaeologists, osteologists and anthropologists (Cunningham *et al.,* 2016; Schaefer *et al.* 2009; Scheuer and Black, 2000; 2004). The use of these texts to enable subadult age estimation has been advised (Márquez-Grant, 2015; Mitchell and Brinkley, 2017) and have been utilised within this research.

Dental eruption (Alqahtani *et al.* 2010), has been stated as the most accurate method of estimating age in subadults as it is unaffected by disease and malnutrition which may influence growth and development rates observed using epiphyseal closure and long bone measurement (Mitchell and Brinkley, 2017). All these methods were employed in the age assessment of 13/83 subadult individuals due to varying completeness of the skeletal remains.

1. <u>Sub-adults (0-17 years)</u>

Sub-adults were divided into additional classes (*Table 3*). The 0-2 year bracket used in this study included perinatal individuals (24+weeks gestational age), this is a broader category than used by

Lewis (2007) for 'infants' which is up to one year of age. The rationale behind this was due to the overall small sample size of the 13/83 skeletal assemblage and an expectation of low numbers within this group. This will be discussed during the thesis. Lewis (2007) uses 'child to describe individuals aged between one year and 14.6 year. The age sub-categories of '3-8years' and '9-14years' divides this in two to enable demographic comparison to be carried out more readily. The '15-17years' category is consistent with Lewis' (2007) classification of an 'adolescent' as '14.6-17years'.

Age assessment in adults

The methods used for age estimation in adults (≥18 years) primarily focus on observable degenerative changes in specific areas of the skeleton including sternal rib ends (Işcan *et al.* 1984; 1985), auricular surfaces of the ilium (Lovejoy *et al.*,1985) and pubic-symphysis surfaces (Todd, 1920; Brooks and Suchey 1990). When estimating age in adults, sex needs to be determined prior to analysis as some of the methodology is dependent on this factor (White and Folkens, 2005).

The use of sternal rib ends for age assessment was developed using the left 4th rib (Işcan *et al.* 1984; 1985) and can be used to potentially age individuals from young to older ages (70-85 years). Due to fragmentation and incompleteness of the ribs (such as within the 13/83 skeletal assemblage), it may be difficult to isolate the left 4th rib. However, further studies have found that this method was also accurate when applied to the 3rd-9th ribs from right and left sides (Buckberry 2015; Márquez-Grant, 2015). Therefore this method was employed. An additional study found that this method did not produce the same age biases as found other methods when body size was accounted for and was one of the most reliable in individuals with normal to obese body mass indexes (Merritt, 2017).

The method of age estimation using auricular surface of the ilium (Lovejoy *et al.,* 1985) has produced differing reliability in some studies. This was reported as low as 27% by Buckberry (2015). A revised method produced by Buckberry and Chamberlain (2002) using the Spitalfields skeletal assemblage has adapted this technique to produce a composite score for more accurate results. One of the main issues which affected the results of the Lovejoy *et al.* (1985) method has been stated as the narrow age brackets indicated (Buckberry, 2015). This current studied used the Lovejoy *et al.* (1985) method as it is well-established and widely used. Merritt (2017), found that the original method showed good reliability regardless of body mass whereas the Buckberry and Chamberlain (2002) over-estimated age in obese individuals.

Dental attrition is another degenerative method commonly used for age estimation (Mitchell and Brinkley, 2017). The Miles (1963; 2001) and Lovejoy (1985) assess changes using all the dentition and the Brothwell (1981) method examines molar wear for this purpose with good reliability. However, the diet of an individual effects the amount of dental wear (Walker and Hewlett, 1990) There were changes to diet during the 18th and 19th century (Whittaker and Molleson, 1996) including the introduction of less course processed foods in addition to the establishment of the dentistry profession which is addressed in chapters one and four. These methods for dental attrition are devised from prehistoric, Anglo-Saxon and medieval individuals and therefore not necessarily applicable to the 13/83 skeletal assemblage. The Lovejoy (1985) method was selected for use this study as it has a comprehensive classification system. However, the results of this method were only applied when other age estimation options were not available. The observation of cranial suture closure (Meindl and Lovejoy 1985) has been widely used within anthropology and bioarchaeology to evaluate age in older individuals. However the reliability of this method has been queried and has therefore only been applied in this study cautiously alongside multiple methods as recommend by BABAO standards (Brinkley and McKinley, 2004; Mitchell and Brinkley, 2017).

It is not within the scope of this research to assess the reliability of individual methods for age estimation. For this reason, multiple methods were applied and age ranges were derived in for individuals based on the combined values. If future research is being conducted into age demographics, the 13/83 skeletal assemblage could be used with the Buckberry and Chamberlain (2002) method as this method are devised from a British skeletal sample from the same time period whereas a lot of the methods routinely employed were formulated from American skeletal material.

2. *Young adult (18-29 years)*

This age category (*Table 3*) was divided into two sub-classes '18-24 years' and '25-29 years'. As mentioned above there is some debate over the ages contained within the young adult group. However the final skeletal maturation (e.g. fusion of skeletal elements) occurs between these ages (Buckberry, 2015; Márquez-Grant, 2015; Mitchell and Brinkley, 2017). It is therefore possible to use additional methods (in combinations to those described above) to accurately determine age such as medial clavicle and anterior iliac crest fusion (Webb and Suchey 1985), and the eruption of the third molar (Alqahtani *et al.* 2010).

3. *Mid-adult (30-49 years)*

The middle adult category (*Table 3*) was divided into four sub-classes of five year increments to enable comparisons to other studies and demographics.

4. *Old-adult (50+ years)*

There are inadequate anthropological methods for determining age in adults (Mitchell and Brinkley, 2017). This will be further discussed in chapter five, therefore the sub-classes created in this method only extend to '60+ years'.

Table 3: Age category classification and methodologies applied.

Age category	Age (years)	Age Sub Code	Methods
1. Sub-adult	0-2	1	Long bone measurements Epiphyseal closure Dental eruption
	3-8	2	
	9-14	3	
	15-17	4	
2. Young Adult	18-24	5	Dental Eruption Epiphyseal closure (iliac crest and medial clavicle) Surface of pubic symphysis Dental attrition
	25-29	6	
3. Mid-Adult	30-34	7	Surface of pubic synthesis Dental attrition Cranial Suture closure Auricular Surface Sternal rib ends
	35-39	8	
	40-44	9	
	45-49	10	
4. Old-Adult	50-54	11	Dental attrition Cranial Suture closure Auricular Surface Sternal rib ends
	55-59	12	
	60+	13	
5.Unspecified adult	18+	0	*only used when aging techniques are not applicable

Stature estimation

Stature is important for osteological and anthropomorphic studies as it indicates the size of an organism (Mays, 2016). Stature is used as a measure of sexual dimorpism, with females being consistantly shorter than males although the amount of sexual dimorpism and height differences varies between populations (Gray and Wolfe, 1980; Holden and Mace, 1999). Although stature does not necessarily form part of palaeoepidemiological studies, the incusion of stature within this study is to enable comparision with other populations and to aid better understanding of the 13/83 sample. Stature was estimated in adult skeletal remains using long bone (such as the femur) maximum length measurements. The maximum bone length is calculated using an osteometric board from the most proximal to the most distal part of the bone (Buikstra and Ubelaker, 1994). Left (non-pathological) bones were selected where available in-line with anthropological standards (Brinkley and McKinley, 2004; Buikstra and Ubelaker, 1994). However, when only right bones were available these were utilised, as previous research found no statistically significant difference between the measurements of left and right bones in medieval Gloucester (Martin *et al.,* 2016). This measurement is then applied to the appropriate regression formulae (Trotter 1970). The formula selected relied on the determined sex and ancestry. The available bones with the lowest standard deviation were selected for measurement and calculation. A study by Mays *et al.* (2016), found that these methods still showed good reliability when applied to British archaeological samples, the femur showed the most accurate results however it was still acceptable to use other long bones if the femur is not available.

Identification of Pathological conditions and diagnostic criteria

The identification of palaeopathological conditions is essential for this research. The identification of palaeopathological conditions relies on the recognition of abnormality and lesions on the entire human skeleton (Roberts and Manchester 2010; Waldron 2009). Ortner (2003), states that are five types of observable changes to the skeleton that may indicate a pathological condition these include bone destruction, bone formation and abnormalities in bone size, shape and density. As stated previously, each skeleton in the 13/83 skeletal assemblage was examined macroscopically and the presence and absence of each skeletal and dental element. These elements were examined for signs of pathological conditions and lesions. This information was then recorded and transcribed onto an Excel spreadsheet using the appropriate data collection forms in appendix 2. The data and conditions found were summarised for each individual along with their biological profile and their burial location (SCC or GI) (see appendix 5). Skeletal elements were then grouped together for the purposes of analysis and pathological conditions/ lesions present on these elements were reported.

Conditions were be identified using the data collection forms included in appendix 2. Each condition was given a code prior to data collection, these can also be found on the data collection sheets in Appendix 2. The diagnostic criteria for commonly assessed (i.e. conditions commonly found in archaeological skeletal assemblages) were determined prior to the commencement of data collection as advised by anthropological standards (Brickley and McKinley 2004; Buikstra and Ubelaker 1994). Conditions which were identified and did not have a predetermined diagnostic criteria were assigned the code 'other' and a differential diagnosis was conducted. For example, Osteochondritis dissecans was coded as '39 – other joint condition'. Only the diagnostic criteria conditions found in this collection are summarised in this methodology.

Analysis of selected human remains included radiological examination using HP cabinet system Faxitron series and IXPect for EZ computer and Microdicom software.

Dental Conditions

The absence and presence of dentition was noted along with whether teeth were loose or *in-situ* was recorded. Dental sockets were observed in preserved maxillae and mandibles to assess post-mortem and antemortem tooth loss (see below). This dental inventory was conducted using visual recording forms and the Fédération Dentaire Internationale (FDI) system of recording as advised in anthropological standards (Brinkley and McKinley, 2004; Mitchell and Brinkley, 2017). Although this data was collected for individual teeth, due to the scope of the research being conducted only the presence and absence of dental conditions within each individual skeleton were reported. The following dental conditions were assessed however, the severity and location on individual teeth was not recorded. Frequencies were calculated using only individuals with dentition present.

Antemortem tooth loss

Antemortem tooth loss is recognisable as the affected sockets are infilled with new bone as they are healing (Roberts and Manchester, 2010). Dentition can be lost for several reasons including extraction, trauma, scurvy or periodontal disease, which accounts for the majority of antemortem tooth loss (Al-Shammari *et al.* 2005). Therefore when the maxilla and mandible were observable it was possible to assess for this condition. The amount of healing and new bone was not recorded and varied between and within individuals with AMTL. However, examples of this have been presented later in this thesis. When AMTL occurs within an individual it is not possible to observe the tooth for other dental conditions, as this study does not analyse data for individual teeth or sockets additional studies may be able to assess this factor.

Caries

Dental caries are classed as an infectious dental disease caused by bacteria in the oral cavity and may be the most common dental pathology (Roberts and Manchester, 2010). These can be recognised by erosion of enamel, cement and dentine due to progressive demineralisation (Hillson, 2005; 2008; Roberts and Manchester, 2010). There are two types of dental caries, crown (coronal) caries and root caries (Aufderheide and Rodriguez-Martin, 1998; Hillson, 2005; 2008). Crown or coronal caries are lesions which affect the various areas of the tooth crown and can progress to form a cavity involving the dentine and the pulp chamber (Hillson, 2001; 2005; 2008). Root caries affect the lower part of a tooth. These may occur due to compromisation of the supportive tissue surrounding the dentition, recession of the gums (gingivae) from periodontal disease and may be more common later in life (Hillson, 2001). The observation of caries in dry fully exposed archaeological remains has diagnostic advantages over living individuals as it is possible to view the dentition without restriction (Hillson; 2008). However, there may be difficulties comparing modern epidemiological studies of caries and archaeological remains due to differing diagnostic criteria and bias within the archaeological sample (Hillson 2001; 2008). Bias may exist due to the differing rates of dental preservation and recovery, as well as differing expression rates by sex and age groups (Hillson 2001; 2008). Hillson (2008), states that it is important to divide individuals by age groups and sex when analysing caries statistically. This was done with the individuals from the 13/83 skeletal assemblage. No differentiation was made between root and crown caries for the purposes of the current study and therefore the prevalence rates stated in chapter 4 indicate the number of individuals with any detected carious lesions.

Calculus

Calculus is mineralised plaque comprising of micro-organisms in the mouth (Roberts and Manchester, 2010). Calculus accumulates at a higher rate in high carbohydrate and/ or protein diets in alkaline oral environment. Calculus can be seen above (supragingival) or below (subgingival) the gum line (Hillson, 2005; Roberts and Manchester, 2010). Supragingival calculus is more common and is typically grey or brown in colour and is frequently thicker than the subgingival type which can be seen on exposed tooth roots, this tends to be green or black in colour. Calculus tends to develop on the dentition nearest the salivary glands (lingual aspect of the mandibular incisors and the buccal aspect of the maxillary molars). This is a common finding in archaeological remains due to differing dental hygiene practices (Roberts and Manchester, 2010). Care is advised when recording the presence of dental calculus as it can be easily damaged (Hillson, 2008). Dental calculus can be used for isotopic analysis providing information on diet and migration (Hillson, 2005). Calculus is therefore useful within bioarchaeological studies in addition to the impact of dental health. This was done on a number of individuals from 13/83 as part of doctoral research being conducted at LJMU. Studies have measured the extent of calculus (Brothwell, 1981) within individuals of a sample however this did not form part of the research in this study.

Dental Abscesses

Periapical cavities (voids surrounding the tooth root) can result from infections, cysts and walled granulomas (Mitchell and Brinkley, 2017; Ogden, 2008). It is becoming more common to use this terminology rather than 'dental abscesses' within palaeopathological and bioarchaeological literature as an inclusive term (Hillson 2005; 2008; Ogden, 2008). Differential diagnosis was not carried out due the extent of different conditions being analysed within this study. Therefore 'dental abscess' has been used in-line with Roberts and Manchester (2010). Acute dental abscesses (DA) can occur secondary to dental caries (Robertson and Smith 2009). These were recognised if there was a drainage channel present for the exudate resulting from infection and inflammation. These usually run from the top (apex) of the tooth to the surrounding alveolar bone and result in localised bone destruction (Keenleyside 2008; Molleson and Cox 1993). As with AMTL this condition requires observation of the maxilla and mandibular skeletal elements. However it is also possible to examine the occurrences of other dental pathological conditions within the neighbouring dentition.

Linear Enamel Hypoplasia

Linear enamel hypoplasia (LEH) indicates nutritional deficiencies and other 'stress indicators' such as childhood illnesses which may have occurred during an individual's growing years (Larsen, 2015). This condition primarily occurs in the permeant dentition where grooves or pits are created when the tooth enamel is forming in childhood in a characteristic linear pattern on the surface of the tooth (Hillson, 2008; Larsen, 2015). They are commonly visible on the incisors and canines (Roberts and Manchester, 2010). As stated previously in this chapter, dental development and eruption occurs at a predictable rate. It is therefore possible to determine the age of an individual when they were subjected to the 'stress-event'. This can be done by measuring the linear pattern and comparing the data with published literature (Hillson. 2008; Larsen, 2015; Reid and Dean, 2006). The presence of this condition was recorded when observed macroscopically. The frequency and depth of lesions was not explored within this study. Additional research into this condition including microscopic analysis is currently being conducted at LJMU. However, even when observed macroscopically this condition can aid in the understanding of the 13/83 skeletal assemblage.

Skeletal Palaeopathology

Skeletal conditions and pathological conditions were classed into six different groups; trauma, congenital, joint, infectious, metabolic and neoplastic. The methods used and a brief description on the identification of the different pathological conditions found in the 13/83 skeletal collection are listed below.

Trauma

Fracture

A fracture is a partial or complete break in continuity of a bone caused by trauma. Types of these include compression, transverse, oblique, spiral, comminuted, greenstick, impacted, open/compound, simple/ closed, and traction/avulsion (Grauer and Roberts 1996; Lovell 1997; 2007; Ortner 2003; Waldron 2009). Antemortem fractures are distinguishable from post-mortem or taphonomic damage due to signs of healing. Post-mortem and taphonomic damage may have a colour change on the break surface compared to the bone surface, this colour difference will not be evident in peri-mortem trauma (Walker 2001). For the purposes of this thesis, only the presence and location of fractures were assessed in individuals, rather than the specific types of fracture. However, examples of fracture types including perimortem fractures these are discussed.

Perimortem fractures show clear fracture lines with either no evidence of healing or a small amount of callus around the area of the fracture (Chhem and Brothwell 2008; Roberts and Manchester 2010). In antemortem healing fractures, there will be signs of healing with either malunion or good alignment. Healed antemortem fractures can be distinguished by changes to the external bone proportions or signs of malalignment. These may be visible radiologically (Chhem and Brothwell; 2008).

Sharp force injury

Sharp force injuries leave characteristic marks on the bone which vary depending on the type of implement used (Sauer 1998). Whilst it is possible to determine the type of blade or implement used in sharp force injuries and the angle of impact(Lewis 2008), it was not attempted on 13/83 skeletal remains.

Congenital conditions

This study examined the presence of congenital conditions rather than non-metric traits such as metopic sutures, and sternal aperture. As all the congenital conditions found in 13/83 were located on the spine, the frequencies per vertebrae were recorded which differs from how all other conditions reported.

Spina bifida occulta

Spina bifida occulta is a clinically insignificant condition where the laminae of the sacrum are unfused and is diagnosed by observation (Barnes 2012; Waldron 2009). This was scored as present when 3 or more vertebral arcs were unfused (Bradtmiller 1984).

Sacralisation /Transitional vertebrae

Transitional vertebrae are a spinal border shift, which can occur in a cranial or caudal direction, where the vertebra has the morphological traits of the adjacent spinal segment (Aufderheide *et al.* 1998). When this condition occurs on the sacrum it is known as sacralisation. Sacralisation is a vertebral shift, the lumbar and/or the coccygeal vertebrae fuse onto and become part of the body of the sacrum, this can be partial or complete fusion (Barnes, 2012). When the first sacral segment (S1) takes on the characteristics of a lumbar vertebra it is known as lumbarisation (Aufderheide *et al.* 1998; Barnes 2012).

Spondylolysis

Spondylolysis is a recognisable defect in which part of the neural arc separates from the main portion of the vertebra from the inferior facets. This may cause spondylolisthesis where the vertebral body slides forward (Roberts and Manchester, 2010). This condition is commonly caused by congenital *pars interarticularis* defect, which is exacerbated by traumatic or occupational stress (Fibiger and Knüsel 2005; Mays 2007). There has been some debate into the correct classification of this condition. However, for the purposes of this study it has been classed as congenital in-line with Aufderheide and Rodrıguez-Martin (1998). Barnes (2012), Molleson and Cox (1993) and Ortner (2003),

Other congenital

Other congenital diseases found in 13/83 were coded when there was evidence of developmental defects defined in Barnes (2012) and were either not classifiable as a specific condition or meet the criteria above.

Joint diseases

These conditions were placed into this group when there was evidence of a pathological condition on an articular surface.

Osteoarthritis (OA)

Commonly classed as a degenerative joint condition, the diagnostic criteria used for OA was according to Waldron (2009). This states that OA is present if there is eburnation or if two of the following are present: new bone formation on the joint surface, changes to the contour of the joint, pitting on the joint surface, and marginal osteophytic growth.

Schmorl's Nodes (SN)

Schmorl's nodes are discernible as an impression on the vertebral body surface which is lined with cortical bone. They are extremely common, especially in the thoracic and lumbar vertebrae. They vary in shape and sometimes extend into the vertebral canal. They are caused by a herniation of the intervertebral disc nucleus. Schmorl's nodes are found with degenerative intervertebral disc disease (Ortner, 2003). Whilst this condition is debatably a joint condition as there is no direct articulation between vertebrae, it has been classed as such for the purposes of this study as in previous literature (Aufderheide *et al.* 1998; Mann and Hunt 2005; Ortner 2003; Pinhasi and Mays 2008; Roberts and Manchester 2010; Waldron 2009).

Degenerative Disc Disease (DDD)

Degenerative Disc Disease or Intervertebral Disc Disease (IVD) as termed by Waldron, (2009) can affect any area of the spine and is very common. It is defined by pitting and osteophytosis of the vertebral bodies (Molleson and Cox, 1993; Roberts and Manchester, 2010). For the purposes of this study bridging osteophytes of the spine and IVD are classed together as DDD where their presence has been stated separately in some studies e.g. T Waldron (1991a).

Other Joint conditions

Other joint conditions which were found either in isolation or did not meet the classification criteria of a specific condition are included in this category. There were several different conditions included in this category.

These conditions included Osteochondritis dissecans (OD). This condition could also be included a traumatic condition however for this study if has been categorised as a joint condition. Osteochondritis dissecans results from either traumatic injury or repetitive stress to the affected joint and is most commonly found in younger individuals. This is identified by a circular depression on the joint surface, most commonly the knee joint. It is caused when a necrotic fragment of bone becomes detached and is resorbed or healed into the lesion (Aufderheide *et al.* 1998; Ortner 2003; Roberts and Manchester 2010; Waldron 2009).

Example of conditions which did not meet specific diagnostic criteria included joints which have evidence of osteophytic growth, however there are no other classifiable OA signs; and an individual had evidence of DISH, however due to fragmentation of the skeleton, it was not possible to observe fusion of 3 or more vertebrae (Waldron, 2009). There was another individual with ante-mortem destruction of the MTC4 head, this could also have been traumatic or infectious however the neighbouring proximal phalanx was absent in this individual, therefore this was classed as 'other joint condition'.

Infectious conditions

Ortner (2008, p194), provides a useful table for differential diagnosis of infectious disease.

Periostitis

Periostitis refers to the inflammation of the periosteal bone surface caused by either local or systemic infection which results in bone forming lesions on the bone surface (Ortner 2008; Weston 2008; 2012). Osseous plaque characterises the skeletal lesions which have either irregularly elevated bone surface or defined margins (Larsen, 2015). These lesions can be healed or active. Once healed these skeletal lesions have the appearance of compact bone. In the event of a localised chronic infection, for example resulting from a skin ulcer, the lesion may appear as a mixture of compact bone and osseous plaque (Ortner, 2008, Larsen, 2015). Periostitis is one of the most common conditions in palaeopathological studies. The location of the lesions should be considered in the differential diagnosis for other palaeopathological conditions (Ortner, 2008; Weston, 2012).

Metabolic Conditions

Cribra Orbitalia and Porotic Hyperostosis (PH)

Cribra Orbitalia (CO) are porotic lesions within the orbits of the frontal bone (Roberts and Manchester, 2010). These range in severity from minor porosity to a porous honey-comb enlarged diploë in the extreme (Steyn *et al.* 2016).

Porotic hyperostosis (PH) was first described under this term by Angel (1966). Linked closely with CO, PH is characterised by macroscopic porosity and pitting. However rather than affecting the frontal orbits, it affects the external surface cranial vault, usually symmetrically. These conditions are two of the most commonly found in human skeletal remains (Walker *et al.* 2009). As stated in Chapter 1, these conditions are skeletal symptoms of metabolic or nutritional distress which include anaemia (Angel 1966; Larsen 2015) and have therefore been included as a metabolic condition.

Rickets/Osteomalacia

Vitamin D deficiency is defined as rickets when it occurs in the growing phase, it is characterised by bowing or deformity of the weight-bearing bones (depending when the individual was affected, the upper limbs may be affected in addition to the lower limb), enlargement of the long bone epiphyses, 'rosary' rib cage and bending of the spine (Holick 2006; Larsen 2015; Roberts and Manchester 2010). Osteomalacia refers specifically to as vitamin D deficiency in adults, skeletal manifestations are more subtle once growth has ceased, this can lead to under diagnosis in archaeological remains. General bone deformities are caused to the weight-bearing bones of the pelvis, rib cage, vertebrae and femora (Brickley *et al.* 2005). A characteristic feature of osteomalacia are pseudofractures (Looser's zones) which may develop into stress fractures. These manifest symmetrically on specific areas of the skeleton including the pubic rami, scapulae, and femoral neck (Brinkley *et al.*, 2005; 2007). Whilst lower limb bowing is most common when vitamin D deficiency occurs during ontogeny, it can also occur with severe deficiency in adults (Larsen, 2015). Therefore, when this was found in the 13/83 collection these individuals were classed as having 'Rickets/osteomalacia' as differentiation was not possible and therefore both these vitamin D deficiencies have been categorised together.

Neoplastic conditions

The location of neoplastic lesions on the skeleton can help with the specific diagnosis of the type of these conditions and this forms part of the results and discussion. However, there is difficulty within osteological analysis with neoplastic diagnosis and the differentiation between primary and secondary lesions (Brothwell, 2008; 2012).

Osteomas

As stated in the introduction, Ivory or Button osteomas are benign growths of bone tissue most commonly found on the cranium and grow slowly. They grow slowly are not normally of clinical significance, however their presence may be symptomatic depending on location such as in the maxillary sinus (Brothwell 2008; Brothwell 2012; de Chalain and Tan 2003).

Other neoplastic conditions

This category was used for one individual who had evidence of neoplastic growth which was not classifiable as a specific neoplasm.

General limitations of methodologies

There are a number of issues within the devising a palaeopathological and palaeoepidemiological study. A number of these have been addressed in chapter 1 and elsewhere. However, the main problems encountered related to different methodologies between studies. The use of up-to-date methods in deriving demography and diagnostic criteria as advised by Mitchell and Brinkley (2017) can be problematic as comparative studies employed other methods. Therefore, comprehensive and cohesive methods as advised by Roberts (2000b) are not always applicable. This will be further explored in chapter 5.

Palaeoepidemiology

Palaeoepidemiology studies measure disease frequency within a skeletal assemblage. This is done by establishing the incidence and prevalence rates. The incidence is the number of individuals presenting new cases expressed within the population at risk. `The formula (a) for incidence rate is expressed below. The incidence rate is used in modern medical epidemiological studies as it is possible to calculate using longitudinal and cohort studies, where patients have a known history and risk factors. The prevalence rate is applicable to palaeopathology and archaeological studies as it examines the number of cases in the study group. It is possible to estimate the incidence rate by studying the prevalence and the duration of the condition. The formulae used for this are also presented below (b and c) (Boldsen 2012; Pinhasi and Turner 2008; Waldron 2007; Waldron 2009).

The crude prevalence rates (CPR) is presented in this study as the number of individuals affected by specific conditions within the total skeletal assemblage (formula b). The true prevalence rate is stated where applicable. This was calculated using the total number of an affected bone and the total specific bone present in the assemblage.

Previous studies as discussed above (for example Grauer and Roberts, 1996; Milner *et al.,* 2015) apply these formulae to individual skeletal elements. In addition, they examine the relationship between disease, sex and age to explore the interaction between the disease and the population. Therefore, these formulae will be applied to the conditions found in Gloucester 13/83 to calculate their prevalence rates.

(a) $\text{Incidence } (I) = \frac{num\text{ber of new cases (n)}}{Population\ at\ Risk\ (N)}$

(b) $\text{Crude prevelence rate } (P) = \frac{Number\ of\ cases\ (n)}{Number\ in\ assemblage\ (N)}$

(c) $\text{True prevalence rate } (P) = \frac{Number\ of\ cases\ by\ skeletal\ element(n)}{Total\ number\ of\ skeletal\ element\ \ (N)}$

(d) Condition prevalence (*P) ≈ Incidence (I) x Duration of the condition (D)*

Chapter 3 Demography of Southgate Congregational Church Burial Register

This chapter explores and presents the information gained through the analysis of the Southgate Congregational Church (SCC) 1784-1837 burial register (Appendix 1). As stated in chapter 1, it is unusual in an archaeological context to be able to estimate the proportion of burials recovered (Waldron, 2007). However, in the case based on the number of burials recorded in burial register (n=295) and the number of skeletons recovered (n=37), 12.54% of burials are estimated to have been recovered. The burial register contained 295 entrants providing information about the attendants of SCC and those buried by the church. It is therefore possible infer direct information about the skeletal remains recovered from SCC. The burial register contained names, the date of burial, (chronological) age at death, the area of residence and in selected cases the names of parents, and occupations. This collected historical data and results can be used to contextualise the burials carried out by the church and enable comparison with the biological and palaeopathological information produced during historical analysis. This aids in the palaeoepidemiological study undertaken in this thesis.

3.1 Residence, Occupations, and years of death

Southgate Congregational Church was a non-parochial church. The area of residence listed (abodes) for individuals in the burial register for SCC can be seen in *Figure 5*. There were a wide range of abodes and parishes listed (44 excluding the 'unknown' category). Information that was unknown or unlisted in the original register the entry is included in Figure 5 (as the 'Unknown category').

A map of Gloucester (Figure 6**Error! Reference source not found.**) from between 1873 – 1888 (National Library of Scotland [online], 2016) shows the location of some of the Gloucester parishes in relation to Southgate Congregational Church and Gloucester Infirmary. Table 5 indicates that the highest frequency of individuals was from the St. Michaels and St Owen's parishes (n=73). However, these parishes only account for approximately 25% (n=73/295) of the total individuals. The parishes with the highest frequencies were close geographically to SCC. However, some of the listed residences were outside Gloucester and are not shown in Figure 6, including St. Catherine (n=8) which is located north of St. John's parish, and Quedgeley (n=5) which is located approximately 5km south of SCC.

Only eleven individuals had occupations listed in the burial register. These included two of the Southgate Congregational Church ministers, a pupil of the minister, two members of the South Gloucester Militia and the remaining six individuals were involved in manufacturing (woolstapling, drapery, shoe making, printing, carpentry and cooping).

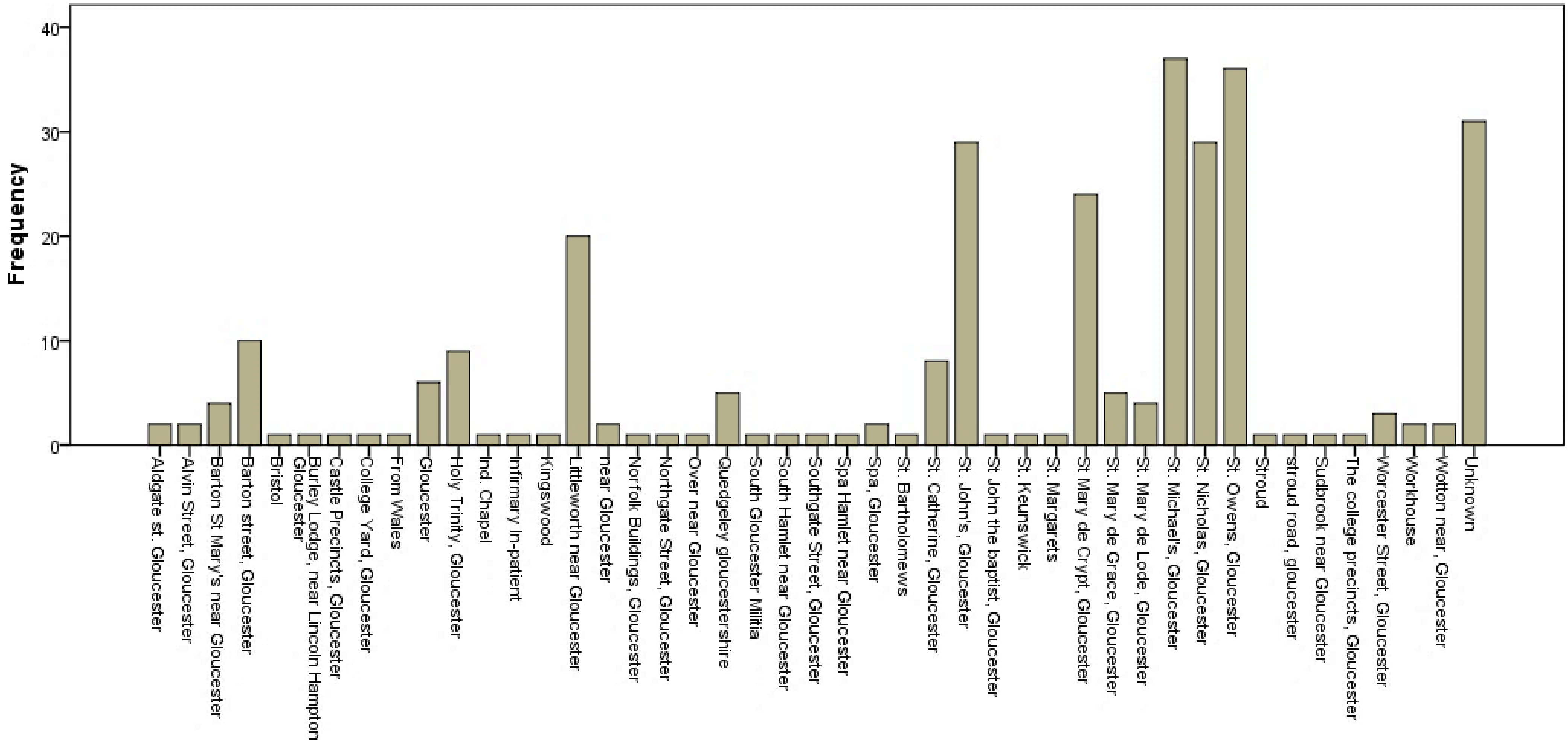


Figure 5: The listed residence of individuals at their time of death from the SCC burial register in alphabetical order.

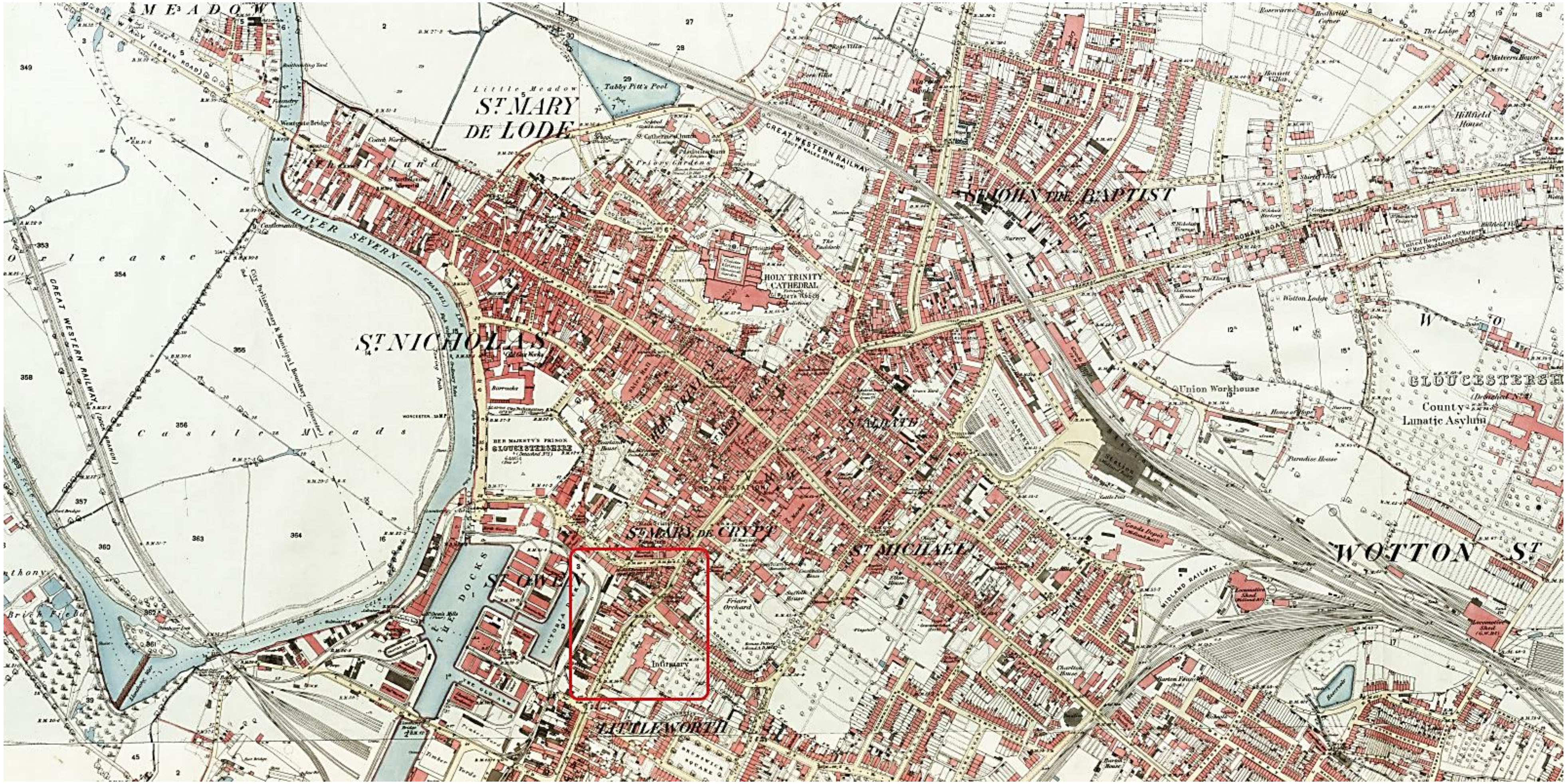


Figure 6: Gloucester c1873-1888 with parochial locations. Location of SCC and Gloucester Infirmary highlighted in the red box. Reproduced with the permission of the National Library of Scotland (2016)

Table 4: Frequency and percentage of the listed parish or residence of individuals from SCC burial register.

Parish/Residence	Number of individuals	
	Frequency	Percent (%)
St. Michael's, Gloucester	37	12.5
St. Owen's, Gloucester	36	12.2
St. John's, Gloucester	29	9.8
St. Nicholas, Gloucester	29	9.8
St Mary de Crypt, Gloucester	24	8.1
Littleworth near Gloucester	20	6.8
Barton street, Gloucester	10	3.4
Holy Trinity, Gloucester	9	3.1
St. Catherine, Gloucester	8	2.7
Gloucester	6	2.0
Quedgeley, Gloucestershire	5	1.7
St. Mary de Grace, Gloucester	5	1.7
Barton St Mary's near Gloucester	4	1.4
St. Mary de Lode, Gloucester	4	1.4
Worcester Street, Gloucester	3	1.0
Aldgate St. Gloucester	2	.7
Alvin Street, Gloucester	2	.7
near Gloucester	2	.7
Spa, Gloucester	2	.7
Workhouse	2	.7
Wotton near, Gloucester	2	.7
Bristol	1	.3
Burley Lodge, near Lincoln Hampton, Gloucester	1	.3
Castle Precincts, Gloucester	1	.3
College Yard, Gloucester	1	.3
From Wales	1	.3
Ind. Chapel	1	.3
Infirmary In-patient	1	.3
Kingswood	1	.3
Norfolk Buildings, Gloucester	1	.3
Northgate Street, Gloucester	1	.3
Over near Gloucester	1	.3
South Gloucester Militia	1	.3
South Hamlet near Gloucester	1	.3
Southgate Street, Gloucester	1	.3
Spa Hamlet near Gloucester	1	.3
St John the Baptist, Gloucester	1	.3
St. Bartholomew's	1	.3
St. Keunswick	1	.3
St. Margaret's	1	.3
Stroud	1	.3
Stroud Road, Gloucester	1	.3
Sudbrook near Gloucester	1	.3
The college precincts, Gloucester	1	.3
Unknown	31	10.5
Total	**295**	**100.0**

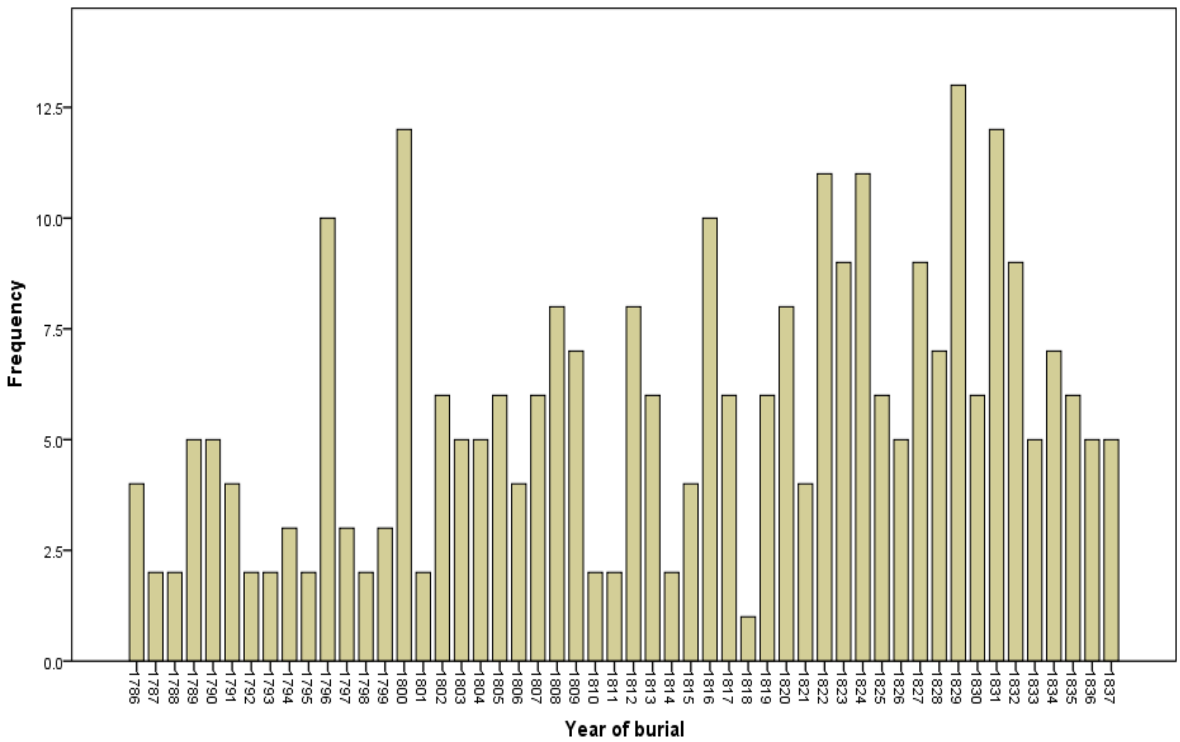


Figure 7: Frequency of individual burials according to year as recorded in the SCC burial register.

The number of individuals buried per year ranged from one individual buried in 1818 to thirteen individuals buried in 1829 (*Figure 7*). There were 295 burials in total over a 51 year period with a mean 5.78 per year. The number of burials between 1786 and 1801 ranged from 2 to 5 except for 1796 (n=10) and 1800 (n=12). The number of burials per year increased (to n≥5) from 1802 to 1837 apart from years 1806, 1810, 1811,1814,1815,1818, and 1821.

3.2 Sex and age

The distribution of sex in adults buried (Table 5) shows that the number of females buried (58%) was a higher percentage than males (39.8%). There were four adult individuals in which sex was unknown or indiscernible from the burial records (2.3%). The 'Old-adult' age group (had the highest rate for both male and female deaths (61.2-61.8%). However, the lowest representation of female adult deaths was in the 'young adult' group (17.6%) and 'mid-adult' group had the lowest frequency of deaths for males (17.1%). Although it is possible to calculate the sex and age distribution for subadults in the burial register, it has not been included within this section as it is not comparable with the collected skeletal data.

Table 5: The sex distribution of adults from the SCC according to the burial register (percentages for within groups presented).

	Sex								
	Female			Male			Unknown		
	n	% age	% sex	n	%age	% sex	n	%age	% sex
Young adult	18	54.5	17.6	15	45.5	21.4	-	-	-
Mid-adult	21	63.6	20.6	12	36.4	17.1	-	-	-
Old adult	63	57.3	61.8	43	39.1	61.4	4	3.6	100
Total (n=176)	**102**	**58.0**	**100**	**70**	**39.8**	**100**	**4**	**2.3**	**100**

As stated in chapter 2, there is are differences between the chronological age of an individual (as stated in the burial register) and the biological age estimated during skeletal analysis. However, the age categories used on the burial register were the same as used for the biological profiles derived from the skeletal remains. This was to enable comparison between the two datasets and to test the assumption that the demographics historical records of SCC burials should show similar patterns to the excavated skeletal remains from Southgate Congregational Church within the 13/83 skeletal assemblage. Therefore any differences found within these demographics will also discussed within this thesis.

The age at death (Table 6) categories with the highest overall percentage were the subadults (32.9%) and old adult (37.3%). Both the 'young adult' and 'mid-adult' categories represented 11.2% of the overall deaths (22.4%). This was lower than the younger and older categories combined. The sub-category of '0-2 years' had the highest representation of any sub-age group (23.7%) which made up 72.2% of the 'subadult' category. The second highest representation of any age group was the '70-79 years' (12.2%). The '35-39 years' group had the lowest number of listed deaths (1.4%).

Table 6: Frequencies of individuals by age at death as per the burial records of SCC.

		Frequencies of individuals		
Age Category	Age at death (years)	n	% age group	% total
Subadult	0-2	70	72.2	23.7
	3-8	11	11.3	3.7
	9-14	8	8.2	2.7
	15-17	6	6.2	2.0
	Unknown	2	2.1	.7
	Group Total	**97**	**100**	**32.9**
Young adult	18-24	22	66.7	7.5
	25-29	11	33.3	3.7
	Group Total	**33**	**100**	**11.2**
Mid-adult	30-34	11	33.3	3.7
	35-39	4	12.1	1.4
	40-44	9	27.3	3.1
	45-49	9	27.3	3.1
	Group Total	**33**	**100**	**11.2**
Old adult	50-54	11	10.0	3.7
	55-59	16	14.5	5.4
	60-69	32	29.1	10.8
	70-79	36	32.7	12.2
	80-89	13	11.8	4.4
	90+	2	1.8	.7
	Group Total	**110**	**100**	**37.3**
Unknown Age		22	100	7.5
Total		**295**		**100**

Chapter 4: Results

This chapter presented information gained through the skeletal analysis of 13/83. Comparison between the biological profiling information and the preservation of skeletal elements in addition to the evaluation of pathological conditions enables differentiation between the SCC and GI cemeteries. This will aid in the understanding of the organisations of these two cemeteries which form the 13/83 skeletal assemblage. The exploration of the organisation also aids to highlight intrinsic and extrinsic factors which might affect successful palaeoepidemiological study of this collection.

Skeletal Analysis of 13/83

Preservation of skeletal elements

As stated in the methodology in chapter 2, the skeletal elements were grouped together into 35 variables for data analysis (Table 8). A more comprehensive skeletal inventory can be seen in appendix 4. There was a variable rate of preservation between the skeletons in the 13/83 collection (Figure 44 in appendix 4) with none of the individuals within this collection being recovered entirely. Therefore, the use of skeletal elements was essential in calculating the true prevalence rates for conditions discovered within this collection. The overall recovery of skeletal elements per skeleton was low (Table 7), ranging from four (3.05%) to 118 (90.08%) out of 131 elements recorded. This is likely due to the number of cranium/skull only individuals (see Figure 45 in appendix 4). There is little variation in the retention of skeletal element between the different age groups, with the exception of the 'old-adult' group which may be related to the small sample size of this group and the skeletal elements required for age estimation.

Table 7: The overall mean percentage (%) retention of 131 scored skeletal elements per skeleton in the 13/83 skeletal assemblage based on age group, excluding unassessed adults..

	13/83 (n=82)	Subadult (n=25)	Young adult (n=17)	Mid-adult (n=29)	Old-adult (n=5)
Mean elements recovered	**34.39%**	31.33%	35.47%	32.32%	58.02%

Using the grouped skeletal elements, there was a significant difference in the retention of skeletal elements (Table 8) between the SCC and GI burials (t_{68}=3.509, p=0.001). This indicates that the representation of skeletal elements from SCC was greater than GI. The cranium (73.2%) and the right ribs were the most commonly preserved elements across the 13/83 collection. The mandible was preserved in 67.6% of the SCC burials, however was present in only 37.8% of the Infirmary burials. The hyoid (7.3%) and coccyx (2.4%) having the least retention. The skeletal elements least There were no significant differences (p=>0.05) in the preservation of left and right-sided skeletal elements for either SCC (t_{24}=-0.509, p=0.616) or GI (t_{24}= 1.436, p=0.164) and in the overall total combined frequencies (t_{24}=0.417, p=0.681). The individual and grouped elements in Table 8 were used to calculate the true prevalence rates of conditions and lesions within individuals from the 13/83 skeletal assemblage.

Table 8: Frequency of individual skeletal elements preserved in descending order, the percentage shown is the preservation within the location for each element (R = right side, L = Left side).

	Location					
	SCC (N=37)		Infirmary (N=45)		Total (N=82)	
	n	%	n	%	n	%
Cranium	30	81.1	30	66.7	60	73.2
R Ribs	25	67.6	25	55.6	50	61.0
Maxillary Dentition*	23	62.2	24	53.3	47	57.3
Thoracic Spine	24	64.9	23	51.1	47	57.3
L Ribs	22	59.5	23	51.1	45	54.9
L Tibia	24	64.9	21	46.7	45	54.9
Lumbar Spine	22	59.5	22	48.9	44	53.7
L Femur	23	62.2	21	46.7	44	53.7
Mandibular Dentition*	23	62.2	20	44.4	43	52.4
L Fibula	22	59.5	20	44.4	42	51.2
R Scapula	23	62.2	19	42.2	42	51.2
L Pelvis	23	62.2	19	42.2	42	51.2
R Tibia	24	64.9	18	40.0	42	51.2
Mandible	25	67.6	17	37.8	42	51.2
L Foot	20	54.1	20	44.4	40	48.8
R Pelvis	21	56.8	19	42.2	40	48.8
R Femur	22	59.5	18	40.0	40	48.8
Cervical Spine	17	45.9	22	48.9	39	47.6
L Radius	21	56.8	16	35.6	37	45.1
R Fibula	20	54.1	16	35.6	36	43.9
R Humerus	22	59.5	14	31.1	36	43.9
Sacrum	16	43.2	19	42.2	35	42.7
L Scapula	17	45.9	18	40.0	35	42.7
R Radius	22	59.5	13	28.9	35	42.7
L Humerus	19	51.4	15	33.3	34	41.5
R Ulna	21	56.8	13	28.9	34	41.5
L Clavicle	13	35.1	19	42.2	32	39.0
R Clavicle	15	40.5	17	37.8	32	39.0
L Hand	16	43.2	16	35.6	32	39.0
L Ulna	18	48.6	14	31.1	32	39.0
R Foot	18	48.6	14	31.1	32	39.0
R Hand	13	35.1	15	33.3	28	34.1
L Patella	12	32.4	15	33.3	27	32.9
R Patella	14	37.8	13	28.9	27	32.9
Sternum	10	27.0	15	33.3	25	30.5
Coccyx	1	2.7	5	11.1	6	7.3
Hyoid	0	0	2	4.4	2	2.4

**Dental preservation scored independent of maxilla or mandibular element retention*

Biological profiles

The biological profiling information as assessed in the skeletal remains from 13/83 are presented in this section.

Sex

Sex determination of individuals from 13/83 (Table 9) was attempted on all adults from this skeletal collection where possible, this was achievable in 54 out of 57 individuals. There was a significant difference in the representation of males and females between the two cemeteries (χ_c^2 = 6.107, p=0.013). There were 18 adult burials out of 37 Southgate Congregational Church burials (48.6%), this included nine females (55% of assessed adults) and eight males (45% of assessed adults) in the SCC burials, compared to the Gloucester Infirmary in which only six out of the 37 assessed adults (excluding indeterminate) were female (16%) and 31 were males (84%). There was a large representation of subadults within this collection and have been excluded from Table 9 as it is not possible to determine sex in these remains.

Table 9: The representation of adult female, male and indeterminate skeletal remains from 13/83

		Location		
		SCC	GI	Total
Adult Female	Female	5	2	7
	Probable Female	4	4	8
	Female Total	**9**	**6**	**15**
Adult Male	Male	4	20	24
	Probable Male	4	11	15
	Male Total	**8**	**31**	**39**
Adult Indeterminate		**1**	**2**	**3**
	Total	**18**	**39**	**57**

Age at death

Individuals were aged into general age groups (subadult, young-adult, mid-adult, old-adult and indeterminate) and sub-age groups (specific age ranges e.g. 0-2years) for the purposes of data analysis (Table 37 in appendix 4). There was a highly significant difference in the general age at death of the individuals (χ^2= 25.957, p=0.000, df=4) between the SCC and the Infirmary burials. In the SCC burials, 19 out of 37 individuals were subadults (51%) compared to only 6 subadults out of 45 individuals (16%) from the Infirmary burial ground. The age distribution of the two cemeteries can be seen in Figure 8, this illustrates the differences in representation. The age at death estimates show a 'U' shape for SCC burials with peaks at the younger and older age groups. This relationship is inversed in GI.

The '0-2 years' age group had the highest representation in the SCC, whereas there was only one individual in this age group in the Infirmary. There were no individuals seen in the 'Old adult' category in the Infirmary burials. The difference in the sub-age group categories between SCC and GI was also highly significant (χ^2=33.415, p=0.001, df=13). The 'mid-adult' age group had the highest representation within the infirmary burials (n=23/45). The two sub-age categories with the highest representation were the '18-24' and '35-39' age groups with seven individuals in each. None of the GI individuals were categorised as 'old-adult' whereas 5 individuals (13.5%) from SCC were within this group which had the highest representation of individuals in the burial register

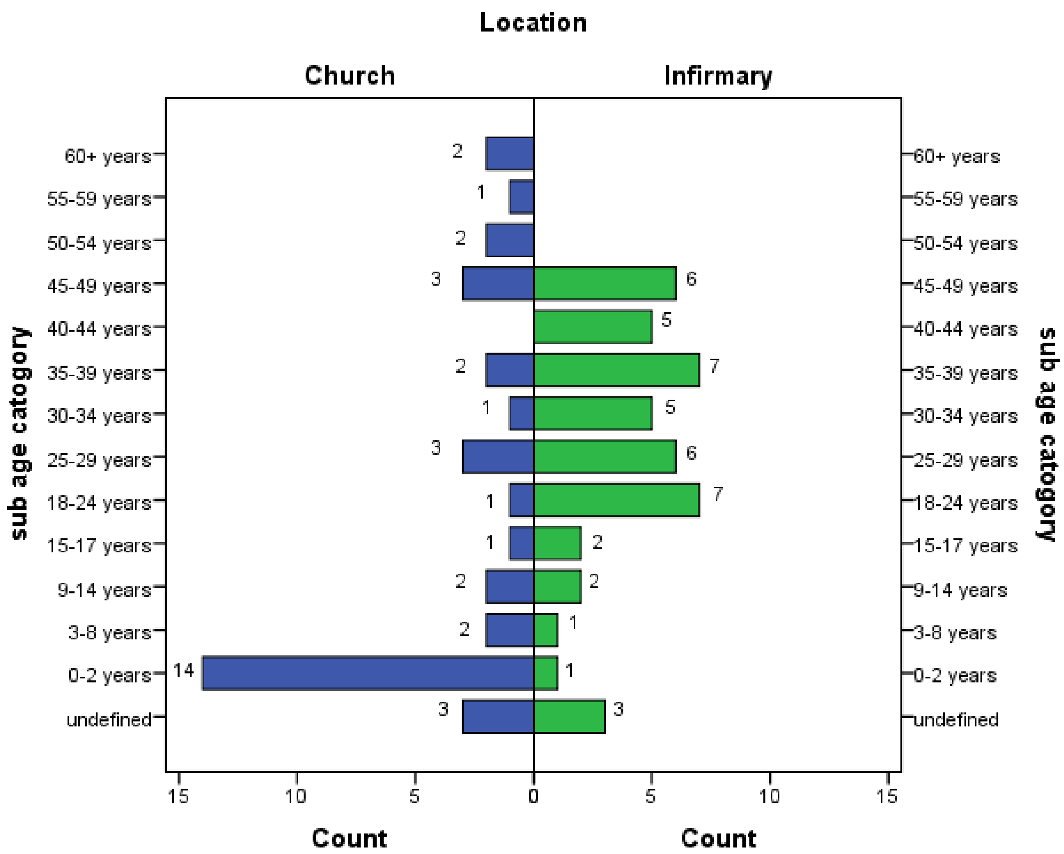


Figure 8: The frequencies of age-at-death distribution between the two sites.

Stature

The mean stature was examined for the males and females for both the SCC and the GI cemeteries and overall in 13/83 (Table 10). This was assessed where it was possible to estimate stature with entire long bones, therefore the sample size was small due to the limited numbers of recovered usable bones (n=38). The tallest was a male from trench III (GI) with an estimated stature of 178.98cm. The shortest was also from trench III 158.08cm of indeterminate sex (stature was estimated in this individual using the mean male and female estimates) (Appendix 5). The mean stature for 13/83 for females was 163.5±4.96cm and the male mean was 170.39± 4.20cm. There was no significant difference within specific sex stature estimation between the SCC and the Infirmary burials. There was a significant difference in male and female stature in the SCC and the combined site, however there was no significant difference between male and female stature in GI (p>0.05). This may be due to the small female sample size.

Table 10: The mean stature estimation for adult males and females from the 13/83. T-test result show the differences between each group.

	Location		
	SCC	**Infirmary**	**Combined 13/83**
Males	N=7 Mean: 168.74±2.47cm	N=20 Mean: 170.91±4.58cm	N=27 Mean: 170.39±4.20cm T(25)=-1.182 p=0.248 ‡
Females	N=7 Mean: 161.99±5.33cm	N=4 Mean: 166.12±3.24cm	N=11 Mean: 163.5 ±4.96cm T(9)=-1.392 p=0.197 ‡
T-test	T(12)=-3.042 p=0.010 †	T(22)=1.978 p=0.061 †	T(36)=-4.334 p=0.000 †

† T-test result for males' vs female height for SCC, GI and combined 13/83

‡ T-test result for males' vs males and females' vs females from SCC and GI

Dental conditions

The frequencies of dental pathologies were calculated if dentition was present (Table 11). There was a significant difference (χ^2_c=4.480, p=0.034) in the number of individuals without dental condition in GI (n=2/26) compared to SCC (n=9/25). There were only 7 individuals in 13/83 which had one single type of dental condition recorded (AMTL n=4, Caries n=1, Calculus n=2) compared to 40 individuals with multiple dental pathologies. Neither dental abscesses nor LEH were not found in isolation in any of the individuals in the 13/83 collection.

Table 11: Number of individuals affected by single or multiple dental pathologies as well as the total number of individuals with dentition present.

	Location		
	SCC	GI	Total
Dental pathologies	n	n	n
Antemortem Tooth Loss	2	2	4
Caries	1	0	1
Calculus	1	1	2
AMTL, Caries, Calculus, Abscess, LEH	1	1	2
AMTL, Caries, Calculus, Abscess	1	0	1
AMTL, Caries, Calculus	3	5	8
AMTL, Caries, Calculus, LEH	1	4	5
AMTL, Caries	1	0	1
AMTL, Calculus	1	1	2
AMTL, Abscess	0	1	1
Caries, Calculus	3	4	7
Calculus, LEH	0	2	2
Caries, Calculus, LEH	1	3	4
present no pathology	*9*	*2*	*11*
Total	**25**	**26**	**51**

Table 12: Frequencies of dental pathologies in 13/83 (Percentage shown indicates individuals affected by each dental condition per location and sex group).

		AMTL		Caries		Calculus		Abscess		LEH	
Location	Sex	n	%	n	%	n	%	n	%	n	%
SCC	Female (n=7)	5	71.4	4	57.1	4	57.1	1	14.3	1	14.3
	Male (n=7)	5	71.4	5	71.4	6	85.7	1	14.3	2	28.6
	Subadult (n=11)	-	-	3	27.3	2	18.2	-	-	-	-
	SCC Total (n=25)	**10**	**40**	**12**	**48**	**12**	**48**	**2**	**8**	**3**	**12**
GI	Female (n=2)	1	50	2	100	2	100	-	-	1	50
	Male (n=19)	13	68.4	12	63.2	16	84.2	2	10.5	7	36.8
	Indet. Adult (n=1)	-	-	1	100	1	100	-	-	-	-
	Subadult (n=4)	-	-	2	50	2	50	-	-	1	25
	GI Total (n=26)	**14**	**54**	**17**	**65**	**21**	**81**	**2**	**8**	**9**	**35**
Total	Female (n=9)	6	66.7	6	66.7	6	66.7	1	11.1	2	22.2
	Male (n=26)	18	69.2	17	65.4	22	84.6	3	11.5	9	34.6
	Indet. Adult (n=1)	-	-	1	100	1	100	-	-	-	-
	Subadult (n=15)	-	-	5	33.3	4	26.7	-	-	1	6.7
	13/83 total (n=51)	**24**	**47**	**29**	**57**	**33**	**65**	**4**	**8**	**12**	**24**

The most common dental condition (Table 12) was calculus (**Error! Reference source not found.** 9) for the SCC (48%) and GI burials (81%). Caries (57%) and AMTL (65%) also affected individuals at a high rate in 13/83. There was a higher frequency of dental conditions in GI compared to SCC for all the pathologies except dental abscesses (8% both in SCC and GI). However, the only significant difference was seen in calculus (χ^2_c=4.644, p=0.31). The dental pathologies found in subadults from 13/83 were caries (n=5), calculus (n=4) and one subadult (from GI) with LEH.

Males had a higher rate of calculus than the females in SCC and overall in 13/83, however all of the GI females had calculus compared to 85.7% of GI males. The small sample sizes may have resulted in bias as there were only two GI females with dentition. The overall prevalence rate for LEH in 13/83 was 24%. There was a higher occurrence rate in GI (35%) than SCC (12%), including one GI subadult.

There was an extremely high Spearman rank correlation (p=0.000) between caries and calculus in both SCC and GI (Table 13). There were also positive correlations observed across 13/83 between AMTL and Abscesses (Figure 10), Caries and LEH, and Calculus and LEH which not significant in either SCC or GI. This may be due to the lower observation rate of dental abscesses and LEH with the specific cemeteries.

One of the individuals from the infirmary (V-U/Sb), has extensive AMTL and evidence of a dental abscess (localised and rounded bone destruction) in the anterior maxilla (Figure 10). Overall in 13/83, there was a significant correlation were found between DA and AMTL, as all four individuals with DA had AMTL. However, this was not significant correlation within the two individual cemeteries which is likely due to only two individuals in each cemetery having DA.

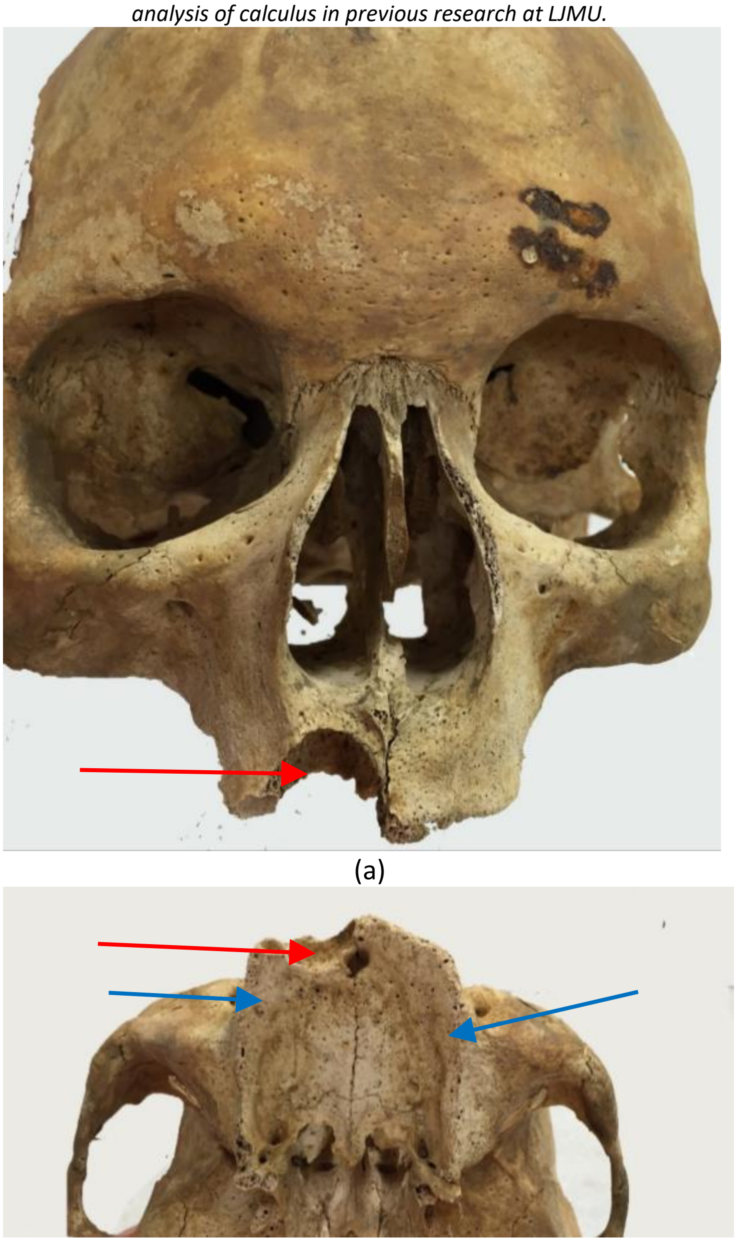
Table 13: Significant Spearman-rank correlations for 13/83 for individuals with any dentition.

	Location		
	13/83 (N=51)	SCC (N=25)	GI (N=26)
AMTL + Abscess	r_s=0.309, p=0.027	r_s=not sig	r_s=not sig
Caries + Calculus	r_s=0.682, p=0.000	r_s=0.676 p=0.000	r_s=0.671, p=0.000
Caries + LEH	r_s=0.296, p=0.035	r_s=not sig	r_s=not sig
Calculus + LEH	r_s=0.410, p=0.003	r_s=not sig	r_s=not sig

The age distribution of dental diseases (Table 36) excluding unassessed adults (n=1) for 13/83 indicated that 'old adults' had the highest rates of abscesses (50%) and a high rate of AMTL (75%). (There were no individual skeletal remains recovered in this age category from the infirmary). The 'Young Adult' (18-25 years) category had the highest rate of caries, calculus and LEH. The 'mid-adult' (30-49 years) had the highest rate of AMTL (78.9%). The general dental condition age trends observed across 13/83 were also seen in both SCC and GI. There was a decrease in the frequency of caries with age (except for GI 'mid-adults' dentition). This may be related to the increase of AMTL with age, however no significant correlation was found. Caries significantly correlated with calculus and LEH overall in 13/83 and was most frequently found with calculus throughout 13/83.

(a) Right lateral view II259 skull (b) Inferior view of II259

Figure 9: Extreme calculus and AMTL from a 45-49 year-old possible female (II259) from Southgate Congregational Church. Calculus is indicated with red arrow and AMTL by the blue arrow. This specimen was used for stable isotope analysis of calculus in previous research at LJMU.



(a)

(b)

Figure 10: Dental abscess of the maxilla on V-U/Sb indicated by the red arrows (a) anterior (b) inferior view, also showing extensive AMTL indicated by blue arrows.

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Table 14: Frequencies of dental pathologies in each age group from 13/83. The total given indicates the number of individuals with dentition in each age group. The percentage given is the percentage affected by group.

			AMTL		Caries		Calculus		Abscess		LEH	
Location	Age Group	Total	n	%	n	%	n	%	n	%	n	%
SCC	Sub-adult (0-17 years)	11	-	-	3	27.3	2	18.2	-	-	-	-
	Young Adult (18-29 years)	4	2	50	4	100	4	100	-	-	2	50
	Mid-adult (30-49 years)	5	4	80	3	60	3	60	-	-	-	-
	Old Adult (50+)	4	3	75	2	50	2	50	2	50	1	25
	Unassessed adult	1	1	100	-	-	1	100	-	-	-	-
	SCC Total	**25**	**10**	**40**	**12**	**48**	**12**	**48**	**2**	**8**	**3**	**12**
GI	Sub-adult (0-17 years)	4	-	-	2	50	2	50	-	-	1	25
	Young Adult (18-29 years)	8	3	37.5	5	62.5	8	100	1	12.5	4	50
	Mid-adult (30-49 years)	14	11	78.6	10	71.4	11	78.6	1	7.1	4	28.6
	GI Total	**26**	**14**	**53.8**	**17**	**65.4**	**21**	**80.8**	**2**	**7.7**	**9**	**34.6**
Total	Sub-adult (0-17 years)	15	-	-	5	33.3	4	26.7	-	-	1	6.7
	Young Adult (18-29 years)	12	5	41.7	9	75	12	100	1	8.3	6	50
	Mid-adult (30-49 years)	19	15	78.9	13	68.4	14	73.7	1	5.3	4	21.1
	Old Adult (50+)	4	3	75	2	50	2	50	2	50	1	25
	Unassessed adult	1	1	100	-	-	1	100	-	-	-	-
	13/83 Total	**51**	**24**	**47.1**	**29**	**56.9**	**33**	**64.7**	**4**	**7.8**	**12**	**23.5**

Skeletal Pathological Conditions

There were 30 individuals with no evidence of pathological condition representing 36.6% of the total collection (Table 15**Error! Reference source not found.**). The number of individuals without pathologies was much higher in the SCC (59.5%) compared to GI (22.2%). The group with the least number of pathologies in the 13/83 skeletal collection were the subadult group (69.2%). These individuals were included in subsequent analysis to understand the frequency of pathological conditions and lesions.

Table 15: The frequencies of individuals without skeletal pathological conditions in the 13/83 collection. Percentage indicates the individuals within adult sex and subadult groups which had no evidence of pathological conditions.

	Location					
	SCC		Infirmary		Total	
Sex	n	%	n	%	n	%
Adult Female	4/9	44.4	3/6	50.0	7	46.7
Adult Male	3/8	37.5	3/31	9.7	6/39	15.4
Indeterminate Adult	1/1	100	-	-	1/1	100
Subadult	14/19	73.7	4/6	66.7	18/25	69.2
Total	**22/37**	**59.5**	**10**	**22.2**	**30**	**36.6**

This section onwards considers only individuals with pathological conditions. Different pathologies were classified into different groups and the individuals within the 13/83 with these conditions were analysed (**Error! Reference source not found.** 16). The frequencies of pathologies were higher in the Infirmary burials compared to SCC, except for neoplastic conditions (SCC n= 2, GI n=1). This may be due to the small representation of these conditions within the entire population. Joint conditions had the highest frequencies throughout the entire 13/83 collection (41.5%). Trauma, congenital and neoplastic conditions all had a small representation (5.4%) in the SCC burials. Trauma alone showed a significant difference between GI and SCC. Metabolic and neoplastic conditions had high chi-squared P-values which indicates that there were minimal differences between the two burial locations.

Table 16: Frequencies of types of skeletal pathologies and conditions found in the individuals from the 13/83 collection. Percentage indicates the individuals within each location with evidence of specific types of pathological conditions.

	Location						
	SCC (n=37)		Infirmary (n=45)		Total (n=82)		
Type of Condition	n	%	n	%	n	%	
Trauma	2	5.4	11	24.4	13	15.9	(χ_c^2=4.182, p=0.041)
Congenital	2	5.4	5	11.1	7	8.6	(χ_c^2=0.274, p=0.601)
Joint	11	29.7	23	51.1	34	41.5	(χ_c^2=2.994, p=0.084)
Infectious	8	21.6	17	37.8	25	30.5	(χ_c^2=1.797, p=0.180)
Metabolic	10	27.0	13	28.9	23	28.0	(χ_c^2=0.026, p=0.872)
Neoplastic	2	5.4	1	2.2	3	3.7	(χ_c^2=0.060, p=0.863)

Trauma

There were 13 individuals with evidence of trauma (Table 17), accounting for 15.9% of the individuals analysed. This included 12 individuals with fractures (SCC=2, GI=10) and one individual with evidence of Sharp force injury. There was a significant difference between the amount of trauma observed in SCC and GI (χ_c^2=4.182, p=0.041).

Table 17: Frequencies of trauma in 13/83. Percentage indicates the individuals within each location with evidence of trauma.

	Location					
	SCC (n=37)		Infirmary (n=45)		Total (n=82)	
Type of condition	n	%	n	%	n	%
Fractures	2	5.4	10	22.2	12	14.6
Sharp force injury	-	-	1	2.2	1	1.2
Trauma Total	**2**	**5.4**	**11**	**24.4**	**13**	**15.9**

Fractures

Most of the fractures observed were antemortem and healed. The types of fracture included spinal compression fractures, a cranial depression fracture as well as simple fractures. One male individual from the Infirmary burials showed evidence of rib fractures in various stages of healing, as well as a peri-mortem spiral fracture to the right femur (Figure 11). The rate of fractures was higher in the Infirmary burials (22%) than SCC (5%) with 15% of the whole 13/83 collection being affected.

The bones which were most commonly fractured (Table 18) were the ribs (8-8.9% of 13/83) and the thoracic spine (8.5%). There was a total of 8 individuals with rib fractures. None of the individuals shown in Table 18 had bilateral rib fractures. One individual from SCC (II249) had evidence of left rib fractures however, none of the right ribs were recovered. There was an individual from the GI burials (III781) in which right rib fractures were observed however the left ribs were not preserved. There were a total 53 individuals with either right and/or left ribs preserved. The prevalence of rib fractures is therefore 15% in this skeletal collection.

Table 18: Distribution of fractures on the skeletons of 13/83 skeletal collection. Percentage indicates the number of skeletal elements affected within each group and location with evidence of fractures. This was calculated using only individuals with evidence of fractures included and the number of each skeletal element present in the collection.

	Location								
	SCC			Infirmary				13/83	
	Male	Total		Male	Indet.	Total		Total	
	n	n	%	n	n	n	%	n	%
Cranium	-	-	-	2	-	2	6.7	2	3.3
Mandible	-	-	-	1	-	1	5.9	1	2.4
T-Spine	1	1	4.2	3	-	3	13.0	4	8.5
Lumbar Spine	-	-	-	1	-	1	4.5	1	2.3
L Rib	1	1	4.5	3	-	3	13.6	4	8.9
R Ribs	-	-	-	4	-	4	16.0	4	8.0
L Hand	1	1	6.3	-	-	-	-	1	3.1
R Fibula	-	-	-	1	1	1	6.3	1	2.8
R Femur	-	-	-	1	-	1	5.6	1	2.5

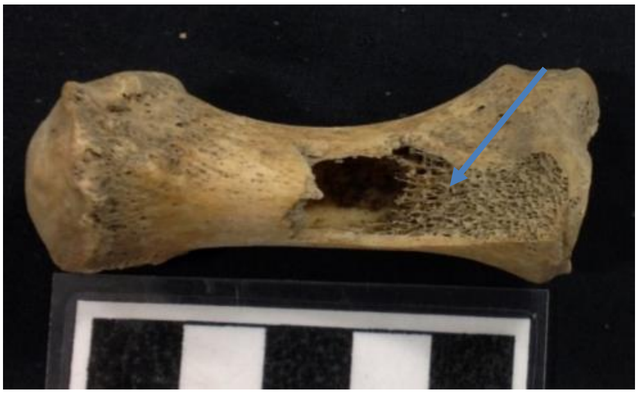
Perimortem fracture

(a) (b) (c)

Figure 11: Perimortem spiral fracture of the right proximal femur of III789, (GI Male, 35-39years) callus formation indicated by red arrows (a) posterior view (b) medial view (c) lateral view.

Sharp force Injury

There was one male from the Infirmary burial ground (Table 17**Error! Reference source not found.**; Figure 12) with evidence of peri-mortem sharp force injury to the right first metatarsal. Only the lower right limb was recovered from this individual. Therefore, further evidence of similar trauma could not be observed.



(a)

(b)

(c)

Figure 12: Perimortem sharp force injury right 1st metatarsal in III723 (GI Male) (a) dorsal view blue arrow indicating lamellar rings with medullary cavity exposed (b) lateral view red arrow indicating kerf/ cut floor (c) medial view, the green arrow indicates the area of bone flaking/ feathering.

Congenital conditions

There were several congenital conditions found in the 13/83 skeletal collection (Table 19). These were spina bifida occulta, sacralisation, spondylolysis and other non-specific congenital conditions. There were 7 adult individuals affected by congenital conditions and none of the subadults.

Spina bifida occulta was only found in one male individual in the 13/83 collection (Figure 13). There were 35 sacra present in this collection therefore 2.86% of individuals were affected.

Sacralisation was observed in three individuals from the 13/83 skeletal collection. This included two cases coccygeal sacralisation (III335, GI Male, 25-29 years, and III789, GI Male, 35-39 years) and one case of lumbar sacralisation (II259, SCC Female, 45-49 years). This condition can affect the sacrum and either fifth lumbar vertebra (L5) and the coccyx (Figure 14). Retention of the coccyx in the skeletal samples was poor in the collection, with only 7.3% of coccyges being recovered. Sacralisation was the most common congenital condition found in 13/83 (8.57%).

Spondylolysis (Figure 15) was found in one adult male (35-39 years) from the Infirmary affecting the fourth lumbar vertebra (L4), representing 2.2% of individuals with lumbar vertebrae. There were thirty-five L4 present in the collection which therefore this indicates 2.86% of the collection were affected by spondylolysis (Table 20).

Other non-specific congenital conditions found on the sacrum included an unfused section of the dorsal wall on an adult female SCC burial. This may be partial lumbarisation; however, this was not specifiable therefore it could not be classified. The other non-specific congenital condition was found in a male Infirmary burial was a cleft in the neural arc of S1. Both these conditions were classed as congenital developmental anomalies by Barnes (2012).

Table 19: Frequencies of congenital conditions in the 13/83 skeletal collection within specific sex groups and in subadults.

		Congenital Condition				
		SBO	Sacralisation	Spondylolysis	Other Congenital	**Total**
Location		n	n	n	n	**n**
SCC	Adult Female	-	1	-	1	2
	Adult Male	-	-	-	-	0
	Indeterminate	-	-	-	-	0
	Unassessed Adult	-	-	-	-	0
	Subadult	-	-	-	-	0
	SCC total	**-**	**1**	**-**	**1**	**2**
GI	Adult Female	-	-	-	-	0
	Adult Male	1	2	1	1	5
	Indeterminate	-	-	-	-	0
	Unassessed Adult	-	-	-	-	0
	Subadult	-	-	-	-	0
	GI Total	**1**	**2**	**1**	**1**	**5**
Total*		**1/35 (2.3%)***	**3/35 (8.57%)***	**1/44 (2.27%)#**	**2‡**	**7/82 (8.53%)**

*Prevalence rate calculated using the sacrum

Prevalence rate calculated using individuals with any lumbar vertebrae

*prevalence rate has not been stated in this table due to variable preservation rates of affected skeletal elements

All the congenital conditions found in the Gloucester 13/83 skeletal collection were found on the spinal column. The sacrum was the most common bone affected (Table 20**Error! Reference source not found.**), however some of these conditions affected multiple spinal skeletal elements. The individuals affected from GI were all male adults, and the individuals affected from SCC were adult females.

Table 20: Location of skeletal congenital conditions in the 13/83 skeletal collection. Percentage indicates the number of skeletal elements affected within each group and location with evidence of congenital conditions.

		Location		
Element	Pathology	SCC Burial	Infirmary burial	Total
L4	Spondylolysis	-	1 (6.67%)	1 (2.86%)
	Element present no Path	19	15	34
	Total element present	**19**	**16**	**35**
L5	Sacralisation	1 (5.56%)	-	1 (2.7%)
	Element present no Path	17	19	36
	Total element present	**18**	**19**	**37**
Sacrum	Spina Bifida	-	1 (5.26%)	1 (2.86%)
	Sacralisation	1 (6.67%)	2 (10.5%)	3 (8.57%)
	Other Congenital	1 (6.67%)	2 (10.5%)	3 (8.57%)
	Element present no Path	14	14	28
	Total element present	**16**	**19**	**35**
Coccyx	Sacralisation	-	2 (40%)	2 (33.3%)
	Element present no Path	1	3	4
	Total element present	**1**	**5**	**6**

Figure 13: Spina bifida occulta in III535, posterior view

Figure 14: Sacralisation of the 1st coccygeal vertebra in III335, anterior view

Figure 15: Spondylolysis of L4 on III183, white arrow indicates osteophytic lipping

Joint conditions

Joint conditions had the highest representation of the grouped skeletal pathologies in 13/83, with 41% of individuals being affected. The specific conditions recorded were osteoarthritis (OA), Schmorl's nodes (SN), degenerative disc disease (DDD) and other joint conditions. These conditions were recorded in 30% of individuals from the SCC (n=11) and 51% of the Infirmary burials (n=23) with an overall frequency of 41%. The individuals affected by joint conditions had one or more of these conditions (Table 21**Error! Reference source not found.**). The majority of individuals with joint diseases had more than one condition (n=20/34) There was a strong correlation between all the joint conditions ($p<0.05$), except for SN and DDD (r=0.184, p=0.098, df-80). The strongest correlation was between individuals with OA and DDD (r=*0*.462, p=0.000, df=80*)*.

Table 21: Frequencies of single and multiple joint disease in individuals from the 13/83 skeletal collection. Percentage indicates the individuals within each location with evidence of joint conditions.

	Location					
	SCC (n=37)		GI (n=45)		Total (n=82)	
Type of condition	N	%	n	%	N	%
Osteoarthritis (OA)	2	5	2	4	4	5
Schmorl's Nodes (SN)	2	5	2	4	4	5
Degenerative Disc Disease (DDD)	-	-	1	2	1	1
Other Joint condition	2	5	3	7	5	6
OA, DDD	-	-	3	7	3	4
OA, DDD, Other joint	1	3	1	2	2	2
OA, Other joint	1	3	2	4	3	4
OA, SN	1	3	1	2	2	2
OA, SN, DDD	-	-	2	4	2	2
OA, SN, DDD, Other joint	-	-	1	2	1	1
OA, SN, Other Joint	-	-	2	4	2	2
SN, DDD, Other joint	1	3	-	-	1	1
SN, Other joint	-	-	3	7	3	4
DDD, Other joint	1	3	-	-	1	1
Joint disease Total	**11**	**30**	**23**	**51**	**34**	**41**

The 'other joint conditions' category which included multiple conditions had the highest representation in the SCC (Table 22**Error! Reference source not found.**). Osteoarthritis had the highest representation in GI. Schmorl's Nodes and degenerative disc disease which affect the spine were also present in multiple individuals from both the SCC and the Infirmary burials. Therefore, the CPR is presented in Table 23**Error! Reference source not found.** and the true prevalence rate in Table 25.

Table 22: Frequencies of individual joint conditions within the 13/83 skeletal collection including individuals with multiple pathologies. Percentage indicates the individuals within each location with specific joint diseases.

	Location					
	SCC (n=37)		GI (n=45)		Total (n=82)	
	N	%	n	%	n	%
Osteoarthritis (OA)	5	13.5	14	31.1	19	23.2
Schmorl's Nodes (SN)*	4	10.8	11	24.4	15	18.3
Degenerative Disc Disease (DDD)*	3	8.1	8	17.8	11	13.4
Other Joint Conditions	6	16.2	12	26.7	18	22.0

*these conditions were calculated with the total number of individuals although they only affect the spine (i.e. CPR)

There was a high frequency of subadults within the SCC burials, these included two individuals (10.5%), with a joint condition. There was also one subadult from GI which showed signs of a joint condition. Males showed higher prevalence rates than females for joint conditions except for OA (Table 23**Error! Reference source not found.**) throughout 13/83.

Table 23: Distribution of joint conditions in adults and subadults from the 13/83. Percentage indicates the individual within each group for each location with evidence of joint disease.

Location	Sex	Joint condition							
		OA		SN		DDD		Other Joint	
		n	%	n	%	n	%	n	%
SCC	Adult Female	3	33.3	2	22.2	1	11.1	2	22.2
(N=37)	Adult Male	2	25	2	25	2	25	2	25
	Subadult	-	-	-	-	-	-	2	10.5
	SCC Total	**5**	**13.5**	**4**	**10.8**	**3**	**8.1**	**6**	**16.2**
GI	Adult Female	2	33.3	1	16.7	1	16.7	1	16.7
(N=45)	Adult Male	10	32.3	9	29.0	6	19.4	11	35.5
	Indet.	1	50	1	50	1	50	-	50
	Subadult	1	16.7	-	-	-	-	-	-
	Infirmary Total	**14**	**31.1**	**11**	**24.4**	**8**	**17.8**	**12**	**26.7**
13/83	Adult Female	5	33.3	3	20.0	2	13.3	3	20.0
(N=82)	Adult Male	12	30.8	11	28.2	8	20.5	13	33.3
	Indet.	1	33.3	1	33.3	1	33.3	-	-
	Subadult	1	4.0	-	-	-	-	2	8
	Total	**19**	**23.2**	**15**	**18.3**	**11**	**13.4**	**18**	**22.0**

Frequencies were calculated using the number of individuals represented in each age group, age groups which presented no skeletal pathologies have been omitted. Due to the small sample size the results for both the SCC and GI were combined. The prevalence rate of OA and DDD were shown to increase with the general age groups (Table 24**Error! Reference source not found.**).

Table 24: Distribution of joint conditions by age groups across the 13/83 skeletal collection. Percentage indicates the individuals within each sub-age group with evidence of specific types of joint conditions.

		OA		SN		DDD		Other Joint	
Age (yrs.)	Sub-age	n	%	n	%	n	%	n	%
Subadult	9-14 yrs	-	-	-	-	-	-	1	25
(0-17)	15-17 yrs	1	33.3	-	-	-	-	1	33.3
Group total (N=25)		**1**	**4**	**-**	**-**	**-**	**-**	**2**	**8**
YoungAdult	18-24 yrs	1	12.5	1	12.5	2	25	1	12.5
(18-29)	25-29 yrs	2	22.2	4	44.4	-	-	4	44.4
Group total (N=17)		**3**	**17.6**	**5**	**29.4**	**2**	**11.8**	**5**	**29.4**
Mid-adult	30-34 yrs	-	-	1	16.7	-	-	-	-
(30-49)	35-39 yrs	6	66.7	3	33.3	4	44	3	33.3
	40-44 yrs	3	75	3	75	2	50	1	25
	45-49 yrs	3	33.3	2	22.2	-	-	2	22.2
Group total (N=29)		**12**	**41.3**	**9**	**30**	**6**	**20.7**	**6**	**20.7**
Old adult	50-54 yrs	-	-	1	50	2	100	2	100
(50+)	55-59 yrs	1	100	-	-	1	100	1	100
	60+ yrs	1	50	-	-	-	-	-	-
Group total (N=6)		**3**	**50**	**1**	**16.7**	**3**	**50**	**3**	**50**
Unassessed adult (N=6)		1	16.7	-	-	-	-	2	33.3

Osteoarthritis

Osteoarthritis (OA) was found in 23.2% of individuals from 13/83 and was the most common joint disease identified. This condition was in only recorded one subadult from the 13/83 skeletal collection (**Error! Reference source not found.** 23 and 24). The number of individuals with OA per individual age group, age groups with no joint conditions were omitted from the results. Females had a slightly higher rate of OA than males throughout 13/83 (Table 23), however this was not significant (χ_c^2=.0.033, p=0.856).

Numerous individual skeletal elements were affected by osteoarthritis in 13/83 (Table 25). The thoracic spine (Figure 16) was most commonly affected (28%) with the ribs and sternum (12-13%) also being affected in high frequencies. There was only one individual (II133 SCC female 35-39 years) identified with patellofemoral (PF) OA (Figure 17). The frequency percent per element was calculated using the total of the elements present.

Table 25: Frequency of osteoarthritis in individual bones of the skeleton. Percentage indicates the number of skeletal elements affected within each group and location with OA. (R = right side, L = Left side, C= cervical, T=thoracic, Lu= Lumbar).

Element	Location							
	SCC		GI				Total	
	Female	Male	Female	Male	Indet.	Subadult	**Total OA**	**Total %**
STERNUM	-	1	-	2	-	-	3/25	12
C SPINE	1	-	-	2	-	-	3/38	8
T SPINE	2	2	1	7	-	1	13/47	28
Lu SPINE	1	1	-	3	-	-	5/44	11
SACRUM	-	1	-	-	-	-	1/35	3
L RIBS	1	1	-	3	1	-	6/45	13
R RIBS	1	1	1	3	-	-	6/50	12
L CLAVICLE	1	-	-	1	-	-	2/32	6
R CLAVICLE	-	-	1	1	-	-	2/32	6
RHUMERUS	-	-	-	1	-	-	1/36	3
L ULNA	-	1	-	-	-	-	1/32	3
R ULNA	-	1	-	-	-	-	1/34	3
L RADIUS	-	1	-	-	-	-	1/37	3
R RADIUS	-	1	-	-	-	-	1/35	3
L HAND	-	1	-	-	-	-	1/32	3
R HAND	-	1	-	-	-	-	1/28	3
L FEMUR	-	-	-	1	-	-	1/44	2
R FEMUR	1	-	2	1	-	-	4/40	10
R PATELLA	1	-	-	-	-	-	1/27	4
R FOOT	-	-	-	1	-	-	1/32	3

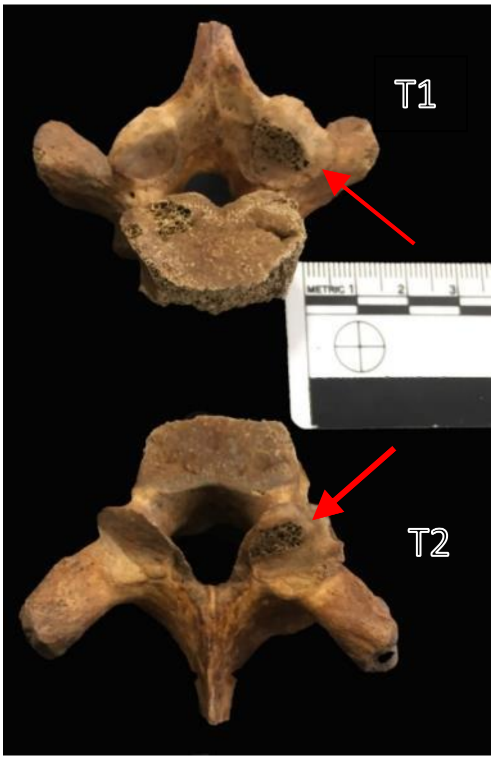


Figure 16: OA of the right inferior/ superior apophyseal joint of T1/2 (II264 15-17-year-old GI subadult) indicated by red arrows

Figure 17: OA of the patellofemoral joint in II133 (SCC Female, 35-39 years) areas or eburnation indicated by red circles

Spondyloarthropathies

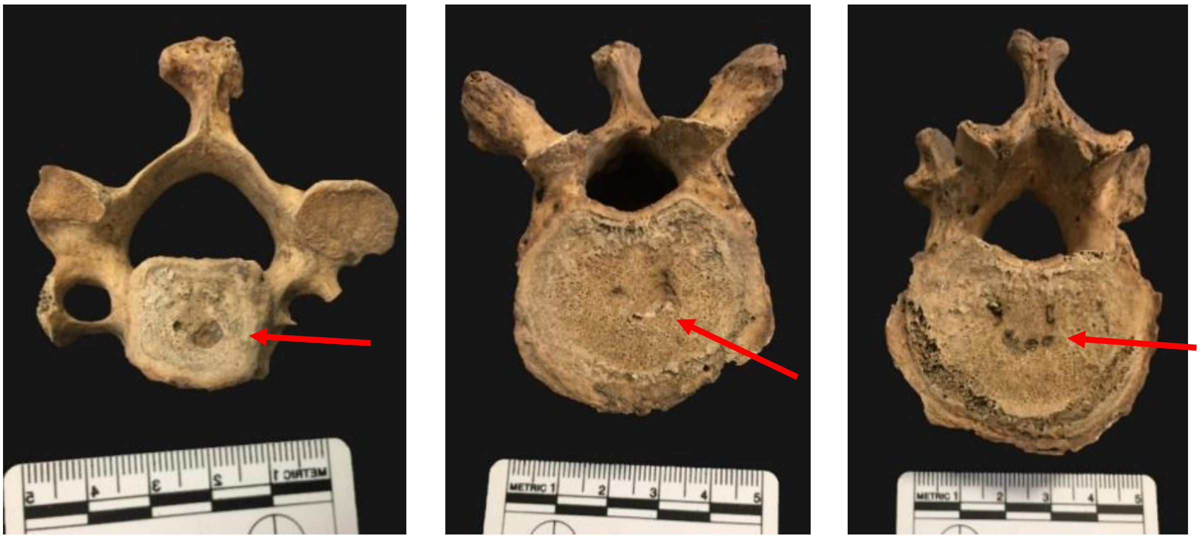
Schmorl's Nodes (SN) and degenerative disc disease (DDD) frequencies show the distribution of these conditions on the spine varies (Table 26**Error! Reference source not found.**). There was no significant correlation found between these conditions. No subadults were affected by these conditions. Neither SN nor DDD were found in the cervical spine from the SCC burials however they were observed at all spinal levels in the GI burials (Figure 18). Schmorl's nodes were not found in the sacrum and have therefore been excluded from Table 26.

The overall crude prevalence rate of SN was 18.5% of 13/83 individuals, with 24.4% in GI and 10.8% in SCC affected. This increases in the true prevalence rate in individuals with SN in retained thoracic spines (31.9%). Schmorl's nodes were present at higher frequencies in the thoracic spine than the lumbar spine (25%) and cervical spine for the entire 13/83 collection. The true prevalence rate of SN in adults is 50% when applied to T10 (see graph in appendix 4)

The crude prevalence rate of degenerative disc disease (Figure 19) was 13.4% in 13/83 (8.1% in SCC; 17.8% in GI). Overall in 13/83, true prevalence rate was found at a slightly higher frequency in the lumbar spine (11.5%) than the thoracic (10.6%). Degenerative disc disease was also found on the sacrum (L5/S1, n=1). There was no significant correlation found between DDD in the C-spine and other spinal levels however there was a highly significant positive correlation between the T-spine and L-spine (r^s=0.544, df=41, p=0.000) and a significant positive correlation between the L-Spine and the sacrum (r^s=0.418, df=33, p=0.015).

Table 26: Frequency and distribution of Schmorl's nodes (SN) and Degenerative Disc Disease (DDD) on the cervical, thoracic, lumbar and sacral regions of the spine in the 13/83 skeletal collection.

		Cervical (n=39)		Thoracic (=47)		Lumbar (N=44)		Sacrum (N=35)
		SN	DD	SN	DDD	SN	DDD	DDD
SCC	Adult Female	-	-	1	1	1	1	-
	Adult Male	-	-	2	1	2	2	1
	SCC Total	**-**	**-**	**3**	**2**	**3**	**3**	**1**
GI	Adult Female	-	-	1	1	1	-	-
	Adult Male	1	3	10	2	6	1	-
	Indet. Adult	-	-	1	-	1	1	-
	Infirmary Total	**1**	**3**	**12**	**3**	**8**	**2**	**-**
Total	Female	-	-	2	2	2	1	-
	Male	1	3	12	3	8	3	1
	Indet. Adult	-	-	1	-	1	1	-
	Total	**1 (2.6%)**	**3 (7.7%)**	**15 (31.9%)**	**5 (10.6%)**	**11 (25%)**	**5 (11.5)**	**1 (2.9%)**



(a) (b) (c)

Figure 18: Schmorl's nodes at all three spinal sections in III248 (GI Male 45-49 years) (a) C3 Inferior view (b) T11 Superior view (c) L1 inferior view

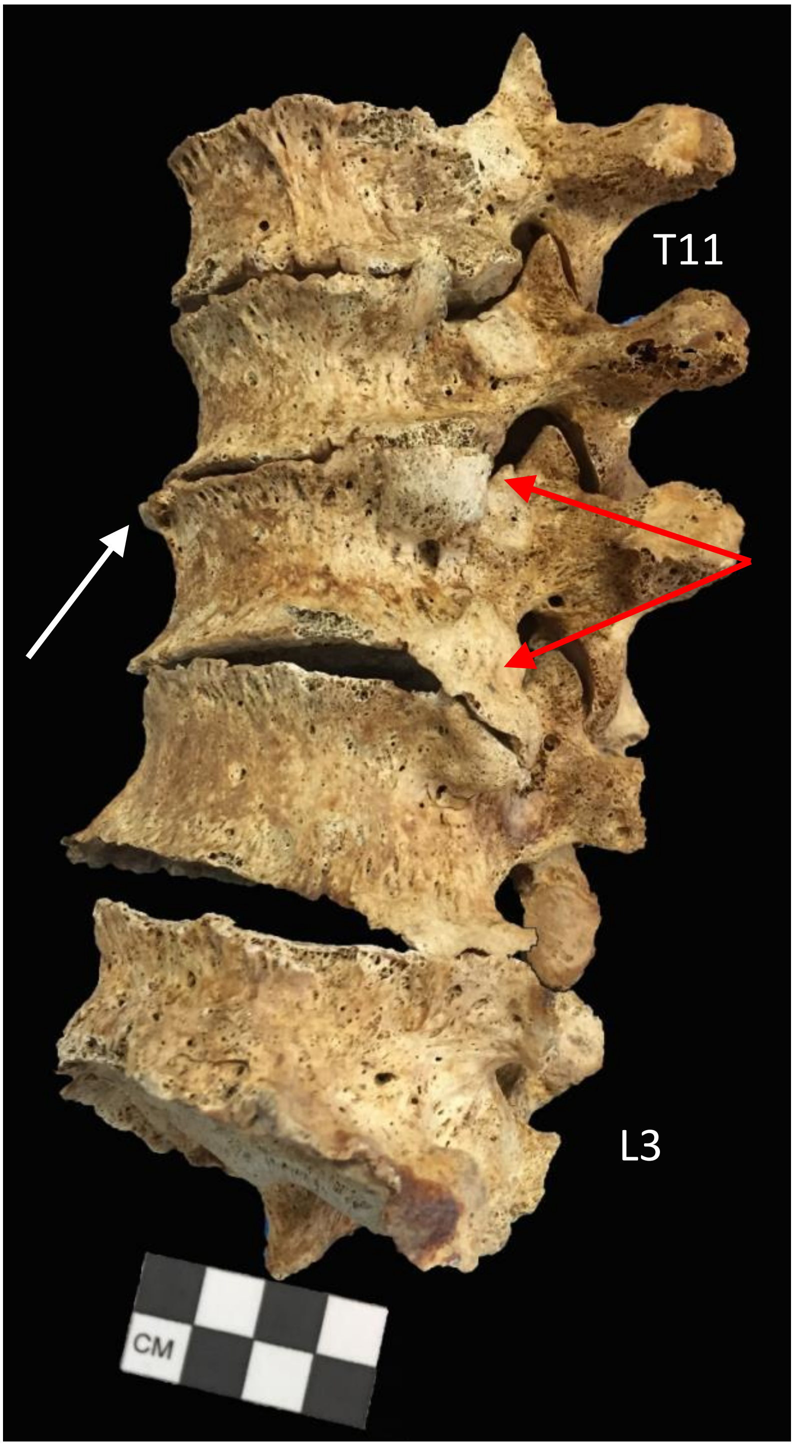


Figure 19: Degenerative Disc Disease with bridging osteophytes indicated by red arrows and marginal osteophytes indicated by white arrows in IIi249 (SCC Male 55-59 years)

Other joint conditions

The frequency of 'Other joint conditions' was highest in the SCC burials and had a high representation across the skeletal collection (Table 23). There were two (10.5%) subadults from the SCC burials were affected by 'other joint conditions', this included one individual with Osteochondritis dissecans Table 23 and Table 24). There were no subadults with this category of joint conditions in GI. The distribution of 'other joint conditions' by skeletal element in 13/83(Table 27) was calculated using the number of each element present. The bones most commonly affected by these conditions were the feet bones and the right hand. Examples included fusion of the distal interphalangeal joint (DIP) in the foot (Figure 20), and osteophytosis of the left medial cuneiform (Figure 21). Five out of the six SCC individuals affected by 'Other joint' conditions were in the hands and the feet. These included one subadult whom also had fusion of the DIP. An individual (II249) show bilateral joint changes in the MTT1 heads, the proximal phalanges were absent in this individual (Figure 22). This skeleton also showed extensive OA and DDD (see above). The skeletal remains from GI had a greater variety of bones affected by miscellaneous joint conditions. The bones of the feet had the highest frequency overall (Table 27). There were higher frequencies of 'other joint conditions' in GI compared to the SCC in all skeletal elements affected. These conditions included a number of conditions such as osteophytosis which did not meet the diagnostic criteria for OA.

Figure 20: Fusion of a right DIP joint in III560 (Male, GI, 35-39yrs)

Figure 21: Osteophytic grown on left medial cuneiform in III183 (Male, GI, 35-39yrs) indicated by red circle

(a) (b) (c)

Figure 22: Bilateral 1st metatarsals of II249 with severe joint changes in the head (a) medial view, (b) lateral view (c) plantar view

(a) (b) (c)

Figure 23: Left Hand of III311 with other joint conditions red line and circle indicates osteophytic growth on distal phalanx, blue line and circle indicates lytic destruction of MTC 4 head (a) left hand in anatomical position (b) Ray I distal phalange (c) MTC 4.

Table 27: Distribution of 'Other Joint' conditions per skeletal element in the 13/83 collection. Percentage indicates the number of skeletal elements affected within each group and location with evidence of other joint condition. The elements with the highest prevalence rate are shown in descending order.

	Location														
	SCC				GI				Total						
	Female	Male	Subadult	Total (%)	Female	Male	Indeterminate	Total (%)	Female	Male	Indeterminate	Subadult	Total	(%)
L Foot	-	1	1	2/20 (10%)	1	2	-	3/20 (15%)	1	3	-	1	5/40	(12.5%)
R Foot	-	1	-	1/18 (5.6%)	-	3	-	3/14 (21.4%)	-	4	-	-	4/32	(12.5%)
R Hand	1	-	-	1/13 (2.6%)	-	2	-	2/15 (16.7%)	1	2	-	-	3/28	(10.7%)
R Patella	-	-	-	-	-	2	-	2/13 (15.4%)	-	2	-	-	2/27	(7.4%)
Lum-Spine	-	-	-	-	-	3	-	3/44 (13.6%)	-	3	-	-	3/44	(6.8%)
L Hand	1	-	-	1/16 (6.6%)	-	1	-	1/16 (6.6%)	1	1	-	-	2/32	(6.3%)
Sacrum	-	-	-	-	-	2	-	2/19 (10.5%)	-	2	-	-	2/35	(5.7%)
L Patella	-	-	-	-	-	1	-	1/15 (6.7%)	-	1	-	-	1/27	(3.7%)
L Ulna	-	-	-	-	-	1	-	1/14 (7.1%)	-	1	-	-	1/32	(3.1%)
R Ulna	-	-	-	-	-	1	-	1/13 (7.7%)	-	1	-	-	1/34	(2.9%)
R Radius	-	-	-	-	-	1	-	1/13 (7.7%)	-	1	-	-	1/35	(2.9%)
R Pelvis	-	-	-	-	-	1	-	1/19 (5.3%)	-	1	-	-	1/40	(2.5%)
L Pelvis	-	-	-	-	-	1	-	1/19 (5.3%)	-	1	-	-	1/42	(2.4%)
R Tibia	-	-	-	-	-	1	-	1/18 (5.6%)	-	1	-	-	1/42	(2.4%)
L Femur	-	-	1	1/23 (4.3%)	-	-	-	-	-	-	-	1	1/44	(2.3%)

Infectious conditions

There was a high frequency of infectious conditions found in the 13/83 with 30% of the represented individuals being affected. The conditions found were periostitis and 'other infectious' conditions (Table 28). Infectious conditions affected 38% of the Infirmary burials (n=17) and 22% of the SCC burials (n=8). Periostitis was the most common infectious condition found in 13/83 with a CPR of 29.3% (SCC 21.6%; GI 35.6%). There were three individuals with 'other infectious' conditions. This included one individual from the SCC burials and two from the Infirmary. These conditions were classified as 'other infection' as the skeleton was subject to an unidentified infectious process or the condition was found in isolation.

There were subadults affected by periostitis whereas none had evidence of other infectious conditions (Table 29).

Table 28: Frequency of individuals with of single and multiple Infectious conditions in 13/83. The percentage was calculated using the number of individuals present in each group.

	Location					
	SCC (n=37)		Infirmary (n=45)		Total (n=82)	
Type of condition	n	%	n	%	n	%
Periostitis	7	19	15	33	22	27
Other infection	-	-	1	2	1	1
Periostitis, Other infection	1	3	1	2	2	2
Infectious Total	**8**	**22**	**17**	**38**	**25**	**30**

Table 29: Number of individuals with periostitis and 'other infectious' conditions in the 13/83 skelatal collection. The percentage representation was calculated using the number of individuals present in each group.

Location	Sex	Infectious condition	
		Periostitis	Other Infectious
SCC	Adult Female (n=9)	2 (22.2%)	1 (11.1%)
	Adult Male (n=8)	5 (62.5%)	-
	Subadult (n= 19)	1 (3.3%)	-
	SCC Total (n=37)	**8 (21.6%)**	**1 (2.7%)**
GI	Adult Female (n=6)	1 (16.7%)	1 (16.7%)
	Adult Male (n=31)	13 (41.9%)	1 (3.2%)
	Subadult (n=6)	2 (33.3%)	-
	GI Total (n=45)	**16 (35.6%)**	**2 (4.44%)**
Total	Adult Female (n=15)	3 (20%)	2 (13.3%)
	Adult Male (n=39)	18 (46.2%)	1 (2.6%)
	Subadult (n=25)	3 (12%)	-
	Total (n=82)	**24 (29.3%)**	**3 (3.7%)**

Periostitis

There were 24 individuals with periostitis (Table 29). In SCC, 62.5% of males had PO and 22.2% of females. These were higher prevalence rates than observed in GI males and females (F=16.7%; M=41.9%). However, the CPR for all individuals was higher GI (35.6%) compared to SCC (21.6%). This may be due to the high representation of subadult SCC burials. Although males were affected more commonly than females throughout 13/83, this was not significant. Adults and subadults are known to be affected by PO and it was also observed in both these age group within 13/83. Only one out of nineteen subadults from SCC had periostitis (3.33%) however two out of the six subadults from GI (33.3%) had this condition.

The femora and tibiae were the most commonly affected skeletal elements by periostitis throughout the 13/83 collection (R Femur 30%, R Tibia 28.6%, L Femur 27.3%, and L Tibia 24.4%) (Table 30). The femora and tibiae were more commonly affected in GI burials (R Tibia 44.4%, R Femur 39.8%, L Femur 33.3%, and L Tibia 33.3%) compared to the SCC burials (R Femur 22.7%, L Femur 21.7%, R Tibia 16.7%, L Tibia 16.7%).

Other infectious conditions

There were three individuals with evidence of infectious conditions which were either found in isolation or were not diagnosable and have therefore been put into this category of results (Table 28 and Table 29).

The left temporal bone in a SCC female exhibited signs of mastoiditis with exposure of the mastoids internal structure (Aufderheide *et al.* 1998). Radiographic imagery showed pneumatic bone which supports the diagnosis of mastoiditis(Gregg and Steele 1982), however it was not possible to confirm the diagnosis due to taphonomic damage.

There was a GI male included in this category with thickening of the compact bone lower limb bones (Figure 24). This condition meets the diagnostic criteria for osteitis (Ortner 2008. This individual had osteitis in the femora, tibiae, and fibulae. Paget's disease of bone (Osteitis Deformans) was excluded using X-ray imaging. This could have resulted as a secondary pathology.

Figure 24: Osteitis of the tibia in III183 (GI Male 35-39 years).

Table 30: Distribution of periostitis on skeletal elements of individuals from 13/83. Percentage indicates the number of skeletal elements affected within each group and location with periostitis. Percentages were calculated using the number of skeletal elements present.

	Location														
	SCC					Infirmary					Total				
	Female	Male	Subadult	Total		Female	Male	Subadult	Total		Female	Male	Subadult	Total	
	n	n	n	n	%	n	n	n	n	%	n	n	N	n	%
R Femur	2	2	1	5	22.7	-	7	-	7	38.9	2	9	1	12	30.0
R Tibia	1	2	1	4	16.7	-	8	-	8	44.4	1	10	1	12	28.6
L Femur	2	2	1	5	21.7	-	6	1	7	33.3	2	8	2	12	27.3
L Tibia	2	1	1	4	16.7	1	5	1	7	33.3	3	6	2	11	24.4
L Fibula	1	-	1	2	9.1	-	5	1	6	30.0	1	5	2	8	19.0
L Humerus	-	-	1	1	5.3	-	3	2	5	33.3	-	3	3	6	17.6
Sternum	-	1	-	1	6.3	-	3	-	3	20.0	-	4	-	4	16.0
L Ulna	-	-	1	1	5.6	-	3	1	4	28.6	-	3	2	5	15.6
R Clavicle	-	-	1	1	6.7	-	3	1	4	23.5	-	3	2	5	15.6
L Radius	-	-	1	1	4.8	-	3	1	4	25.0	-	3	2	5	13.5
L Clavicle	-	-	1	1	7.7	-	3	-	3	15.8	-	3	1	4	12.5
R Humerus	-	-	1	1	4.5	-	2	1	3	21.4	-	2	2	4	11.1
L Ribs	-	-	1	1	4.5	-	4	-	4	17.4	-	4	1	5	11.1
R Fibula	-	1	1	2	10.0	-	2	-	2	12.5	-	3	1	4	11.1
R Ribs	-	-	1	1	4.0	-	4	-	4	16.0	-	4	1	5	10.0
L Hand	-	1	1	2	12.5	-	1	-	1	6.3	-	2	1	3	9.4
R Ulna	-	-	1	1	4.8	-	2	-	2	15.4	-	2	1	3	8.8
L Scapula	-	1	1	2	11.8	-	1	-	1	5.6	-	2	1	3	8.6
R Radius	-	-	1	1	4.5	-	1	-	1	7.7	-	1	1	2	5.7
Sacrum	-	-	1	1	6.3	-	1	-	1	5.3	-	1	1	2	5.7
R Pelvis	-	-	1	1	4.8	-	1	-	1	5.3	-	1	1	2	5.0
R Scapula	-	-	1	1	4.3	-	1	-	1	5.3	-	1	1	2	4.8
L Pelvis	-	-	1	1	4.3	-	1	-	1	5.3	-	1	1	2	4.8
L Patella	-	-	-	-	-	-	-	1	1	6.7	-	-	1	1	3.7
R Patella	1	-	-	1	7.1	-	-	-	-	-	1	-	-	1	3.7
Cranium	-	-	-	-	-	-	2	-	2	6.7	-	2	-	2	3.3
R Foot	-	-	-	-	-	-	1	-	1	7.1	-	1	-	1	3.1
C Spine	-	-	-	-	-	-	1	-	1	4.5	-	1	-	1	2.6
T Spine	-	-	-	-	-	-	1	-	1	4.3	-	1	-	1	2.6

Metabolic conditions

The crude prevalence rate of metabolic conditions in 13/83 was approximately 30%. There were three metabolic conditions found in the 13/83 collection; cribra orbitalia (CO), porotic hyperostosis (PH) and Rickets/Osteomalacia (R/O). There were 10 individuals (27%) from the SCC with metabolic conditions and 13 individuals from GI (29%). There were four individuals from the SCC and three from GI affected by multiple metabolic conditions (Table 31).

Table 31: Individuals with metabolic conditions in the 13/83 skeletal collection. Percentage indicates the proportion of individuals affected by conditions.

	Location					
	SCC (n=37)		Infirmary (n=45)		Total (n=82)	
Type of condition	n	%	n	%	n	%
Cribra Orbitalia (CO)	-	-	1	2	1	1
Porotic hyperostosis (PH)	3	8	9	20	12	15
Rickets/Osteomalacia (R/O)	3	8	-	-	3	4
CO, PH	3	8	3	7	6	7
PH, R/O	1	3	-	-	1	1
Metabolic Total	**10**	**27**	**13**	**29**	**23**	**28**

The frequencies of metabolic conditions in the 13/83 skeletal collection show that Porotic hyperostosis had the highest frequency (23.2%) throughout the collection (Table 32). All three conditions were present in the SCC subadults. Metabolic conditions were only found in males from GI. The frequencies were calculated using the number of males, females and subadults in 13/83.

Table 32: Frequency of specific metabolic conditions in 13/83 according to sex. Percentage indicates the number of males, females and subadults with metabolic conditions. Only groups affected by these conditions are included in this table

Location	Sex	Metabolic condition					
		Cribra Orbitalia		Porotic hyperostosis		Rickets/ Osteomalacia	
		n	%	n	%	n	%
SCC	Adult Female (n=9)	1	11.1	1	11.1	-	-
	Adult Male (n=8)	-	-	3	37.5	2	25.0
	Subadult (n=19)	2	10.5	3	15.8	2	10.5
	SCC Total (n=37)	**3**	**8.1**	**7**	**18.9**	**4**	**10.8**
GI	Adult Male (n=31)	4	12.9	12	38.7	-	-
	GI Total (n=45)	**4**	**8.9**	**12**	**26.7**	**-**	**-**
Total	Adult Female (n=15)	1	6.7	1	6.7	-	-
	Adult Male (n=39)	4	10.3	15	38.5	2	10.3
	Subadult (n=26)	2	8.0	3	12.0	2	12.0
	Total (n=82)	**7**	**8.5**	**19**	**23.2**	**4**	**4.9**

Overall in 13/83, mid-adults showed the highest frequency of cribra orbitalia (14.3%), the Old-Adult category showed the highest frequency of porotic hyperostosis (40%), and subadults showed the highest rate of Rickets/Osteomalacia (8%) (Table 33).

Table 33: Crude prevalence rates of metabolic conditions in different age groups for the entire 13/83 collection. Percentage indicates the number age groups affected by these conditions. Only groups affected by these conditions are included in this table

		Metabolic condition					
		Cribra Orbitalia		Porotic hyperostosis		Rickets/ Osteomalacia	
	Age in years	n	%	n	%	n	%
Subadult (0-17 years)	0-2 (n=15)	1	6.7	1	6.7	-	-
	3-8 (n=3)	-	-	-	-	1	33.3
	9-14 (n=4)	-	-	1	25.0	1	25.0
	15-17 (n=3)	1	33.3	1	33.3	-	-
	Group Total (n=25)	**2**	**8.0**	**3**	**12.0**	**2**	**8.0**
Young adult (18-29 years)	18-24 (n=8)	-	-	1	12.5	1	12.5
	25-29 (n=9)	1	11.1	2	22.2	-	-
	Group Total (n=17)	**1**	**6.7**	**1**	**6.7**	**-**	**5.9**
Mid-adult (30-49 years)	30-34 (n=6)	-	-	2	33.3	-	-
	35-39 (n=9)	-	-	3	33.3	-	-
	40-44 (n=4)	2	50.0	2	50.0	-	-
	45-49 (n=9)	2	22.2	3	33.3	1	11.1
	Group Total (n=29)	**4**	**14.3**	**10**	**35.7**	**1**	**3.6**
Old adult (50+)	50-54 (n=2)	-	-	1	50.0	-	-
	55-59 (n=1)	-	-	1	100.0	-	-
	Group Total (n=5)	**-**	**-**	**2**	**40.0**	**-**	**-**
Unassessed adult total(n=6)		**-**	**-**	**1**	**16.7**	**-**	**-**

<u>Cribra Orbitalia and Porotic hyperostosis</u>

Cribra orbitalia and porotic hyperostosis are linked and affect the cranium only (For example Figure 25). Cribra orbitalia (CO) in 13/83 had a CPR rate of 8.5% and a true prevalence rate of 11.6%. Cribra orbitalia only affects the orbits of the frontal bone whereas porotic hyperostosis primarily affects the bones of the cranial vault. Both cribra orbitalia and porotic hyperostosis were found together in six individuals, three from each SCC and GI (Table 31). Only one individual (from GI) had cribra orbitalia independent from porotic hyperostosis. The frequency of cribra orbitalia and porotic hyperostosis was higher in the Infirmary individuals than the SCC. There was a greater difference between porotic hyperostosis in SCC (18.9%) and GI (26.7%) than cribra orbitalia (SCC 8.1%, GI 8.9%) (*Table 32*). Porotic hyperostosis had the highest representation in the Old adult age category (40%) whereas cribra orbitalia was absent in this age category (Table 33). Mid-adults had the highest representation of cribra orbitalia (14.3%). Porotic hyperostosis also had a high representation (35.7%). The frequencies stated above are the crude prevalence rates within 13/83 (n=82). As CO and PH only affect the cranium and there were 60 crania in 13/83, this shows a true prevalence rate of 11.6% of CO and 31.7% of PH.

(a)

(b)

Figure 25: Skull of III311 (GI Male 40-44 years) with (a) Cribra Orbitalia indicated by the red arrow and (b) Porotic hyperostosis indicated by the red circle.

<u>Rickets/Osteomalacia</u>

Rickets/Osteomalacia affects the weight-bearing bones and affected the femora and tibiae of individuals from 13.83 and was only found in the SCC burials. There were four individuals affected including two male adults and two subadults. This accounted for 10.8% of SCC burials and 4.9% of total 13/83 burials. It was found in one individual who was also affected by porotic hyperostosis (Table 31 and Table 32). The age group which was the most commonly affected was the subadult group, with 33.3% of 3-8 year olds showing signs of the condition (Table 33**Error! Reference source not found.**).

Neoplastic Conditions

There were three individuals with evidence of neoplastic conditions in the 13/83 skeletal collection (Table 34). This included two individuals from the SCC burials and one individual from GI. The individual from the Infirmary had evidence of both Osteoma and other neoplastic growth in the right ribs (Table 35).

Table 34: Frequency of neoplastic conditions in 13/83. Percentage indicates number of skeletal elements affected within each group and location with neoplastic conditions

	Location					
	SCC (n=37)		Infirmary (n=45)		Total (n=82)	
Type of condition	n	%	n	%	n	%
Osteoma	2	5	-	-	2	2.4
Osteoma, Other neoplastic	-	-	1	1	1	1.2
Neoplastic Condition Total	**2**	**5**	**1**	**1**	**3**	**3.7**

The distribution of neoplastic lesions on the skeletons of 13/83 were on the cranium and right ribs (Table 35). All three of the individuals affected were male. All three osteomas found were on the crania (two affecting the frontal bones and one was in the maxillary sinus). This affected 7% of the crania from the SCC and 3% of GI burials with an overall representation of 5% in the 13/83 skeletal collection. There was one individual with a neoplasm in the right ribs, this represented 4% of GI burials and 2% in the 13/83 collection. This was calculated using the total number of individuals with R Ribs and crania present.

Table 35: Distribution of neoplastic lesions on the skeleton in 13/83. Percentage indicates number of skeletal elements affected within each group and location with neoplastic conditions

	Location					
	SCC		Infirmary		Total	
	Adult Male		Adult Male		Adult Male	
	n	%	n	%	n	%
Cranium (Osteoma) (n=60)	2	7	1	3	3	5
R Ribs (Other neoplasm) (n=50)	-	-	1	4	1	2

Figure 26: Ivory/button osteoma on frontal bone of III212 (GI Male, 40-44 years). Indicated within the red circle.

Figure 27: Osteoma in the maxillary sinus of II207 (SCC Male, 50-55years). Indicated by the red arrow.

Table 36: Frequencies of dental pathologies in each age group from 13/83. The total given indicates the number of individuals with dentition in each age group. The percentage given is the percentage affected by group.

			AMTL		Caries		Calculus		Abscess		LEH	
Location	Age Group	Total	n	%	n	%	n	%	n	%	n	%
SCC	Sub-adult (0-17 years)	11	-	-	3	27.3	2	18.2	-	-	-	-
	Young Adult (18-29 years)	4	2	50	4	100	4	100	-	-	2	50
	Mid-adult (30-49 years)	5	4	80	3	60	3	60	-	-	-	-
	Old Adult (50+)	4	3	75	2	50	2	50	2	50	1	25
	Unassessed adult	1	1	100	-	-	1	100	-	-	-	-
	SCC Total	**25**	**10**	**40**	**12**	**48**	**12**	**48**	**2**	**8**	**3**	**12**
GI	Sub-adult (0-17 years)	4	-	-	2	50	2	50	-	-	1	25
	Young Adult (18-29 years)	8	3	37.5	5	62.5	8	100	1	12.5	4	50
	Mid-adult (30-49 years)	14	11	78.6	10	71.4	11	78.6	1	7.1	4	28.6
	GI Total	**26**	**14**	**53.8**	**17**	**65.4**	**21**	**80.8**	**2**	**7.7**	**9**	**34.6**
Total	Sub-adult (0-17 years)	15	-	-	5	33.3	4	26.7	-	-	1	6.7
	Young Adult (18-29 years)	12	5	41.7	9	75	12	100	1	8.3	6	50
	Mid-adult (30-49 years)	19	15	78.9	13	68.4	14	73.7	1	5.3	4	21.1
	Old Adult (50+)	4	3	75	2	50	2	50	2	50	1	25
	Unassessed adult	1	1	100	-	-	1	100	-	-	-	-
	13/83 Total	**51**	**24**	**47.1**	**29**	**56.9**	**33**	**64.7**	**4**	**7.8**	**12**	**23.5**

Chapter 5: Discussion

The 13/83 Gloucester skeletal collection is an important example of 18th and 19th century burials from both a non-parochial church and an Infirmary burial ground.

The Burial Register for Southgate Congregational Church (National Archives, 2016) starting in 1786 and finished in 1837 despite burials at SCC continued until approximately 1860 (Gloucester 2016). This was due to the establishment of the national government's 'General Registers Office' which listed deaths from 1837. This Office also became responsible for issuing Death Certificates including cause of death which had not previously been necessitated (Hardy 1994). This information was collected at a local level and was published nationally, this practice continues in a similar form to current day.

The annual numbers burials from SCC increased in frequency generally from 1802. This supports the historical information that the congregation of the church increased with the ministry of William Bishop (from 1794-1832) and the list of individual residences also reflects the outreach of SCC. The burial register residencies list in also indicates that the congregation of this church were not specifically from the parish of St. Owens (Herbert, 1988). Traditionally until the late 19th century, people had the legal right to be buried in their parish churchyard (Wiggins 1991). Therefore, it is highly likely that entities in the burial register attended the church and chose to be buried in SCC.

The Burial Acts of 1850 and 1852 restricted burials in non-Church of England burial grounds into municipal cemeteries. These Burial Acts were introduced to address public health concerns due to population increases during this time period, and the problems arising from overcrowding in burial grounds (Wiggins 1991). This supports the information relating to the cessation of burials at Southgate Congregational Church (Gloucester 2016) and likely the Infirmary burials.

Demographics and occupations of Southgate Congregational Church and Gloucester Infirmary

Gloucester city had a strong history of trade and retail in addition to clothes and garment manufacture from at least the 17th century. In an occupational census of 1608, 49% working men from the Gloucestershire countryside of involved with agriculture compared to only 3.9% of men in Gloucestershire towns. Trade and retail had the highest employment (19.3%) with garment and textile manufacture accounting for a combined 25.3% (Tawney and Tawney 1934). These occupations continued to have a presence into 18thcentury Gloucester with clothing and pin manufacture becoming more prominent (Ripley 1980). The SCC burial register only listed occupations for a small proportion of the total burials, there was only column provision in the register for listing occupation from 1833 unit the end of the register. Prior to this information on occupation was mentioned infrequently in the registers text (see Appendix 1). Excluding three individuals employed by the church (two ministers and a pupil), there were two individuals who had been employed by the South Gloucester Militia and six entities involved in product and clothing manufacture. This supports information that the burials from SCC were representative of the general population of Gloucester rather than the gentry. However, due to the small sample size it is not conclusive.

The individuals within the Gloucester Infirmary burial ground would likely have been poor compared to the church burials as their care had been provided by charitable concern (Herbert, 1988). However, Southgate Congregational Church as a non-conformist church was involved in outreach work which included the provision of Sunday School and other services to the slums and working-class areas of Gloucester (Herbert 1988; Snell 1999). The Sunday School movement was instigated in the late 18th century was related to the child labour and the education of children in Gloucestershire pin factories (Snell 1999). Therefore, as the individuals within GI burial ground were poorer than SCC and had been resident within the infirmary, it was expected that there would be a higher representation of pathologies. The demographics for the church and the Infirmary were also expected to be different as the individuals buried in the Infirmary cemetery would have been referred there via subscription whereas the church burials were individuals who attended the non-conformist Southgate Congregational Church. Excavation and analysis of a similar Newcastle Infirmary burial ground examined the burial records and skeletal remains. The authors state that admission to the Infirmary excluded individuals with certain conditions (including some infectious and cancerous), pregnant women and children under the age of seven (Mitchell *et al.* 2011). If similar policies were enforced at GI this may explain some of the different demographics between SCC and GI.

Preservation of skeletal remains

Preservation and recovery of human remains are important to understanding the demographics of a population for analytical purposes (Walker *et al.* 1988). The recording of individual and grouped skeletal elements enables assessment of the health status of individuals within the sampled populations. The A significant difference between SCC and GI in the preservation of grouped skeletal elements, this could be related to the extrinsic factors stated by Waldron (2007) affecting recovery and preservation of human remain. The limitations highlighted in Chapter 1, were supported by the analysis of retained skeletal elements in the 13/83 skeletal assemblage. This research does not examine the reason behind the differences in preservation between the two burial grounds as this is already being conducted at LJMU. However, skeletal element inventories have been utilised to assess the frequency of pathologies in different skeletal elements.

Examination of excavation records retrieved from Gloucester City Museum (for examples see appendix 3) showed a number inconsistency in the recorded material and the skeletal remains housed at LJMU. This may relate to the problems with the recovery of the skeletal remains from the site, however other factors cannot be excluded (Waldron 2007). Photography of skeletal remains from Trenches II and III show elements present which are absent from the 13/83 collection (for examples see *Figure 28*). These include skeletons in which only the crania are present in the LJMU collection whereas photographs show an entire skeleton (e.g. II243, II283 and III322). Comparison was not possible for all the excavated skeletons as not all were photographed *in-situ*. It is stated on some the context sheets that this was due to time constraints at the time of excavation. These anomalies may be due to the amount of time elapsed between the excavation of the skeletal collection in 1983 and analysis in this thesis. However, it has also been stated by the mayor of Gloucester (who took part in the excavation) that the site was subject to vandalism and theft by trespassers at the time of excavations (Hampson pers. Comm., 2016). Although the loss of skeletal material is expected throughout time, both prior and following excavation (Waldron, 2007). In the future, this issue may need to be explored further as the absence of various skeletal elements can lead to result bias. For the purposes of this research, all the individual burials present from Southgate Congregational Church and Gloucester Infirmary cemeteries in the LJMU 13/83 collection have been utilised.

(a) II191 and II206 E-W burial

(b) II243 and II244 E-W burials

(c) II283 W-E burial

Figure 28: Examples of excavation photographs from trench II (a) Double burial of II191 and II206, both these skeletons had sacra present during excavation. (b) Double burial of II243 and II244 (c) II283 was a reversed burial (W-E alignment) Images ©Gloucester City Museum

Biological profiles

Sex

The ratios of adult male and female skeletons analysed from Southgate Congregational Church cemetery was similar to the ratio shown in the church register. Previous comparison between sex determined using anthropological methods and individuals of known sex found that sex had been correctly identified in the majority of individuals (Molleson and Cox 1993). A study of skeletal preservation from a Native American mission compared human remains and the burial records of the mission also found that there was no significant difference in sex ratios between the recovered human remains and individuals listed in the burial register (Walker *et al.* 1988). All three of these skeletal samples showed similar sex ratio trends. Therefore, the results of sex determination within 13/83 is likely to be equally accurate (Molleson and Cox 1993; Walker *et al.* 1988). This indicates that the male sex bias within the skeletal remains from Gloucester Infirmary is true for the sample. A similar extreme male bias was not evident in a study of an urban medieval hospital cemetery in Cambridge (Cessford 2015). Although, males were slightly more frequently observed than female in the Cambridge sample and the sex demographics were closer to those of SCC and other archaeological skeletal assemblages as documented by Molleson and Cox (1993) and Walker *et al.* (1988). A study of the 18-19th century Newcastle Infirmary cemetery (Boulter *et al.* 1998; Mitchell *et al.* 2011) states that certain females were excluded from treatment within that Infirmary and that individuals included in the cemetery were the unclaimed dead. It is unknown if the entry into GI was similarly prohibited, however the male sex bias within these burials compared to SCC and earlier hospital cemeteries could reflect the changes within medical care between the medieval and post-medieval periods. Another explanation could be differing burial practices and cemetery organisation between the two 13/83 cemeteries. As highlighted in chapter 1, one of extrinsic limitations in the study of human remains is incomplete recovery due to burials being undiscovered or obstruction (Waldron, 2007). If male and female remains were buried in separate locations, the female burials may not have been uncovered as part of the 13/83 excavation. Information stated in the contemporary archaeological record stated that some human remains from Gloucester Infirmary cemetery were lost due to a dock wall collapse (Appendix 3). As also mentioned previously, further excavation of the site in 1989 uncovered further discovery of remains from Gloucester Infirmary and Southgate Congregational Church, which support this hypothesis.

Age

As stated previously (Chapter 2), there are differences between the biological age as determined in osteological analysis and the chronological age of an individuals as stated within historical (including forensic and medical) records such as burial registers (Mitchell and Brinkley, 2017). This has been explored extensively in previous scientific literature (for examples see Lewis (2007)). The demographics for both the biologically derived age and chronological age profiles within Southgate

Congregational Church showed a 'U' shaped pattern which is expected within the historical and modern developing world (Waldron, 2007). Life-expectancy was increasing during the 18th and 19th centuries due to a reduction in mortality (McKeown and Record, 1962). It was therefore predicted that this reduction would be evident within SCC, however infant mortality rate remained high and there was a large proportion of older individuals listed in the burial register. When comparing the skeletal remains recovered from Southgate Congregational Church and the historical records from this cemetery, the largest age-category in the SCC skeletal remains were the subadults. This was different from the burial register which indicated that individuals over the age 50 years were the most frequent. However, when examining more specific age groups the youngest (0-2 years) had the highest representation in both the SCC register and excavated burials. This indicates a high level of infant mortality which is an expected trend in pre-industrial British populations (Waldron, 2007). This is further supported by information within the Burial Register with multiple child burials from the same families (Appendix 1, e.g. the 'Bourne' family lost four children aged between seven weeks and 17 months of age between 1803-1810). These trends differed from those found in subadults during the excavation of the parochial Gloucester church of St Catherine's (originally St. Oswald's Priory) recovered which found 94 post-medieval individuals including 28 subadult. The largest group of subadults from St. Catherine's were aged between 2.6-6.5 years (Lewis 2013). This contrast may be related to differing burial practices and cemetery organisation.

The excavation area for SCC was within the walls and in proximity to the church building (see appendix 3). There as a double burial of two perinatal subadults (II118a – 0-1.5months and II118b-32-34w prenatal) which located in isolation from the other burials at the south side of the church. Burial of unbaptised infants and stillbirths in consecrated ground was prohibited by the established Anglican and Catholic churches. However, the non-conformist churches such as SCC did not follow traditional burial practices including deviation from the west-east burial alignment (for example II283 and II250, see appendix 3) and the inclusion of stillbirths and unbaptised infants (Tarlow 2010). Therefore, the inclusion and high representation of 0-2 year old burials may be related non-conformist burial practices of SCC in contrast to those parochial burials found at Spitalfields, St. Catherine's and other churchyards such as. This is also supported by the excavation of a larger non-conformist burial ground in London (Connell and Miles 2010), which found that subadults aged '0-5 years' accounting for approximately half of all recovered burials.

Bello *et al.* (2006), studied three skeletal assemblages including Spitalfields and found that bones from 0-4 year olds were least well preserved. The preservation of subadult remains has been investigated in numerous studies which state that the fragility of these remains may be more susceptible to taphonomic processes (Bello *et al.* 2006; Mays 2010; Saunders and Hoppa 1993; Walker 1995). However, the high representation of subadult remains from SCC contrast these findings and the overall recovery of skeletal elements did not vary greatly between subadults and other age groups. Therefore, the findings in Southgate Congregational Church support statements made Buckberry (2000) and Lewis (2007) whom did not find differences in the preservation of subadult remains and those authors believed that the assumption of poor-preservation within bioarchaeological research has led to under-utilisation and study of these remains.

There was a highly significant difference in the age distribution between SCC and GI burials. The distribution pattern for GI shows normal distribution with the middle adults being the most frequent. This strongly infers that the cemetery organisation and burials were different between the Southgate Congregational Church and Gloucester Infirmary. There were very few subadults burials recovered from Gloucester Infirmary with only one individual in the '0-2years' age category and there were no adult skeletons discovered within the 'Old Adult' category. This was similar to the demography of over 400 skeletons from a Cambridge medieval hospital cemetery which did not include any burials under the age of six years but did include did include 'old-adults' (Cessford 2015). The study of Newcastle Infirmary also states that children under the age of seven were not allowed admission (Mitchell *et al.* 2011). This was the general trend observed in GI individuals. There was one GI subadult in the '3-8 years' category, who was individually aged as at 6-7 years. The inclusion of a 0-2 year old could indicate that the practices at Newcastle Infirmary were not the same as applied in Gloucester. However, this individual may have been included in the GI cemetery for another reason.

Comparison of age profiles between burial records and biological profiles of individuals from a north American mission found that subadults and individuals aged over 45 were under-represented (Walker 1995; Walker *et al.* 1988). The authors state that preservation of skeletal remains of the subadults and the old-adults may be responsible, as age-related bone degeneration may result in under-representation. However, despite the small sample size the oldest age group showed the best recovery of elements per age-group within the skeletons of 13/83 (appendix 4). The trends seen in their study were similar to that of SCC in relation to the total number older adults and could also explain the age distribution in Gloucester Infirmary.

The anthropological methods applied in this study for estimating age are commonly used however there are limitations in the aging of adults over 60 years. Dental attrition (Lovejoy 1985) can age up until 55 years. Cranial suture closure (Meindl and Lovejoy 1985) highest age bracket is 56.2 years ± 8.5. The auricular Surface (Meindl and Lovejoy 1985) and surface of the pubic symphysis (Brooks and Suchey 1990) age up to approximately 60 years. Sternal rib ends surface degeneration (Işcan *et al.* 1984; İşcan *et al.* 1985) can be used in some case up to 70 years. The limitation of these methods could explain bias and the under-representation in 'old-adults' compared to the burial records which have been found in previous studies (Molleson and Cox 1993; Walker 1995; Walker *et al.* 1988). Information gained from Southgate Congregational Church burial register indicates a large number of individuals over the age of 50 with the oldest 93 years. A new method has been proposed (Falys and Prangle 2015) which has been found to successfully determine age up to 80+ years using the sternal age of the clavicle in test populations. In future in may be possible to apply this methodology into research relating to the demographics of the 13/83 collection.

Stature

Male mean stature estimation has found as consistently greater than females regardless of the population under study (Gray and Wolfe, 1980; Holden and Mace, 1999). Long bone measurements such as those used in stature estimation have been used as a measure of sexual dimorphism and for sex determination (Mall *et al.,* 2001; Spradley and Jantz, 2011). Although this has been seen as reliable these measurements have been found to vary greatly between samples even from similar geographic locations (Martin *et al*. 2016; Spradley and Jantz, 2011). This has been related to numerous factors including differences in occupation (Larsen, 2015; Martin *et al*. 2016; Ruff, 1987), reproductive selection (Fink *et al.,* 2007; Nettle, 2002), and nutritional factors (Gray and Wolfe, 1980). Nutritional and environmental factors during childhood are known to have an impact on the terminal height of an individual (Floud *et al.* 1990; Larsen 2015; Steckel 1995; Steckel *et al.* 2002). Molleson and Cox (1993) assessed the final stature of individuals by birth years and found this changed depending on years with different environmental stresses.

There was no significant difference in stature between the males from SCC and GI nor between the females in the two cemeteries. This indicates that the individuals contained within these cemeteries were similar and subjected to the same nutritional, environmental and selection factors. As expected within a studied sample, there was a highly significant difference between male and female stature overall in 13/83 and in SCC. However there was no significant difference between males and females from GI. The mean stature was taller in the GI compared to SCC. This may be due to the small sample of assessable female remains in GI despite having a larger total sample size.

Examination of 18th century military records show an adult male mean stature of 170.5cm between 1749-and 1753 (in peacetime), and 167.3cm between 1769-1774 (war-time) (Steegmann Jr 1985). A comparison of stature estimations London post-medieval cemeteries (Connell and Miles 2010) found that male mean stature ranged 1.68-1.75m in seven skeletal assemblages and 1.57m-1.61m in females from six skeletal assemblages (excluding Spitalfields which was erroneously stated as 1.40m). The estimated mean stature for females in both SCC and GI were higher than the London populations. This could indicate that post-medieval Gloucester was subject to less nutritional and environmental stress than London during the same time period.

Overall observations and problems

In order to successfully conduct a palaeoepidemiological study the sample should be representative of the population under investigation (Waldron, 2007). Therefore it is essential that the intrinsic factors stated in Chapter 1 need to be limited. This was not achievable within the 13/83 skeletal assemblage as the demography of the sample showed unavoidable bias. The biological profiles within SCC and GI show significant differences in the sex and age distribution between the two cemeteries which supports the archaeological information that these burials have separate origins and/ or that the cemeteries were differently organised. Examination of the SCC burial register (Appendix 1) adds contextual information about the population of the church. The demography found in the SCC cemetery are close to the known burials in the register and the expected demography of pre-industrial post-medieval Britain. The demography for Gloucester Infirmary was not the same as expected from a normal population sample of the post-medieval Britain as with the Southgate Congregational Church. The comparable Infirmary cemetery in Newcastle was used for unclaimed fatalities (Mitchell *et al.* 2011). The exclusion of certain demographics from the hospital (and therefore the burial ground) may have also been applied within GI. However, while this cannot be confirmed at present there were parallels between the demographics of GI and Newcastle Infirmary. Due to the male sex bias in the skeletal sample from the infirmary burials and the large proportion of subadults in the SCC burials, statistical analysis was not attempted based on sex. However, pathological frequencies of adult males and females as well as subadults have been stated in some cases. As the 13/83 skeletal assemblage was found as unbalanced and the relative sample size small, all the remains were utilised. The time-scale of burials enabled an approximate recovery rate to be calculated for the skeletal remains. Therefore the biases within the sample hinder true palaeoepidemiological study and comparison to modern epidemiology. The demographics and frequencies of pathological conditions within 13/83 were compared to other studies and examples.

Dental pathologies

The individuals with retained dentation or observable dental arcs were analysed for the frequency of dental conditions within the 13/83 skeletal assemblage. These conditions were among the most commonly found within the studied collection. All the dental pathologies found in 13/83 had a higher frequency in GI compared to SCC except for dental abscesses which were equal.

There was no evidence of dental treatment (excluding possible AMTL through tooth extraction) in any of the 13/83 skeletons. Artificial dentures and fillings were found within individuals from Spitalfields (Molleson and Cox, 1993) and in Georgian Kent (Cox *et al.* 2000). These would have been expensive treatments which were unlikely to have been available to the individuals of Southgate Congregational Church and Gloucester Infirmary. This supports the assumption that the 13/83 individuals were of lower socio-economic status than Spitalfields and of closer status other 18th-19th century studied collections such as St. Brides, Crossbones and Bunhill (Connell and Miles 2010; Mant and Roberts 2015).

The method used for frequency analysis did not examine individual dental sockets or teeth due to constraints in the study. Therefore additional methods could not be employed to calculate additional factors such as caries correction factor (Erdal and Duyar, 1999; Lukacs, 1995).

Antemortem tooth loss

Antemortem tooth loss due to dental extraction was occurring during the Georgian period. However direct evidence of this from skeletal remains is difficult to identify as tooth-loss can occur for multiple reasons (Lukacs 2006; Molleson and Cox 1993). The number of individuals with AMTL in the 18th-19th century 13/83 collection was higher than a Medieval Irish study (Novak 2014). This supports the meta-analysis study (Müller and Hussein 2017) examining trends in AMTL and Caries rates before the 18th Century. Müller and Hussein (2017), found little change between populations prior to the 18th century and a moderate increase from the 18th century onwards. These changes were hypothesised to be related to altered dental hygiene practices and increased tooth extraction. It has been stated that by the mid-twentieth century the majority of older or elderly individuals were completely edentulous (Müller *et al.*, 2007).

A study on prehistoric Canary Islanders (Lukacs 2006) and early medieval Western Ireland (Novak 2014) found that the rate of AMTL was more common in the males than females. The rate of AMTL was the same for males and females in SCC. However, males had a slightly higher prevalence rate than females in GI and in 13/83 overall. Therefore 13/83 follows the trends observed in previous studies.

The number of individuals with AMTL increased with age throughout the 13/83 skeletal remains. None of the subadults were affected and high levels in 'mid-adults' and 'old-adults'. The increase of AMTL with age has been observed in numerous studies including Romano-British (Raitapuro-

Murray *et al.* 2014), Spitalfields (Molleson and Cox 1993; Whittaker and Molleson 1996) and continues to be observed globally in modern populations (Al Shammery *et al.* 1998). The 'old-adult' group had a slightly lower rate of AMTL than the 'mid-adults' in 13/83. This may be due to small sample size in 'old-adults' and the absence of individuals within this age group from GI. Studies of modern British populations report and predict falling levels of dental loss (Müller *et al.*, 2007; Steel *et al.*, 2000, Steel *et al.*, 2004). Data obtained from a 1998 UK national dental survey showed that there was a correlation between tooth loss related to periodontal disease and caries. The older individuals within this study were likely to have had received dental treatment and possibly dental clearance prior to the introduction of universally available NHS interventions (Steel *et al.*, 2000). The authors further state that there were notable reductions in total number of edentulous adults between 1968 (37%) and 1998 (13%) and predict that only 4% of British adults with be affected by this condition by 2028 (Steel *et al.*, 2000). This predicted reduction in both complete and partial tooth loss has also been recorded in subsequent studies in Europe, with USA showing slight increases (Müller *et al.*, 2007; Steel *et al.*, 2004).

Overall in 13/83, there was a positive correlation between AMTL and dental abscesses. There were no other AMTL positive correlations found overall in 13/83 or the individual cemeteries. This may be linked to periodontal disease (discussed below) and its risk factors. These risk factors may account for the higher AMTL crude prevalence rate observed in 13/83 compared to earlier populations.

Caries

Figure 29: Dental crown caries on the lower right (mandibular) deciduous first molar of II228.

The distribution of dental caries in past populations have been widely studied, especially in Britain. These include studies of Roman, Anglo-Saxon and medieval populations which indicate that the distribution of dental caries varied little during these times (Corbett and Moore 1976; Moore and Corbett 1973; 1975; Müller and Hussein 2017; Raitapuro-Murray *et al.* 2014; Whittaker and Molleson 1996). Excavation of 17th century London plague pits (Moore and Corbett 1975) showed an increased prevalence of total caries compared to earlier periods. This continued to rise into the mid-nineteenth century (Corbett and Moore 1976) and was assessed as being closer to a modern population. This also supports the finding of Müller and Hussein (2017) and has been attributed to changes in diet, sugar importation and food manufacturing. Examination of the Spitalfields collection (Whittaker and Molleson 1996) found there was a very high prevalence of individuals with caries (87%) affecting one or more teeth. This was a much higher frequency than the findings in the 13/83 collection. There was a higher proportion of individuals from GI than SCC. The higher amount of observed caries in Spitalfields may be related to differences in diet and social status between Spitalfields and 13/83. However, a study comparing caries rates in three London 18-19th centuries found a CPR of 78.9 -79.5% regardless of socio-economic background (Mant and Roberts 2015).

The age group from Spitalfields most commonly affected was the 26-35-year-old age category with all individuals in this group showing signs (Molleson and Cox, 1993; Whittaker and Molleson, 1996). This was the same overall in 13/83 skeletons, with 75% of the 'young adults' (18-29 years) age group having caries. In SCC had the all the young adults had caries whereas a smaller propotion of this age group were affected in Gloucester Infirmary with the 'mid-adult' group more frequently affected. As stated above, tooth loss due to caries could explain the reduction in caries rate in the older individuals in the 13/83 skeletal assemblage and as the caries correction factor was not applicable in this study the true rate of caries may have been underestimated. The higher rates within the 18th-19th century London population may indicate that there was greater availability of cariogenic foods in London than the same time period in Gloucester.

Carious lesions were also found both the deciduous (Figure 29) and permeant dentition of subadults. The prevalence of carious lesions is known to have increased in subadults within the industrialised countries, along with adults from the middle of the 19th century due to dietary sugar intake (Moore and Corbett, 1978; Sheiham, 1984). The period of time which burials were occurring in Southgate Congregational Church and Gloucester Infirmary also slightly pre-dates the widespread increase in sugar intake, which may account for the differences in the contemporaneous population studies. Public health measures employed within the industrial world such as the substitution of sugar, fluorinated tooth paste and water resulted in significant reduction of caries in subadults by the end of the 20th century compared to developing countries (Sheiham, 1984). Anti-biotic preventative treatment has also been used in humans and non-humans to reduce caries rates due to cariogenic bacteria, however this increases the risk of anti-biotic resistant strains developing and reduced efficiency of these drug within patients (Simón-Soro and Mira, 2015; Sheiham, 1984). The reduction in caries rates displayed modern epidemiological studies compared to earlier populations is due to better awareness and preventative strategies which would have been inaccessible in 18th-19th century Gloucester.

Calculus

Calculus has been stated as one of the most common dental conditions and contributes to periodontal disease (Roberts and Manchester), which is supported by the findings in 13/83. A study an early medieval cemetery found calculus in all the adults and 75% of the subadults (Caffell *et al.* 2005), and a study of the Pre-Hispanic Canary Islands recorded it in 88.5% of individuals. A comparative study (Whittaker *et al.* 1998) between Romano-British and Spitalfields Londoners found that the prevalence of calculus in the 18th-19th century was lower during the than the Romano-British. This was attributed to the higher rate of AMTL within Spitalfields. However, as with a study of calculus in Prehispanic canary islanders (Delgado-Darias *et al.* 2006) There was no significant correlation found in 13/83 between AMTL and calculus, however the trends observed in these conditions were also found the Whittaker *et al.* (1998) study. There was a significantly higher frequency of in the infirmary compared to SCC and closest to the earlier populations. The higher frequency of calculus in GI compared to SCC may be related to an increase of risk factors and lower socio-economic status in GI and poorer general health within the individuals.

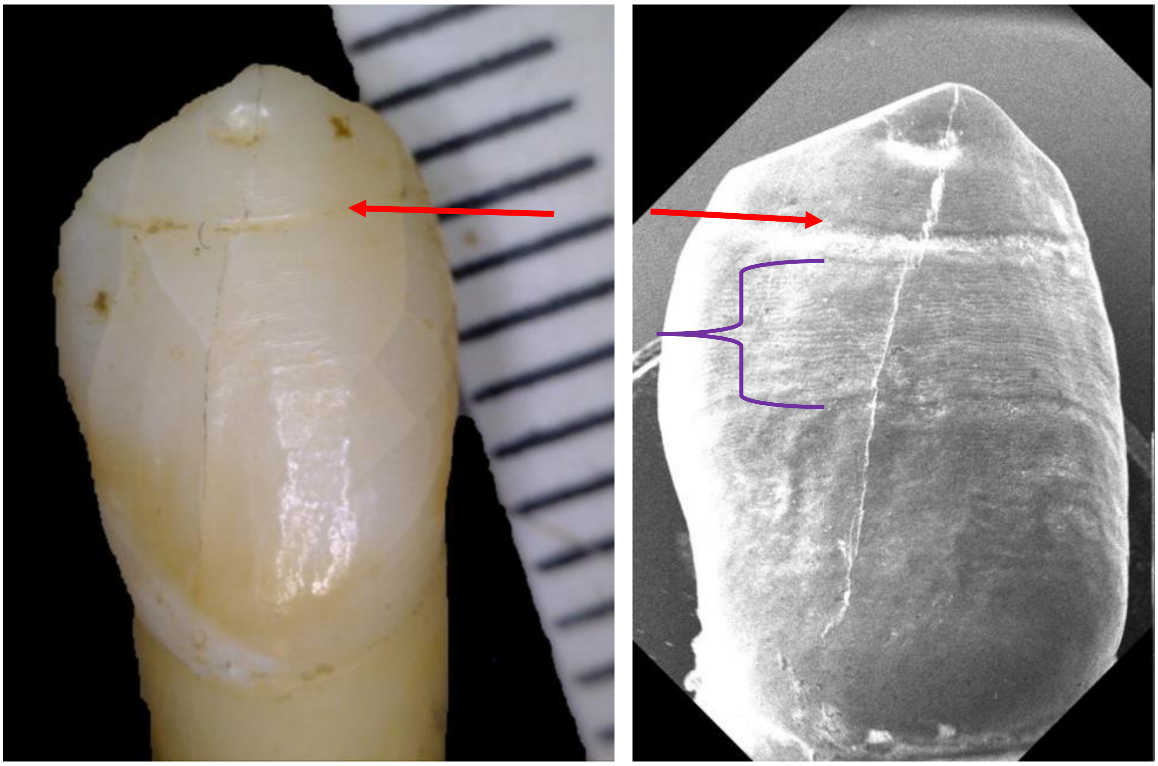
A study (Connell and Miles 2010) of a contemporaneous non-conformist burial ground in London found that calculus was more frequent in males. This showed similar trends to those found in the 13/83 skeletal assemblage, with the exception of GI which is likely due to the males sample bias within that cemetery. Greene *et al.* (2005), also found that males had significantly higher amounts of calculus in the maxillary dentition but no significant difference in the mandibular. As all dentition has been scored together in this it is not possible to compare the specific location of dental calculus. The rise in tobacco smoking which was occurring during the 18th-19th which was primarily a male occupation (Proctor, 2004). Smoking has been definitively linked to poor oral health and calculus frequency (Albandar *et al.*, 2000; Bergström, 1999). This factor may have contributed to the higher prevalence in males.

Dental calculus in subadults was also found at a higher rate in GI than from SCC, this however may also be attributed to the small sample size of subadults in GI. All the individuals in the 'young adult' category had the dental calculus. This differed from the Spitalfields findings (Whittaker *et al.* 1998) where there was an increase in calculus with age, however the trends in that study found no age correlation in the comparative Roman sample. These age trends also reflect those observed for caries in 13/83.

Dental Abscesses

Dental abscesses (DA) were rarely found in the 13/83 skeletal assemblage. This was a much lower rate than the prevalence in early Medieval skeletal remains from Filton, Bristol (Caffell *et al.* 2005). None of the subadults had evidence of DA although found in the other three general age categories. The most commonly affected group in the Caffell *et al.* (2005) study was the older adult group. As stated in the introduction, dental infections such as abscesses were a significant cause of mortality until the invention of antibiotics in the 20th Century (Robertson and Smith 2009). Treatment of DA, during the 18th and 19th century, included dental extraction (AMTL) to drain the exudate from the abscess (Loudon 1985). The lower observance of DA compared in 13/83 compared to the early medieval collection may be due to more effective treatment by dental extraction.

Linear Enamel Hypoplasia



(a) (b)

Figure 30: Linear Enamel Hypoplasia on the right mandibular canine of III200, indicated by the red arrows. (a) Photograph of microdefect (b) scanning electron microscopy photograph, the purple bracket indicate the area of LEH microdefects not visible macroscopically. (Images captured and reproduced with permission from Dove (2017)).

Linear enamel hypoplasia (LEH) is caused by metabolic disturbances due to environmental or systemic stress whilst the tooth is forming (Larsen 2015). The location of the enamel defect of the tooth indicates at what age the individual was subjected to this (Reid and Dean 2006). A study of known age-at-death 18th and 19th century individuals from Spitalfields and St. Brides found that there was a correlation between the earliest age occurrence of LEH and younger age at death (King et al. 2005). This thesis only examined LEH presence on a macroscopic level (Figure 30a) therefore the age of initial LEH occurrence was not assessed. The presence of a subadult with LEH in 13/83 could be further investigated and the collection compared to the trends observed in Reid and Dean (2006). King et al. (2005), found that LEH was visible macroscopically in a third from the London samples and all the individuals when examined microscopically had LEH. This is a similar macroscopic rate to GI. Further research is being conducted at LJMU including Scanning Electron Microscopy (SEM) (*Figure 30*b) and encompassing some individuals from 13/83 which may show similar frequencies of microscopic defects to Spitalfields and St. Brides. The higher crude prevalence rate in LEH within GI burials compared to SCC indicates that GI individuals were more likely to have been subject to nutritional and/or metabolic disturbances during tooth formation. A study of a medieval hospital cemetery in Cambridge found LEH in had 44.6% of adults (Cessford 2015). This was higher than Gloucester infirmary which indicates that the medieval individuals were subject to higher metabolic and nutritional stress than the post-medieval individuals within the 13/83 skeletal assemblage.

Linear enamel hypoplasia had significantly positive correlations with both calculus and caries. This supports many epidemiological studies have found a link between LEH and an increased risk of caries. This is due to the deficiency in the enamel caused by LEH leading to increased susceptibility to caries infections (Goodman and Rose 1990; Infante and Gillespie 1977; Li *et al.* 1996; Vargas-Ferreira *et al.* 2015).

Periodontal disease and overall observations.

The prevalence of periodontal disease has been extremely high throughout human history and is one of the most commonly found conditions in palaeopathology (Pihlstrom *et al.* 2005; Raitapuro-Murray *et al.* 2014). The pathogenesis has been suggested to arise from gingival inflammation due to calculus, leading to regression of the alveolar bone, tooth-loss, higher rates of caries and dental abscesses (Delgado-Darias *et al.* 2006; Lukacs 2006; Raitapuro-Murray *et al.* 2014; Robertson and Smith 2009). The correlations found between calculus, caries and LEH, and AMTL and Abscesses suggests that periodontal disease was common within 13/83. A 2014 study found that there was little change in the frequency of periodontal disease between Romano-British and German medieval populations however there was a marked increase in modern population which could be related to increased risk factors such as smoking and diabetes (Raitapuro-Murray *et al.* 2014). These risk factors were becoming more frequent during the Georgian period.

The rate of dental disease and systemic poor health have been the subject to multiple epidemiological studies and have a high correlation with an increased mortality rate (Buhlin *et al.* 2003; DeStefano *et al.* 1993; DeWitte and Bekvalac 2010). In Cessford (2015), the frequencies of dental pathologies in adult burials from a medieval urban hospital were very similar to the those in GI, with slightly higher frequencies of calculus, abscesses and LEH. These slight differences may be related to a growing awareness of poor dental health during the 18th-19th centuries. This also indicates that individuals buried within hospital cemeteries from different time periods were subject to similar dental conditions and possibly similar biological stresses.

The differences in the dental pathologies between the GI and SCC supports the archaeological evidence that these were different samples from Gloucester's population. The higher rate of LEH in GI supports contextual evidence that the individuals buried were subject to higher biological or nutritional stresses and possibly of lower social status and general health than SCC (DeWitte *et al.* 2016). The lack of restorative and dental treatment evidence in 13/83 suggests that the population was different than Spitalfields and lower socioeconomically (Mant and Roberts 2015). This is also supported by the occupations listed in the burial records.

Greater awareness of dental conditions have led to a reduction in their frequency in modern Britain. Access to public health services, intervention and education has had a positive effect which was not accessible to the Post-Medieval individuals of Gloucester. It is predicted that continued reduction in prevalence rates with continue if populations has access to these services

Skeletal conditions

By the mid-nineteenth century Gloucester Infirmary was not the only hospital in Gloucester (Herbert, 1988; National Library of Scotland, 2016). Other institutions included the workhouse infirmary, psychiatric 'lunatic asylum', and maternity 'lying-in' hospitals with the locations spread across Gloucester (see Figure 6. Chapter 3). These other types of were arising more commonly around Britain between 1790-1810 (Herbert, 1988; Porter, 1985). The establishment of dispensaries which gave medical advice and medication was also rising and in combination other care providers meant that general infirmaries such as Gloucester Infirmary limited admission to treatable conditions and excluded individuals with infectious fevers (Porter, 1985).

As expected, skeletal conditions were more frequently observed within Gloucester Infirmary burials compared to Southgate Congregational Church. This is likely due to differences in the two sample groups, as individuals from the infirmary were more likely to have been of poor health status prior to death. This also supports previous research which found higher rates of pathologies in burials from medieval (Grauer and Roberts 1996) and 18^{th}-19^{th} century Naval hospitals (Boston 2014; Shortland *et al.* 2008). Although the frequencies of pathological conditions were higher in GI for most of the recorded skeletal pathologies, this was only significantly higher in traumatic conditions. This supports the historical and biological profiling information that Southgate Congregational Church was representative of the general population of Gloucester and that Gloucester Infirmary primarily limited admission to treatable conditions.

Trauma

One of the enduring images of this time period in Britain is related to the increase of child labour and factory work within the industrial revolution (Fraser, 1973). This was also the case within Gloucester with the rise in pin-making factories and manufacture (Snell, 1999). Conditions within factories were extremely hazardous due to long working hours and unguarded machinery resulting in workplace injuries and trauma such as accidental amputation and fractures, if an individual fell or became caught in equipment (Bartrip, 1990; Fraser, 1973). There was very little legal protection or privation for factory workers should they become injured at work and it was not until state intervention in the mid to late-nineteenth century did conditions improve (Bartrip, 1990; Fraser, 1973; Lee, 1973). This was achieved through legislation and occupational medicine as it was found to be in the best interest of the employer to keep their workforce healthy (Bartrip, 1990; Lee, 1973; Porter, 1985). Therefore charitable hospitals such as Gloucester Infirmary would treated injured individuals whereas Southgate Congregational Church provided education for the child labour force (Porter, 1985; Snell, 1999).

Fractures

As expected analysis of fracture patterns in 13/83 indicated that the individuals within Gloucester Infirmary were more likely to have evidence of fractures than Southgate Congregational Church burials. This rate was predictably lower than the medieval Nubian study (Kilgore *et al.* 1997) with was remote geographically and in time. Fracture analysis at the Chichester medieval hospital showed similar differences to those in 13/83 with a higher fracture rate (15.1%) than the associated non-hospital burials (3.3-5.6%) (Judd and Roberts 1998). However, the analysis in another medieval hospital in Cambridge found only 5% of individuals had evidence of fractures (Cessford 2015). The fracture rate in for SCC was closest to the non-hospital skeletal collections of 18th-19th century Spitalfields (Molleson and Cox 1993), St. Martins Birmingham (Brickley and Smith 2006) and the medieval British (Grauer and Roberts 1996) studies. There was a higher CPR in individuals from a post-medieval London non-conformist cemetery (8.4%) compared to SCC (Connell and Miles 2010). This may be related to differences within the populations of Gloucester and London, in addition to the differences in the sample sizes.

Connell and Miles (2010) found that adult females had a higher prevalence of fractures (15.5%) than the males (10.9%). This is in contrast to the findings in 13/83, as with the exception of an adult of indeterminate sex, only adult males had evidence of fractures. This may be related to the male sex bias in GI, however males had higher expression rate in the majority of palaeopathological studies for example; Brickley (2006); Grauer and Roberts (1996); Judd and Roberts (1998); Kilgore *et al.* (1997); Milner *et al.* (2015); Roberts (2000b). Modern epidemiological studies show also that males have a higher frequency of fractures per year than women until the age of 55 years (Court-Brown and Caeaser, 2006; Van Staa *et al.,* 2001). However, the overall studies show that children are the most common group affected by fractures in the UK, with approximately a third of all under 17 year olds having experienced this form of trauma (Cooper *et al.,* 2004). This rate is only exceeded by women over 85 years (Cooper *et al.,* 2004; Cummings *et al.,* 1985; Sporer *et al.,* 2006). This is different from the observed trends within 13/83 as despite the high prevalence subadults these individuals showed no evidences of fractures or other trauma. However, as the majority of recorded fractures were well healed it is unknown at what ages these fractures occurred. There were no signs of trauma (such as amputations) recorded which could be directly linked to child labour indicated during the industrial revolution. However due to variable preservation and recovery of remains this cannot be excluded. The increased risks of fractures due to longer life expectancy has been documented within the modern British populations and this is particularly noticeable in post-menopausal females due to the increased risk of osteoporotic and pathological fractures (Cooper *et al.,* 2004; Court-Brown and Caeaser, 2006; Cummings *et al.,* 1985; Sporer *et al.,* 2006; Van Staa *et al.,* 2001). The presence of males with fracture may therefore be related to differences in the sex and age demography of the sample compared to living populations.

The study of rib injuries can be an important factor in understanding human activity throughout time (Larsen 2015). These are usually located close to the rib angle and caused by direct trauma caused by interpersonal violence, repeated activities and falls (Lovell, 2007). Rib fractures (Figure

31) were the most commonly found fractures in 13/83. In a 2003 study, Roberts and Cox found that rib fractures were the most frequently found overall throughout time. The number of archaeological sites with identifiable rib fractures was also found to increase from 28% in the early-medieval period to 57% of post-medieval sites such as 13/83 (Brickley 2006; Roberts and Cox 2003). The rate of rib fractures at St Martin's (15.6%) was very similar to the overall prevalence rate in 13/83, with most occurring as a result of work placed injury (Brickley 2006). A modern epidemiological study of rib fractures in the elderly found a higher risk of mortality in these patients (Stawicki *et al.* 2004). Therefore, rib fractures would have carried similar complications during the 18th and 19th centuries. There was one individual with a perimortem rib fracture in addition another peri mortem fracture (see below). The majority of fractures observed in 13/83 were well-healed and antemortem. Due to the risk of infection fractures would have had a higher risk of mortality prior to the introduction of anti-biotic treatment in the 20th century (Walker 2001). The most frequent location of fractures seen in clinical practice are in the forearm bones, the ribs also scored highly but below the bones of the lower limb (Cooper *et al.,* 2004; Court-Brown and Caeaser, 2006; Van Staa *et al.,* 2001). This is consistent with studies of long bone fractures in medieval and earlier populations with also state high frequencies of arm bone fractures (Kilgore *et al.,* 1997; Milner *et al.,* 2015). The lower rate of rib fractures in modern studies may also be related to low self-reporting as uncomplicated rib fractures do not require clinical attention (Lovell, 2007).

Analysis of fracture patterns from a 18th-19th century Naval Hospital (Boston 2014) found a high level of healed nasal (Figure 32), cranial depression (Figure 33) and metacarpal fractures (Figure 34). Nasal, mandibular and compression fractures were observed in males and females from another 18-19th century non-conformist cemetery (Connell and Miles 2010). These types of fractures were also found in 13/83 and have been used to infer patterns of domestic abuse or interpersonal violence. This includes an increased popularity in sports such as boxing during the 18-19th centuries (Brickley and Smith 2006; Connell and Miles 2010; Walker 2001). The three individuals with skull fractures were all from GI and may have been involved in these sports or interpersonal violence. The absence of skull fractures in SCC may be related to the smaller adult sample size or not being exposed to the same levels of interpersonal violence. However, the presence of an antemortem metacarpal fracture in a SCC male could also indicate that that that individual was involved in these activities during their lifetime. These types or fractures are still commonly seen within modern Britain (Cooper *et al.,* 2004; Court-Brown and Caeaser, 2006; Van Staa *et al.,* 2001).

There was one male from the GI cemetery with evidence of perimortem fractures, including a spiral fracture of the proximal right femur and on a right rib fragment in addition to healed rib fractures on the same side. This individual had a number of other pathologies including spondylolysis, OA and DDD (discussed below). Spiral fractures occur as a result of rotational stress to the longitudinal axis of the bone (Lovell 1997; 2007). This type of injury may occur if clothing was caught in machinery, causing the femur to rotate and fracture the bone (Bartrip, 1990; Fraser, 1973; Lovell, 2007). Therefore, this may have been an occupational injury. The presence of healing callus indicates that the injuries to the right rib and femur occurred not long prior to death and the severity of the femoral fracture likely contributed to cause-of-death (Walker 2001). Even in modern clinical cases, femoral fractures have a long healing time (3-6 months) and can lead to complications such as blood loss, nerve damage and misalignment (Lovell 1997; 2007). Therefore, without modern medical intervention this type of fracture would have had severe consequences. As this individual was excavated from the GI burial ground, they were likely receiving care prior to death. The listing of workplace injuries, trips and falls accounts for a high proportion of trauma found in the Naval Hospital (Boston 2014). This may also account for the significantly higher rate of fractures from GI compared to SCC and other studied skeletal assemblages, as these condition would have been likely considered treatable.

Sharp force Injury

Evidence of fatal sharp force injury has been previously recorded within a medieval individual from the 1989 excavation of Southgate St. (Valoriani et al., 2017). The perimortem sharp force injury found in remains from Gloucester Infirmary indicated no evidence of healing on the bone. This burial has been truncated and the lower limbs only retained. The original excavation records state that the rest of skeleton was removed by the dock wall collapse circa 1965 (see appendix 3). Therefore, evidence of further sharp force injury on this individual is unobservable. The origin of the cut mark is unknown, it may have been accidental (e.g. work place), however surgery or biopsy (either peri or post mortem) cannot be excluded. Both surgery and post-mortem examination (see below) are known to have been carried out at Gloucester Infirmary (Dittmar and Mitchell 2015; Herbert 1988). Analysis and comparison of the cutmark may provide further incite in the future.

Overall observations

The trends in trauma seen within 13/83 are consistent with previous studies and show examples of patterns consistent with accidental, occupational and recreational fracture patterns. Changes were observed between the 18th-19th century collection and those observed within clinical studies. These are due to differences in treatment, activities, changing risk factors and population dynamics (Lovell, 2007). Longer life expectancies have led to an increased risk of osteoporosis and osteoporotic fractures (Cummings *et al.,* 1985). These type of fractures are usually located at the neck of the femur, distal forearm, proximal humerus, pelvis and the spine, although they can affect any skeletal element (Cummings *et al.,* 1985; Sporer, 2006). With the exception of spinal compression fractures none of these fracture types were observed. However, despite preventative treatment these types of fragility fracture are expected to continue in Britain.

Fracture pattern examples in 13/83

Figure 31: Misaligned rib fracture associated with II243/II244 SCC burials. Area of fracture indicated by red arrow.

Figure 32: Nasal fracture on III781. The red arrow indicates the area of the fracture which is located across the nasal bones. The bones show misalignment as a result of the traumatic injury.

Figure 33: Depression fracture on the frontal bone of III681 close to the coronal suture. The outline of the depression is surrounded by the white circle.

Figure 34: Healed fracture of left 5th Metacarpal of II208 (mediolateral view)

Congenital conditions

The types of congenital conditions found in 13/83 would not have been detectable during life. The incidence rate of malformations and congenital conditions diagnosable at birth has reduced in modern times from 1.91% in the 1950's (Leck *et al.* 1968) to 0.82% in the 1990's (Rankin *et al.* 2005). This is likely due to the increased rate of termination and prevention techniques during pregnancy. There was no evidence of congenital conditions in the subadult remains in 13/83. As stated in chapter 1, this may be related to the soft tissue anomalies being unobservable in skeletal remains. However, these conditions contributed significantly to mortality in subadults under 5 years in past populations (McKeown and Record 1960).

Spina bifida occulta

There was only one individual with spina bifida occulta (SBO) in 13/83. This is similar the prevalence rate reported in the Spitalfields collection (2.3%) (Molleson and Cox 1993) and higher than observed in St. John's Medieval cemetery (1%) (Cessford 2015). The prevalence rates found in both 13/83 and Spitalfields was lower than a study of the 18th-19th century St. Brides London skeletal collection (15.2%) (Saluja 1988). Saluja (1988) compared St. Brides with a contemporary modern population (15.7% using plain film x-rays) and found that there was no significant difference between the two populations over the preceding 200 years. The occurrence of SBO and other neural tube defects has been linked with folic acid intake and genetic predisposition (Armstrong *et al.* 2013; Viswanathan *et al.* 2017). The consistent prevalence rate of SBO between the 18th – 20th centuries differs from current studies (1980-2017). These studies have found that the supplementation of folic acid during pregnancy has significantly reduced the rate of neural tube defects (Blencowe *et al.* 2010; Copp *et al.* 2013; Hewitt *et al.* 1992; Viswanathan *et al.* 2017; Wolff *et al.* 2009). The higher rate of SBO in the St. Brides and the 1980's population compared to both Spitalfields and 13/83 could indicate that the Spitalfields and Gloucester population had better access to dietary folic acid (obtained from fresh fruit and vegetables) then the poorer London parish of St. Brides (Blencowe *et al.* 2010; King *et al.*, 2005). However, the recording methods for spina bifida occulta also differed between studies which could also account for the differences in representation. This current study on 13/83 recorded the condition as present if three or more laminae were unfused whereas the Saluja (1988) study scored presence in one or more vertebrae. Individuals in this thesis with less than three fused were classed as having an 'other congenital condition' (see below). Inconstancies in the diagnosis of SBO in palaeopathology has also been stated by Kumar and Tubbs (2011) making comparative studies problematic. However, as this condition can indicate the presence of more serious types of spina bifida which would not be present in skeletal material and is therefore worthy of study. Spina bifida occulta although asymptomatic may cause other spinal and pathological conditions.

Sacralisation/ transitional vertebrae

Transitional vertebrae were found in 13/83, there was no complete lumbarisation of S1 recorded. However, there was an individual with possible partial lumbarisation (see 'other congenital' section). Sacralisation has also been found to occur more frequently than lumbarisation in other populations (Connell and Miles 2010; Sharma *et al.* 2011). The presence of these conditions may not be considered pathological (Waldron 2009). However, there is a strong correlation between lumbosacral transitional vertebrae (including coccygeal sacralisation) and degenerative disc disease (including Schmorl's nodes) within modern populations (Aihara *et al.* 2005; Castellvi *et al.* 1984; Konin and Walz 2010). All three of the individuals with sacralisation had other degenerative spinal conditions. This therefore supports the assumption that transitional vertebrae can also be pathogenic.

Spondylolysis

As stated previously spondylolysis has been classed as congenital for the purposes of this study, however occupational/mechanical stress and trauma contribute to the aetiology of this condition (Fibiger and Knüsel 2005; Mays 2007). Within modern populations, spondylolysis is present in 3-7% of individuals (Resnick and Niwayama 1988), which is close to the representation in 13/83. Spondylolysis affects males more frequently than females (Fibiger and Knüsel 2005; Mays 2006; HA Waldron 1991b; T Waldron 1991b). The individual found with spondylolysis in 13/83 was male, which supports this information. This was more common in 13/83 than in the contemporaneous cemeteries of Bunhill (1.26%) (Connell and Miles 2010), and Spitalfields (1.42%), and lower than Romano-British, Anglo-Saxon and medieval studies (HA Waldron 1991b; T Waldron 1991b). This defect was found at the L4, which is the second most frequent location on the spine in palaeopathology after L5 (Fibiger and Knüsel 2005). The condition is most commonly located in the lower lumbar spine (L4-L6) as this area of the spine is subject to greater mechanical use. However it can also occur (approximately 4-6% of cases) at upper spinal levels (T11-L3) when the *pars interarticularis* defect is present (Mays 2007). Therefore, care needs to be observed when recording this condition as it does not affect the spine equally at all levels, however should not be overlooked in non-lumbar regions. There was osteophytic growth on the specimen), which has been used to infer the more serious secondary spondylolisthesis, however this is difficult to diagnose in skeletal remains (Mann and Hunt 2005; Mays 2006; Ortner 2003).

Other congenital and overall observations

There were two individuals with conditions classed 'other congenital' as they did not meet the diagnostic criteria for specific conditions. The posterior vertebral spine also appears to differentiate from the rest of the sacral body. This indicates partial cranial border shift (partial lumbarisation) as described by Barnes (2012). Lumbarisation was found to be significantly more common in females than males during comparative studies (Aufderheide *et al.* 1998). One individual (Figure 36) had unfused laminae below the S3 level, this could not be classified as SBO in this study as only two vertebrae were affected. However, this could be classed as a developmental spinal dysraphism (Kumar and Tubbs 2011).

Overall the congenital conditions found in 13/83 are consistent with the most common conditions found in other palaeopathological studies. The 13/83 collection showed congenital prevalence rates which were closer to Spitalfields, and lower than St. Brides. This indicates that certain congenital the risk factors, such as dietary folic acid were more prevalent in the impoverished of London. This study has also highlighted the need for consistent recording methods in congenital conditions. The frequency of transitional vertebrae and spondylosis does not appear to have changed significantly between the post-medieval and modern studies, whereas spina bifida occulta has reduced in frequency. A continued reduction of these types of conditions is predicted due to intervention strategies and pre-natal care. Modern medical techniques in the detection and treatment of congenital conditions has also lead to extended life-expectancy in previously fatal conditions (McKeown and Record, 1960; Rankin *et al.,* 2005). Therefore examples of different types of congenital conditions may become more common in the skeletal record.

Figure 35: Cleft of the 1st sacral vertebra II206, possible partial lumbarisation. Area of cleft indicated by arrow

Figure 36: Unfused laminae of S4 and S5 on III311. Area of cleft indicated by arrow

Joint conditions

Despite their prevalence during the 18th and 19th century neither gout nor rheumatoid arthritis were conclusively found in the 13/83 skeletal collection. This was concurrent with the findings in the Spitalfields collection (Molleson and Cox 1993; Porter and Rousseau 2000).

There was a higher crude prevalence rate of joint disease in GI compared to SCC this could be linked with differing occupations and demographics within the burials There was a higher representation in of joint conditions in the male skeletal remains for all the conditions recorded except for Osteoarthritis.

Osteoarthritis (OA)

The high frequency of osteoarthritis (OA) in 13/83 supports previous studies describing it as the most common joint condition found in palaeopathology (Jurmain and Kilgore 1995; HA Waldron 1991a; Waldron 2009). This is regularly stated as the second most commonly found palaeopathology after dental disease (Jurmain 1991; Jurmain and Kilgore 1995; Waldron 2009; Weiss 2006; Weiss and Jurmain 2007). This is inconsistent with other findings in 13/83 as porotic hyperostosis was equally prevalent and periostitis was more frequently observed. The majority of these previous studies examined preindustrial individuals, therefore the changes in occupation (including industrialisation) and labour division in the 18th-19th century 13/83 collection may account for the changes in prevalence of OA. Industrial processes reduced the amount of physical labour required in manufacture, this was reflected in the increase of the child and female factory employment during this (Fraser, 1973; Snell, 1999).

The prevalence of degenerative joint changes in females from a Cambridge medieval hospital was reported as approximately 30% compared to 61% of males (Cessford 2015). The crude prevalence rate OA in females across both SCC and GI was similar to the earlier sample. However, in 13/83 the prevalence was higher in females than males. This differs from the known individuals (aged over 25 years) at Spitalfields which found males (34.5%) to have significantly higher crude prevalence than females (24.3%) (HA Waldron 1991a). The rate of OA observed in palaeopathology consistently shows females having a lower rate than males in past populations (Larsen, 2015). Modern studies indicate that females have generally higher rates of OA, however when individuals under 50 years present clinically there is a higher prevalence in males (Felson *et al.* 2000; Felson and Zhang 1998). The large sex differences of observed degenerative joint conditions in Cambridge compared to 18th-19th century individuals is also likely due to population change through time (Cessford 2015). The continued increase in female OA within modern clinical epidemiology also supports the assumption that longer life-expectancy is a contributing factor to the changing trends.

The overall rate of OA increased with age per the general age groups from subadults to 'old-adults'. This is in-line with the prevalence rates found in modern epidemiological studies (Cotran *et al.* 1989) and was similar to that found in Spitalfields with half of the male individuals over 65 years being affected (H. Waldron; 1991a). The exclusion of subadults (HA Waldron 1991a) in Spitalfields and young adult remains (<35years) in both Spitalfields and St. Brides studies (HA Waldron 1997) affects the comparison between these collections and the contemporaneous 13/83 collection. The age criteria used by HA Waldron (1991a; 1997) would have excluded a number of individuals from 13/83 with OA. Therefore Rogers *et al.* (1987) statement regarding the importance of the inclusion of all individuals where possible is supported by this study. The high representation of subadults within SCC may account for the lower overall representation of OA in SCC compared to GI. The absence of 'old-adults' within the GI burials also affects the comparison of age-related degeneration between the two cemeteries.

The shoulder joint was the most commonly affected joint in both identified and unidentified individuals from Spitalfields (Molleson and Cox 1993; Waldron 1995). A study examining OA distributions in different time periods found that shoulder OA was the most commonly found in medieval and post-medieval individuals (Waldron 1995). Spinal OA was found to be most common in pre-medieval individuals and this location was also the second most frequently affected in the other sites and times. There was no evidence of OA in the scapulae in 13/83, this contrasts with the findings of the previous studies. The thoracic spine was the most frequently affected spinal elements in 13/83 (including apophyseal and rib facet joints). This may also account for the high prevalence rate of OA found in the ribs articulations. The spinal facet joints are the only true synovial joints within the spine have a significant painful impact on individuals (Gellhorn *et al.* 2013). The observation of spinal OA is more prevalent in humans compared to non-human primates which has been related to bipedalism (Brown *et al.* 2008; Jurmain and Kilgore 1995). However, despite its prevalence, facet joint OA receives less attention than large joint (e.g. hip and knee) and peripheral OA within medical and palaeopathology literature (Gellhorn *et al.* 2013; Jurmain and Kilgore 1995). Osteoarthritis in the apophyseal joints can be used as an indicator of bone loading and mechanical stress during life and is associated with degeneration of the spinal joints progressively worsening in older individuals (Brown *et al.* 2008). Osteoarthritis patterns found at Spitalfields also found high levels in the thoracic spine (Molleson and Cox 1993; HA Waldron 1991a). Poor spinal health was documented factory workers during the industrial revolution. This was attributed to working conditions and was specifically noted within former child labourers (Fraser, 1973). The subadult (15-17 years) with evidence of thoracic OA fits these criteria.

Osteoarthritis of the major lower limb joints (hip and knees) is a leading cause of disability within modern populations, especially in the elderly (Felson and Zhang 1998). The knee joint is one of the most commonly affected joints in current populations. It is multipart synovial joint which comprises of three compartments (medial and lateral tibiofemoral, and patellofemoral) (Davies *et al.* 2002). Patellofemoral OA receives less attention than tibiofemoral OA within a clinical setting, however PF

OA can progress to other compartments of the joint (Davies *et al.* 2002). This condition would have likely impacted the mobility of the individual affected in SCC. A significant positive correlation was found in Spitalfields between knee and hand OA (HA Waldron 1997). It was not possible to assess this in 13/83, as II133 was the only skeleton with knee OA and preservation of skeletal elements was poor. Another observed case of OA which would have had a severe impact on the individual is in II249 (SCC Male 50-59 years). There was extreme eburnation to bilateral lower arm bones (elbow and wrist joints) including the radial heads and the distal ulnae and articulations and the carpals and left third metacarpal head (Figure 37), this individual also had degenerative disc disease and other joint conditions (see below). Rheumatoid arthritis (RA) cannot be excluded from this individual as OA can be symptomatic of RA, and there was bilateral multiple joint involvement including the most commonly affected joints. However, as the diagnostic criteria for RA was not met, it cannot established (Aufderheide and Rodríguez-Martín 1998).

Osteoarthritis can be used as an occupational marker within palaeopathology (Larsen 2015). Spinal and knee OA have been attributed to the repetitive lifting of strenuous loads in occupations including shipbuilding, mining and other manual labour (Larsen 2015; Waldron 1994; Waldron 2007; Weiss and Jurmain 2007). The presence of OA in the in the elbow and wrist such as exhibited on II249 (Figure 37) has been linked with foundry workers (Waldron, 2007). However, observation of OA in the hand bones of Spitalfields Weavers found no significant difference between occupational and localised OA (Waldron, 1994). OA has multiple aetiologies in addition to occupation including age, trauma, metabolic and nutritional deficits and genetic susceptibility (Felson and Zhang 1998). Therefore, whilst the occupations being carried out in Gloucester during the industrial revelation may have contributed to the patterns of OA observed in 13/83, the demographics such as age and sex distribution of are different to those observed in other collections. The prevalence of OA within 13/83 cannot be conclusively be attributed to occupations.

Figure 37: II249 (SCC Male 50-59 years) with extreme OA L arm with distal ulna and MTC 3 head erosion and eburnation

Spondyloarthropathies

Spinal specific conditions found in 13/83 were Schmorl's nodes and Degenerative Disc Disease. Previously these conditions have been linked and both have multiple and unknown aetiologies (Hilton *et al.* 1976; Saluja *et al.* 1986).

Schmorl's nodes

Schmorl's nodes (SN) are caused by herniation of the intervertebral disc and invasion of this tissue into the vertebral endplate bone (Dar *et al.* 2010; Hilton *et al.* 1976). As stated above, this condition has multiple aetiologies which include trauma, and degenerative disease, however the majority are idiopathic (Peng *et al.* 2003; Saluja *et al.* 1986). Schmorl's nodes are more commonly asymptomatic, however some individuals present clinically with symptomatic pain (Takahashi *et al.* 1995). When SN occur after trauma studies have stated that the lesion may be initially painful reducing over time, however the size of the lesion may also contribute to symptomatic SN (Faccia and Williams 2008).

Analysis of SN in both modern clinical and archaeological remains found prevalence rates ranging from 8.1% in modern Israeli military parachute instructors to 80% in English 15th century battlefield victims (Burke 2012). The prevalence rate in adults from 18-19th Century St. Brides was 49% (Burke 2012; Saluja *et al.* 1986). The rate observed in a normal adult skeletal population has been stated as 48.6% using the Hamann-Todd Human Osteological collection (Dar *et al.* 2009). The prevalence rate for 13/83 is lower than would be closer to this rate if subadults had been excluded in the study, as half of all adults with T10 had evidence of this condition.

Schmorl's nodes were more common in males compared to females throughout 13/83 and there was no significant correlation with age. This was as expected when compared with palaeopathology and medical literature (Dar *et al.* 2009; Hilton *et al.* 1976; Saluja *et al.* 1986).

Schmorl's nodes are rarely reported in the upper spinal levels in bioarchaeology and anthropology, this may be due to researchers focusing on the thoracolumbar regions. Schmorl's nodes are uncommon in the upper spinal levels, however they were discovered in 13/83. There have been cases reported including cervical SN in American Military skeletal remains (Burke 2012) and in various medical studies (Kestle *et al.* 1989; Lipson *et al.* 1985; Moustarhfir *et al.* 2016). The thoracic spine was the most commonly affected area in 13/83 overall with no difference observed between thoracic and lumbar regions for the SCC burials. This also indicates the same SN patterning as in previous studies mentioned above.

The demographics and prevalence of SN in 13/83 are close to the patterns observed in other collections from both the clinical and archaeological studies. The inclusion of subadults in the 13/83 alters the prevalence rates in comparative studies, however SN can be used as an indicator of Scheuermann's disease (juvenile kyphosis) (Moustarhfir *et al.* 2016) and therefore they were included in the sampling. Further analysis could be carried out into the distribution of these lesions within the spine at each vertebral level.

Degenerative Disc Disease

Degenerative Disc Disease (DDD) is commonly found in archaeological collections. Radiological studies have found evidence of spinal osteophytes in 20-30% of older individuals (Klaassen *et al.* 2011). However, a study of the Hamann-Todd American collection found that 100% of individuals age over 40 had evidence of DDD (Nathan 1962). Spinal osteophytes can vary in severity, scoring systems of DDD are applied differently in studies. Nathan (1962) states that lower rates of DDD may be related to the under-diagnosis of spinal osteophytes.

There were higher rates in males compared to females and as with OA the prevalence rate increased as per the age groups. This was not at a significant level in 13/83 however these trends have been observed within other collections such as Spitalfields (Molleson and Cox 1993; T Waldron 1991a), the American Hamann-Todd (Nathan 1962) and Terry collections (Snodgrass 2004).

Degenerative disc disease can affect any area of the spine, and was found at all four spinal levels in 13/83. The lumbar vertebrae were most commonly affected and only one individual has evidence of DDD on the sacrum at the L5/S1 level. Multiple studies state that the most commonly affected areas of the spine are the cervical and lumbar vertebrae (Nathan 1962; Resnick 1985; Rojas-Sepú lveda *et al.* 2008; T Waldron 1991a). Except for the sacrum, the cervical spine showed the least amount of DDD. This contrasts with other studies which recorded DDD at high frequency levels in the cervical spine and may be related to the assessment limitations in this current study on 13/83. The areas of the spine most prone to osteophytosis are the weight bearing areas of the spine at C3, T8 and L4-5 which reflect the spinal curvature and bipedality (Hilton *et al.* 1976; Sofaer Derevenski 2000). Degenerative disc disease can cause symptomatic problems at different spinal levels such as dysphagia and spondylotic myelopathy when located in the cervical and thoracic spine (Klaassen *et al.* 2011; Kumaresan *et al.* 2001). A study of individuals from an isolated Scottish island found that the lumbar spine of individuals showed occupational differences of DDD compared to another population (Sofaer Derevenski 2000). This is interesting as the Scottish population had known specific occupational skeletal stresses. However as stated above with OA, there are multiple variables which need to be taken into consideration when assessing for occupation based on these bone markers.

The degenerative joint diseases of OA and DDD had a highly significant correlation this is as expected as these conditions are linked. The presence of vertebral OA is sometimes grouped with DDD or is classed as OA. The differential diagnosis affects the ability to compare some studies as the disease processes are very similar. Therefore, if further research were employed on the 13/83 collection assessment it would be useful to examine the distribution of degenerative lesions on individual vertebrae. Correlation between DDD and non-spinal OA may also give addition information about the lifestyles in 18th and 19th century Gloucester as has been shown in previous studies (Knusel *et al.* 1997; Nikita *et al.* 2013; Sofaer Derevenski 2000).

Other joint conditions

There were multiple conditions of the joint which were either undiagnosable or found in isolation.

Osteochondritis dissecans

As mentioned above there was one subadult with osteochondritis dissecans (OD) (*Figure 38*). This was the only skeleton in 13/83 with this condition and the only individual from SCC in this category with 'other joint condition' not affecting the hands and the feet. OD is frequently observed clinically and has been observed in multiple palaeopathological studies including a Chilean Mummy (Kothari *et al.* 2009), the American Great Plains (Loveland *et al.* 1984) and Ancient Britain (Wells 1974). It is most often observed in the 12-25 year age group with the knee joint being affected in up to 90% of cases (Loveland *et al.* 1984). This may be related to the risk of trauma and activity patterns (Loveland *et al.* 1984; Wells 1974). The biological profile of II235 is consistent with these previous observations.

Figure 38: Osteochondritis dissecans lesion on the left lateral condyle of femoral epiphysis (unfused) in II235 (SCC, 12-14 years old).

Overall Joint condition observations and epidemiological trends

The joint conditions observed within 13/83 showed similar patterns and frequency to studies of past populations. Degenerative joint conditions such as osteoarthritis and degenerative disc disease are becoming more frequent with modern Britain due to an aging population (Chen *et al.,* 2012). The trends observed in these conditions are also similar to those observed within fracture patterns, with males generally having higher prevalence in younger age groups with female rate surpassing this in post-menopausal years. These conditions cause significant pain and disability to the modern population with severe economic costs to productivity loss of over £3 billion with over £800 million spent on joint replacement (Chen *et al.,* 2012; Lee *et al.,* 2001). The economic cost of lower back problem, which is one of the most common conditions injuries seen in General Practice was estimated as $100 billion per year in the United states (Croft *et al*., 1998; Katz, 2006). These conditions would not have been easily treatable in the 18^{th}-19^{th} century; however the consequences were recognised. The field of surgical orthopaedics was emerging and growing by the end of the 18^{th} century with early surgical attempts to treat hip osteoarthritis at the beginning of the 1800's. These included excision of the joint and limb amputation (Gomez, and Morcuende, 2005). There was no evidence of such treatment within any of the 13/83 burials although evidence of amputation and surgery have been identified in other hospital cemeteries of this era (Anderson 2002; Boston 2014). The continuing cost of these conditions make the study of their epidemiology important and understanding the prevalence within a modern populations will continue as the populous ages along with other influencing comorbidities.

Infectious conditions

The increases in population during the Industrial Revolution lead to disease outbreaks in Gloucester including Cholera (Cox 2005). As stated in the introduction, this was common during this time period (Condrau and Worboys 2007; Mooney 2007). There was a separate isolation hospital set up on Barton Street east of Gloucester city during the 1832 and 1834 cholera outbreaks (Herbert 1988). Therefore, it is unlikely that the fatalities would have been buried within GI burial ground. There was no increase of burials indicated from SCC burial register during these years. Infectious conditions were the second most frequently observed group of skeletal pathological conditions in 13/83. As with all the previous conditions discussed there was a higher prevalence rate in GI compared to SCC although not significantly different. This is as expected due to the risks of infection within an 18th-19th century hospital. There were no pathogen specific infectious conditions such as leprosy or treponematosis discovered. However, there were high levels of periostitis recorded.

In Newcastle infirmary individuals with specific infectious conditions were excluded from admission (Mitchell *et al.* 2011). This is also consistent with general principles of admission during this time (Porter, 1985). In addition to the separate Isolation hospital on Barton St. If admission to GI was the same as Newcastle Infirmary this may explain the absence of these conditions from the Gloucester Infirmary cemetery. Skeletal evidence of tuberculous and treponemal disease have been reported at very low frequencies (<1%) in larger church cemeteries from the 18th-19th centuries (Connell and Miles 2010; Molleson and Cox 1993). Therefore, due to the small sample size in SCC and overall in 13/83 observation of these conditions was unlikely. In London and other cities, patients with treponemal disease were confined to 'Lock' hospitals and asylums as one of the symptoms of tertiary syphilis is psychosis (Friedrich *et al.,* 2009; Porter, 1985). Therefore these patients may also have been treated at Gloucester's separate 'Lunatic Asylum'.

The study of patterns in non-specific infectious conditions can however give indication about the general health of the population under study and indicate other concurrent conditions.

Periostitis

The prevelence rates of periostitis (PO) was higher than reported in both St Johns medieval hospital (Cessford 2015) and the Bunhill non-conformist (Connell and Miles 2010) cemeteries. A study of periostitis on medieval subadults from Chichester and Northumbria reported approximately 60% had PO (Ribot and Roberts 1996; Roberts 2000a). This was a higher rate than found in subadults either 13/83, St. Johns (Cessford 2015) or Bunhill (Connell and Miles 2010). The subadults affected this condition in 13/83 included a 8-9 year old with diffuse PO involving the dorsal side of the left MTCs (right sided bones were absent) which could indicate a systemic infection. Infections of the hands are common within modern clinical studies (Patel *et al.* 2014) and would have also been in past populations prior to anti-biotic invention. These can have multiple aetiology and immunocompromised individuals will be more susceptible to infection which would have been a risk factor for individuals within GI.

A localised periostitis lesion on the proximal right femur (Figure 40), was solid dense and undulating indicates a long-standing wound such as an ulcer (Weston 2012). An X-ray image of this lesion showed no underlying pathology. This individual also had hip OA and a fusion of a foot DIP joint on the same limb. The location of this lesion is consistent with a decubitus ulcer (bed/ pressure-sore), which are common in elderly and immobile patients (Tryggestad *et al.,* 2006; Versluysen, 1985). The co-existing conditions within this individual would have likely limited the mobility and increased their risk of pressure-sores. These types of wounds have severe consequences, even with the availability modern treatments and therefore much clinical effort is dedicated to the prevention of ulcers (Anders *et al.,* 2010; Bliss, 1998; Peery *et al.,* 1990). These conditions are also linked with poor circulation and neuropathic comorbidities in condition like diabetes mellitus (Armstrong *et al.,* 1998; Baker *et al.,* 1992). Ischemic leg ulcer in diabetics result in amputation for up to a quarter of patients (Abidia *et al.,* 2001). Due to the aging population and increased prevalence of diabetes mellitus in the modern population, these types of lesions are important to record in the osteological record and are expected to become more commonly found.

Periosteal lesions can also indicate of systemic infection, in addition to localised. Examples of this can be found in 13/83. There was an individual recovered from the GI cemetery with extensive periostitis on the bones surfaces surrounding the thoracic cavity including the scapulae, clavicles, manubrium, ribs and vertebrae (Figure 39). This could indicate that this individual was exposured pathogens and/or infection of the respiratory tract (Roberts 2016). As this individual was within Infirmary they were likely receiving care for this condition. Exposure to respitory irratants was common within workplaces during the Industrial Reveloution and was known to cause long-term effects in workers (Bartrip, 1990; Fraser, 1973; Lee, 1973). However the specific cause of this the cannot be definitivly determined. Another example of systematic infection indicated by periositis was also found on the endocranium of one of the individuals with signs of autopsy. This will be discussed below.

it is important to assess the true prevalence rate (TPR) and skeletal elements affected by periostitis in addition to the individuals in an assemblageThe most common bones affected in 13/83 were the femora, tibiae and fibulae. These trends are similar/ to those observed in previous research (Cessford 2015; Connell and Miles 2010; DeWitte 2014; DeWitte and Bekvalac 2011; Larsen 2015). The frequency of tibial periostitis was higher in GI than previous studies of Romano-British, Anglo-Saxon and medieval skeletal remains with the exception of a medieval monastic cemetery (Weston 2008). This supports the assumption the the tibia has a high risk of being affected by this condition. This is likely due to the anatomical location of the bone in proximity to the skin surface, and therefore more likely to suffer from injury or infection (Weston, 2008).

The ratio of males, females and subadults with PO in 13/83 showed that males were much more likely to be affected. This difference was consistent in both SCC and GI, and in other studies (Cessford 2015). The lesion patterns and frequency of periostis indicates that there were a number of chronically and acutely ill individuals within these cemeteries.

Figure 40: III560 (GI Male, 35-39years) R Femur periostitis localised lesion indicated within the red circle.

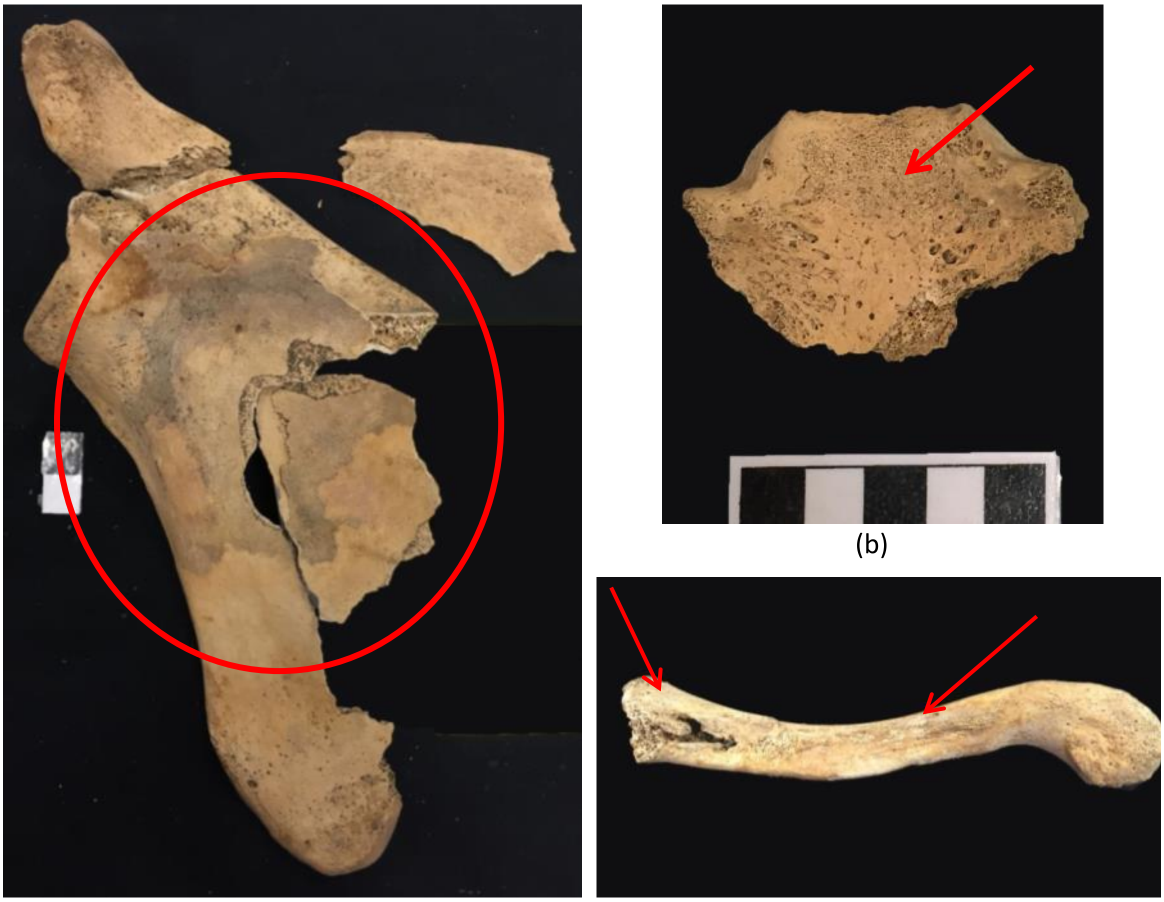


Figure 39: Extensive periostitis in III814 (GI Male, 17-19 years) examples highlighted by the red circles and arrows (a) Right scapula anterior view, (b) Manubrium posterior view, (c) Right clavicle inferior view.

Other infectious conditions and overall observations

There were three individuals with 'other infectious conditions' in the 13/83 skeletal collection. Osteitis is another non-specific infection which affects the cortical bone and this was observed in one skeleton. Two individuals were reported as having osteitis within the contemporaneous Bunhill cemetery affecting a young adult female and mid-adult male (Connell and Miles 2010). This supports the diagnosis, also affecting the lower limbs. However, osteitis in 13/83 was found in isolation and at a small prevalence rate in Bunhill so comparisons cannot be conclusive. Two of the three individuals with 'other infectious conditions' were female, one of these as stated in chapter 4 had possible mastoiditis.

Despite the absence of specific infectious conditions within 13/83, the patterns and observation of periostitis and other non-specific infectious conditions are useful. The age and sex trends within periostitis are consistent with other studies. As hypothese the CPR of infectious conditions was higher in the infirmary which supports an increased risk within the individuals receiving treatment. Systemic infections may have contributed to the mortality of the individuals. The localised infections may have been related to other pathologies which may have required medical care explaining their presence within the GI burials. Therefore these conditions still enable an insight into the individuals of 13/83.

During the 18^{th}-19^{th} centuries epidemics arose commonly within urban setting such as Gloucester due to poor living and working conditions, Birth-rates within cities were lower than the mortality rate due to infections which was another factor continuing toward migration into cities from the surrounding areas to maintain the workforce (Armelagos et al., 1996; Herbert, 1988). These included aforementioned smallpox outbreaks as well as other conditions like diphtheria, measles, typhoid, typhus and polio (Armelagos et al., 1996). These conditions would not exhibit specific signs on the skeleton although may have resulted in inflammation of surrounding tissues causing periostitis (Roberts and Manchester, 2010). Respiratory infections both specific (e.g. TB) and non-specific conditions such as bronchitis and pneumonia were common during this time due to environmental factors (Armelagos et al., 1996; Bartrip, 1990; Fraser, 1973).

The impact of broad-spectrum antibiotic invention such as penicillin in the middle 20^{th} century has had enormous on the global population (Socransky and Haffajee, 1992). This has resulted in previously life-threatening conditions being easily treatable. Antibiotic treatment and vaccination programmes have led to the eradication and control of many once common infectious disease such as Smallpox (Fenner *et al.,* 1988), Polio (Kew *et al.,* 2005) and Measles (Hopkins *et al.,* 1982). The world's population has doubled due to effective control measures on infectious disease (Heymann, 2005; Walsh, 2003). However, recent years have seen a resurgences of conditions such as treponematosis due to a number of factor including unsafe practices, co-existing conditions such as HIV and antibiotic-resistant strains (Angus *et al.,* 2006; Armelagos *et al.,* 1996; Simms et al., 2005).

The effectiveness of antibiotic drugs has led to over-reliance and prescription of these medications reducing their efficiency within patients and the evolution of antibiotic resistant pathogen strains e.g. MRSA (Armelagos et al., 1996; Heymann, 2005; Satcher. 1995; Walsh, 2003). This is predicted to have severe consequences to the living population with the emergence of new disease pandemic and epidemics.

Public inoculation and vaccination programmes began in the 1840's (Beck, 1960). As mentioned above these have also had global impact in the combat of infectious diseases that do not respond to antibiotic treatment (Satcher 1995). These included polio, diphtheria, TB, measles, mumps, rubella, meningitis, hepatitis and influenza strains (Heymann, 2005; Satcher 1995). Anti-vaccination movements against childhood immunisations over the last two decades have led to outbreaks of preventable conditions with fatal consequences (Kata, 2012; Tafuri *et al.*, 2014; Wolfe and Sharp, 2002). Influenza (flu) is a potentially fatal viral condition with multiple strains, annual flu vaccinations are carried out on most at risk groups, such as the very young, people over 65 years, individuals with chronic conditions such as asthma and diabetes mellitus, and health care professionals (Anderson and Thornley; 2014). A pandemic of the H1N1 strain between 1918-1920 ('Spanish Flu'), resulted in of a minimum 50 million deaths globally (Johnson and Mueller, 2002). Unlike other strains of influenza, not only the young and old suffered but young and middle adults were also significantly affected (Johnson and Mueller, 2002). The scale of this pandemic has been described to revival that of the 'Black Death' in the 14th Century (Holt. 1985; Potter, 2001). The 2009 re-emergence of H1N1 led to first global pandemic flu pandemic of the 21st century. The mean age-at-death was 37 years with fatalities estimated between 7500 and 44,100 in the US over six months (Viboud et al., 2010). This outbreak lead to increased immunisation programmes across the world however due to new and emerging strains, these are not always predictable (Kaiser, 2006). Pandemic and epidemic outbreaks of infectious disease are therefore predicted into the 21st century within the UK, however better understanding, management and access to universal health care will continue to limit their impact compared to those seen during the 18th and 19th centuries.

Metabolic conditions

The amount of individuals suffering from metabolic conditions was lower than reported in individuals from a 18th-19th century Irish workhouse during the period of the Potato Famine (Geber and Murphy 2012). This supports the assumption that the Gloucester individuals buried within 13/83 may not have been subjected to the same level of nutritional deficiencies as the contemporaneous impoverish Irish population. As stated in chapter 4 there were three metabolic conditions recorded in 13/83 which were Cribra Orbitalia, Porotic hyperostosis and Rickets/Osteomalacia.

Cribra Orbitalia /Porotic Hyperostosis

These linked conditions have been stated as some of the most commonly found within palaeopathology (Walker *et al.* 2009). These conditions were frequently found together in 13/83 This was closer to the 15.4% reported by Brothwell (1981) in 17th Century London than the rate observed in Spitalfields (34%) with were attributed to childhood anaemia (Molleson and Cox 1993). The 13/83 rate was also lower than other studies from Italy (Salvadei *et al.* 2001), Poland (Kozak and Krenz-Niedbała 2002) and a medieval Cambridge hospital (Cessford 2015).

These conditions were found in male and females adults and subadults in SCC, however only adult males from GI exhibited manifestations of any metabolic conditions. It has been proposed that females are more susceptible to metabolic/nutritional deficiencies due to pregnancy and child-rearing and are therefore more likely to be affected by CO/PH (Mensforth *et al.* 1978). However, males were more commonly affected than females within 13/83. A meta-analysis study (Stuart - Macadam 1985), found that the majority of previous CO/PH showed no significant difference between males and females. Therefore, the previous assumption was not supported. Subsequent studies such as Paine *et al.* (2007), Keenleyside and Panayotova (2006), and Kozak and Krenz-Niedbała (2002), have also failed to find a consensus or significant differences. It is probable that the higher representation of males compared to females could account for the higher frequency of CO/PH within 13/83. However, other environmental factors cannot be excluded.

Multiple studies have focused on childhood CO/PH such as Lallo *et al.* (1977), Mensforth *et al.* (1978), and Palkovich (1987). There were only two subadults these conditions in 13/83 which included a 6-12 month old infant with both CO and PH. When these conditions are observed in infants, it has been linked to poor maternal nutrition, endemic factors and nutritional stresses during weaning (Lallo *et al.* 1977; Palkovich 1987). A meta-analysis by (Stuart-Macadam 1985) including Romano-British and worldwide studies, found that CO was more commonly observed in subadults compared to adults. This differed from the findings within 13/83 as CO/PH most frequently were observed in the mid and old-adult age groups despite the high representation of subadults in the sample.

Rickets/Osteomalacia

The living and working conditions in 18th-19th centuries Gloucester would have limited the exposure to sunlight (such as factory work) and increased the risk of Rickets and osteomalacia (R/O) (Cox 2005; Herbert 1988; Loomis 1970). It was not until after the first world war, measures were employed to counter this (Gibbs 1994). Evidence of vitamin D deficiency (R/O) in 13/83 was only found in skeletons from SCC. The representation of subadults within the is in line with Mays (2008) statement, as despite 90% of children in the early 20th century suffering from rickets, skeletal evidence of this may only be discernible in 10-25% of people in later life. As stated above, Southgate Congregational Church carried out outreach programs and educational work with children working in factories (Herbert, 1988). Rickets was described as one of the workplace hazards found in the child labour force during this time although the aetiology was not understood (Fraser, 1973). Health and safety practices within the United Kingdom have greatly improved working conditions. However, evidence of vitamin D deficiency had been recorded in Bangladeshi factory workers within the 21st century with serious health consequences (Islam *et al.,* 2008).

A study (Lewis 2013) on subadult skeletons from St. Oswald's Priory in Gloucester, states that evidence of metabolic disease (including rickets) was found in 7.1% of subadult skeletal remains from rural Gloucester (early medieval period). However, Lewis (2013) stated that there were no metabolic conditions recorded in the post-medieval sub-skeletons from St. Oswald's. The Bunhill cemetery in London found evidence of rickets in 6.7% of the total individuals (n=16), only one of these individuals was an adult. The majority of subadults with rickets in the Bunhill cemetery were under 0-2 years and five of the subadults had associated pathological fractures (Connell and Miles 2010). The frequency of R/O found in 13/83 is similar to other comparable palaeopopulations. Due to the high number of subadults with SCC, it was more likely to observe R/O than in GI. This may account for the absence of this condition being recorded in GI. Rickets has seen a resurgence in modern epidemiological studies due to a number of factors including changes to weaning practices, feeding patterns, reduced exposure to light (including use of sunscreen) and in children with darker pigmented skin (Wagner and Greer, 2008; Welch, 2000). The consequences of vitamin D deficiency can be severe, in adults as well as children including idiopathic pain, increased risks of fractures and development of osteoporosis. However this condition if the detected early enough, it is treatable due to medical intervention vitamin supplication (Gartner and Greer, 2003; Holick, 2006; Wagner and Greer, 2008).

Overall observations of metabolic conditions.

As stated in chapter 1, Gloucester grew significantly during the Industrial Revolution (Cox 2005). This lead to nutritional and metabolic deficiencies within the population such as those observed in the skeletons excavated from 13/83. The frequencies of these conditions were lower than those observed in the contemporaneous London (Molleson and Cox 1993) and Irish (Geber and Murphy

2012) populations. This may be related to the working and living conditions, as despite the Spitalfields population being more affluent, the environmental conditions in both London (over-population) and Ireland (famine) were subject to different and more extreme stresses than Gloucester. The similar frequencies in metabolic conditions between SCC and GI suggest that both these sample groups were subject to the same environmental circumstances.

Longer life expectancy and general lifestyle changes (e.g. increased rates of obesity) within the modern population have led to changes in the metabolic disease frequencies. Osteoporosis is now the most common of these conditions and results in poor bone density (Ortner, 2003; Cummings *et al.*, 1985). This condition is more common in post-menopausal women and increases the risk of fragility fractures and bone degeneration (Cummings *et al.*, 1985). Diabetes mellitus is another metabolic condition endemic within modern populations (Alberti, 1998; World Health Organisation, 1999). There are with multiple complications with late-onset (type II) affecting daily living of sufferers, such as reduced circulation, neuropathy, limb amputation, increase cancer risks, reduced cardiac and kidney functions (Huang, 2014). This has resulted in approximately 10% of the NHS budget is spent on diabetic patients and its complications (Sharma *et al.*, 2014). These two conditions both contribute to the growing national global disease burden (Lozano *et al.*, 2012) resulting from an aging population which would not have been as problematic in post-medieval Gloucester. These trends are expected to continue to grow as the population continues to age.

Neoplastic conditions

As stated in Chapter 1, observation of neoplastic growths (benign and malignant) are rare within archaeological remains (Brothwell 2012; Marks and Hamilton 2007). There was only one individual within Spitalfields with evidence of malignant disease (Molleson and Cox 1993). However, with the possible exception of the rib lesion, all the neoplasms observed in 13/83 were benign. The frequency of osteomas was omitted from the Spitalfields report and other comparable skeletal collections such as Connell and Miles (2010) and Cessford (2015).

The rise in these conditions in modern populations has been partially attributed to longer life expectancy (Molleson and Cox 1993; Roberts 2016). All three affected individuals in 13/83 were aged as over 40 years. This supports the theory that older individuals are more likely to have been affected by neoplastic conditions. Although there was no significant difference between neoplastic conditions in SCC and GI, there were individuals with older age-at-death estimates SCC than GI.

Osteoma

Osteomas are most commonly found on the cranium and are most frequently found in archaeology which is supported by the findings in 13/83 (Brothwell 2008; Brothwell 2012). Previous studies have not found any significant sex differences in the frequencies of osteomas (Brothwell 2008; Brothwell 2012). All three individuals with osteomas within 13/83 were male. This may be related to the small sample size and the sex bias within the sample. Two of these lesions were located on the frontal bone and one was in the maxillary sinus. Cranial osteomas are usually asymptomatic however depending on the location, they may become obstructive and within a clinical setting require surgical intervention (Brothwell 2008; de Chalain and Tan 2003). The maxillary sinus osteoma may have been caused by chronic sinusitis (Brothwell 2012). Sinusitis has been used as an indicator of poor air quality within bioarchaeology and been observed in contemporaneous collections with 13/83 (Roberts 2007; Roberts 2016). This also supports historical information about hazards of daily living during the Industrial Revelation. Observation of neoplastic conditions within bones was limited due to primarily macroscopic analysis, and the maxillary sinus of II207 was only observable during due to taphonomic fragmentation of the skeletal remains. Therefore, similar lesions cannot be excluded from 13/83 as destructive and radiographic analysis was not carried out on all the skeletal material.

Other neoplastic condition and overall observations

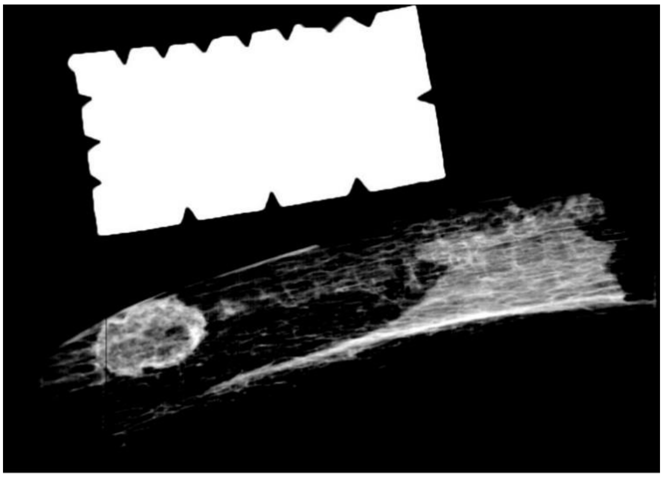
A small neoplasm was observed within a right rib fragment of (*Figure 41*a) within the trabecular bone. As with the maxillary osteoma, this was only visible due to taphonomic damage. This individual also had rib fractures present on the left side, therefore radiographic imaging was used for differential diagnosis. The growth had clearly defined margins and was not uniformly dense. The anteroposterior radiograph (*Figure 41*c) indicates that the lesion may originate from the cortical bone. Rib tumours are rarely observed within both clinical and palaeopathology (Lambert 2002; Zarqane *et al.* 2013). The one found in the Gloucester Infirmary burial is likely benign (Hughes *et al.* 2006). Radiological analysis was conducted on the neighbouring ribs and no other lesions were discernible.

The absence of definitive malignant disease in 13/83 may be due to a number of factors including known difficulties in differential diagnosis (Brothwell 2012), soft-tissue tumours not being evident in skeletal remains (Brothwell 2008), and a small sample size. A study of Newcastle Infirmary, stated that individuals with neoplastic conditions which were considered untreatable in the 18th-19th century were not allowed admission to the hospital. If similar admissions were prohibited from GI this could also explain the absence of the conditions and that there was no significant difference between the frequency of neoplastic conditions between SCC and GI.

The rate of cancer observed in clinical data has increased due to reduced mortality and is a leading cause of death within the Britain (Lozano *et al.*, 2014). Breast and prostate cancer are the most common cancer locations and are known to metastasise to the ribs (Stewart and Wild, 2017). The cancer rates are likely to increase with more effective treatments being developed. As these conditions are impactful to the modern population more effort needs to be employed in there diagnosis with skeletal assemblages.

(a)

(b)



(c)

Figure 41: Neoplasm in the right rib of III212 (a) macroscopic (P-A) view (b) Superoinferior radiograph (S-I) view 50kw100ms (c) anteroposterior (A-P) view 60kw100ms radiograph.

Evidence of post-mortem examination

There was evidence of post-mortem craniotomy on two individuals from GI (*Figure 42* and *Figure 43*). The presence of these two individuals with evidence of autopsy within the GI burials and absence of such in SCC adds contextual evidence of the separation of these two burial grounds. Charitable hospitals established during the 18th century, such as Gloucester Infirmary were often associated with anatomy schools and carried out public autopsies and training dissections (Mitchell *et al.* 2011). Excavation of a larger contemporaneous Infirmary burial ground in Newcastle-upon-Tyne found signs of craniotomy in 11-18% of burials (Boulter *et al.* 1998; Chamberlain 1999; Mitchell *et al.* 2011). Whereas there were additional signs of post-mortem examination (such as thoracotomy) in the Newcastle burials, no such signs were seen in 13/83. Other examples of autopsy have been found in archaeological remains from French plague victims (Signoli *et al.* 1997), Spitalfields (Molleson and Cox 1993), and a Naval hospital (Anderson 2002).

Cut-marks can be seen on both III179 (*Figure 42*b-d) and III335 (*Figure 43*) which are consistent with a saw or similar tool (Anderson 2002; Dittmar and Mitchell 2015). Taphonomic damage leads to further fragmentation the crania. Using the criteria established by Dittmar and Mitchell (2015), there is no evidence that these skeletal remains were used for dissection or anatomical collection but were subject to cranial autopsy. Periostitis was found on the endocranium of III179 (*Figure 42*b&c), indicates inflammation or infection in the surrounding tissues (such as the brain and the meninges). This could have contributed towards the cause of death and would have been established during autopsy.

The biological profiles of these two individuals (III179, III335) were similar, they were both males, 25-29 years and their stature was estimated between 168-169cm. The pathologies present elsewhere in these skeletons were also alike.

(a)

(b)

(c)

(d)

Figure 42: Craniotomy of III179 (a) Superior endocranium, (b) Occipital fragment with cutmark and periostitis on the cruciform eminence, (c) Right temporal bone with cutmark and periostitis, (d) Frontal bone cut marks.

(a)

(b)

(c)

Figure 43: Craniotomy of III335 (a) anterior cranium, (b) frontal bone with cutmark, (c) inferior endocranium.

Chapter 6: Conclusion

6.1: Review of Aims and Objectives

As stated in the Introduction, the overarching aims of this research was to conduct a study into the different pathological conditions present in a specific British urban 18th and 19th century population (Gloucester) and to examine the differences between burials from a non-conformist church and infirmary. This enabled further understanding of health and disease in late Georgian Britain and enabled contextualisation of Gloucester's inhabitants compared to other cities at the same time. This indicated that the general health Gloucester was better than contemporaneous skeletal assemblages.

This thesis illustrates that the 13/83 skeletal collection incorporates individuals buried from the non-conformist independent Southgate Congregational Church and Gloucester Infirmary during the 18th and 19th centuries. However, the small sample size presents problems for both data analysis and comparison is problematic. The excavation of St. Owens Medieval cemetery in 1989 further explored the Southgate Street and uncovered additional burials from SCC (see appendix 3). Close examination of the archaeological plans, in addition to analysis of the recovered skeletal material (also partially housed at LJMU) could provide potential information.

Examination of the SCC burial register along with the archaeological records provided important contextual information about the individuals buried by the church, including the names, residences, age, sex and occupations of individuals. The burial register for Gloucester Infirmary was not examined. This was due to the register not being available online, however there is a record of an existing GI Burial register and could potentially be accessed via the Gloucester Archives. This may require direct collaboration and provide valuable information about the individuals from Gloucester Infirmary which may explain potential bias in the sample.

This comparison showed that the skeletons recovered from Southgate Congregational Church were a good representation of individuals attending and buried by this church. Historical information about the church and infirmary gave information about the attendees with links to child labour and factory work. The individuals within Gloucester Infirmary were therefore likely to be a good representation of those which perished there. These cemeteries show different organisation and selection biases within these cemeteries were likely occurring concurrently with burial.

The preservation of skeletal elements was higher in SCC compared to GI. The time elapsed since excavation and missing skeletal elements from excavation photography could relate to the looting of the unsecured site but may also introduce bias to the sample. Further analysis of the 13/83 curation along with an examination of the documentation may need to be carried out. Potentially contact with institutions and individuals involved needs to be established. This includes trying to locate the 'missing' 13/83 and 3/89 skeletons.

The information presented in this thesis gives publishable information about the demographics pf the sample, which was previously unavailable. Reports and documentation about this excavation was limited. Therefore, misconceptions arose about the provenance of the 13/83 skeletal assemblage, which through correct curation was established as 18th-19th century post-medieval rather than part of the medieval St. Owen's cemetery. This was an important distinction as significant changes occurred between these times in Gloucester and throughout Great Britain. These included socio-economic changes, environmental stresses, disease trends, and methods employed to control and treat conditions.

Through analysis of the archaeological record and historical sources, the location of individual burials could be identified. It was therefore possible to understand their proximity to each other and to which cemetery they belonged. Therefore information gained though skeletal analysis could be compared between the burial locations. This also enabled the skeletal material excavated from the 3/89 trial trench (trench IV) to be excluded from analysis as it was identified as originating from the separate medieval St. Owens church.

Historical information about Gloucester during this time showed population growth indicative of the Industrial Revolution (Cox, 2005; Herbert, 1988; Lewis, 2013). As mentioned previously this led to social deprivation and conditions which were not previously present in the population. Although this was to the same extent as sites like London charitable outreach was still necessitated. This was carried out by institutions such Southgate Congregational Church and Gloucester Infirmary in relation to education and health (Herbert, 1988).

This thesis aimed and achieved to the formation of biological profiles from the 13/83 skeletal assemblage and indicated that the age and sex profiles are significantly different between GI. This includes a bias to males in GI and subadults in SCC. There was a large number of 'old-adults' listed in the SCC burial register which were not represented in the skeletal material. This is may be related to limitations in anthropological methods. Application and testing of new age-estimation methods could be employed.

Skeletal and palaeopathological analysis was conducted on each individual set of skeletal remains; this showed a variety of dental and skeletal conditions. The combination of these analyses enabled palaeoepidemiological study to contextualise these conditions frequencies within Gloucester and comparison with past and modern populations. This was aimed and achieved for all the conditions found in the 13/83 skeletal assemblage.

Comparative frequencies between the two cemeteries within the 13/83 skeletal assemblage showed a generally higher prevalence in Gloucester Infirmary compared to Southgate Congregational Church. This was a significant difference in the dental conditions. This may be related to individuals from the Infirmary being subjected to higher levels of systemic stress and due to lower socio-economic status. The methods used in this research analysed the presence and absence of dental pathologies rather than exact location, which makes an extensive comparison with other populations problematic which focus on specific pathologies. This could be further investigated in future studies.

The skeletal pathologies found within 13/83 were consistent with other 18-19th century skeletal collections. As expected, the frequencies of pathologies were consistently higher within the Gloucester Infirmary burials compared to Southgate Congregational Church. The presence of craniotomy skulls indicated that autopsies were being carried out on individuals within the infirmary. This additionally supports the separation of the two burial grounds within the 13/83 archaeological site.

6.2: Summary of finding and predicted course of disease

There were many hazard experienced by individuals living during the 18th and early 19th century compared to previous times. The emerging industrialisation drew people to cities and towns seeking employment. The consequences of this led to infectious disease outbreaks, socio-economic crises, poor living and working conditions, and changes to mortality rates. However, understanding and awareness grew about disease epidemiology with public health methods emerging to combat this. Gloucester Infirmary was one of the first free hospitals established in Britain, forming part of a national trend which provided care to the impoverished. The medical profession also changed significantly as a result of social change leading to more learning opportunities. Non-conformist churches such as Southgate Congregational Church also led the way in education of the poor. The establishment of the British Welfare state was also a social stress of this, although universal access to health care until the mid-twentieth century (Bartrip, 1990; Fraser, 1973; Lee, 1973).

Awareness relating to the consequences of poor dental health was arising with the official establishment of the dentistry profession in 1858. The types of dental treatment and dentures seen in other skeletal material from this time would not have been accessible to the people of Gloucester. The trends in dental conditions were similar to those of other studies from the 18-19th century with an increased prevalence of conditions compared to earlier times. This is due increased risks of caries and periodontal disease such as tobacco smoking and easy access to sugar. These trends continued into the 20th century, with over a third of all adults being edentuolous by 1968. Tooth loss through extraction would have been one of the only forms of dental treatment available to the 18th-19th century Gloucester. It was not until the invention of the NHS that access to universal health care saw the amount of tooth loss reduce. The continued reduction in frequency of dental conditions is predicted within the United Kingdom. Conversely, the amount of tooth loss has increased within the USA since 1968, a county without universal health care. The demographics of those affected by these conditions showed little change between the post-medieval Gloucester sample compared to other studies regardless of chronological time.

It was hypothesised that the 13/83 skeletal assemblage would show higher frequencies in conditions related to poor living environments (such as metabolic and infectious disease) than earlier urban populations. Both metabolic and infectious conditions were among the most frequently found in the 13/83 skeletal assemblage. Linear enamel hyperplasia (LEH), which has been used as a marker for nutritional stress was found to have similar prevalence rates to other 18^{th}-19^{th} century skeletal collections. However, this was found at lower frequencies to earlier populations indicating that less environmental stress during childhood and tooth development. The prevalence rates of skeletal metabolic conditions supported this hypothesis condition frequency was like many of the contemporaneous sites. However, Gloucester showed lower rates than Spitalfields and Irish studies and had greatest affinity to earlier London populations. This is likely due to the expansive population growth in London compared to the rest of the country and mass famine occurring in Ireland. Comparison between Gloucester Infirmary and Southgate Congregational Church showed little difference in the amount of metabolic conditions. This indicates that the environmental causes were universally experienced by the inhabitants of Gloucester.

Infectious conditions were also found extremely frequently within the 13/83 skeletal assemblage. This cannot be reliably related to general environmental factors alone as the condition was more prevalent in the infirmary. The rate of periostitis was higher than other population samples including a contemporaneous non-conformist church and medieval hospital. Therefore, the individuals across both Gloucester Infirmary and Southgate Congregational Church cemeteries. Unlike earlier population there was no evidence of pathogen specific infections such as Syphilis, TB, or Leprosy. This may have been due to segregation of patients, reduction in prevalence over time or the small sample size of 13/83.

It was also hypothesised that different frequencies of conditions would be found between SCC and GI. As the individuals were receiving treatment within GI prior to burial a higher frequency of conditions such as fractures are expected. The hypothesis was accepted the frequencies of all conditions were more frequently observed in Gloucester Infirmary except for neoplastic conditions. Trauma was the only group of conditions where the difference was significant. This is likely due to treatment within the Infirmary. These may have been work related injuries. Only one individual showed significant peri-mortem trauma which may have contributed to cause of death. It is uncertain when individuals received a fracture due to complete healing. The presents of facial and hand fractures indicate that interpersonal violence was occurring during this time.

It was therefore hypothesised that there will be different prevalence rates found between 13/83 and other previously published contemporary skeletal collections. The population from the Spitalfield Crypts were also of a higher socio-economic status than the 13/83 individuals which is hypothesised to indicated differences between discussed populations. Overall, the conditions seen in 13/83 provide highlight the difficulties encountered by individuals of this period. The prevalence of these conditions does show different trends to earlier populations. However, it also shows that there was a massive amount of social change occurring. The population of Gloucester did not suffer the same levels of hardship as other populations in bigger cities. Many of the prevalence rates were similar to larger cities at earlier times.

Global burden of disease

Joint conditions were the most common group of pathological conditions within the 13/83 skeletal assemblage. These conditions have a significant pain impact on individuals causing pain and disability. Modern epidemiological studies state that spondyloarthropathies and osteoarthritis have a large impact on global economy. Large joint OA, can now be treated by joint replacement which would not have been available in earlier populations. Therefore, these conditions likely had even more impact on 18th-19th century sufferers. There is direct correlation between these conditions and age. Due to aging populations the trends seen are different in clinical data compared to palaeoepidemiological studies. Males are more likely to suffer from joint conditions at a younger age. However, in post-menopausal life women are more likely to suffer.

Reductions in mortality were beginning the time burials were occurring at the 13/83 site. This is evidence through information in the burial register, although not present in the skeletal material. This has continued into the 21st century. As a result, disease trends have changed. Whereas throughout most of human history the most common health hazard would have been infectious disease, this is no longer the case. Longer life-expectancies have led to increased risk of chronic conditions such as cardiovascular disease, osteoporosis, diabetes, cancer, OA and other degenerative conditions. Many of these conditions have secondary complications which include fractures and increased susceptibility to infectious disease. These conditions also contribute to the Global disease burden.

Effective methods have been employed to control infectious disease. However, the anti0vaccination movement has presented increased risk of preventable disease to the general population resulting in outbreaks of old conditions within the modern world. Antibiotic resistant strains of disease are evolving and are predicted to continue. This is likely due to over-use of these medications. Fatal flu epidemics are also predicted to rise and resurge as vaccination programmes are not universally available or necessarily effective. It is therefore predicted that there will be a rise of old and new infectious conditions.

6.3: Limitations of study

The limitations of this study were common with most palaeoepidemiological studies as stated by Waldron (2007). There were biases within the sample which made comparison between the two cemeteries difficult. This also meant that samples were unbalanced and true palaeoepidemiological study was not possible.

The preservation of skeletal elements was variable between the samples. Due to time constraints in this study skeletal and dental elements were grouped. This made direct comparisons with other research difficult.

6.4: Future research

Future studies can expand on the existing data collected. This could include further analysis and comparison of dental conditions on individual elements.

Exploration of other skeletal assemblages from Gloucester could enable analysis of conditions over time within this specific geographic location. Further analysis of the 3/89 skeletal collection housed at LJMU and the archaeological records may enable further skeletal material from the 18th and 19th centuries to be discerned.

Access to historical and archival information is being made easier through internet search engines such as Ancestry.com and findmypast.co.uk. This is an important future tool for researchers as it can provide information on the demographics of their samples through church registries and other primary sources.

Ancestry was not assessed as part of this as the collection was assumed to be medieval at the onset of this research. The 13/83 Gloucester collection is now confirmed as 18th/19th century. Ancestry should therefore be assessed when further research is conducted on this collection, as there was a known Black/African population in Georgian Britain.

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Appendix 1:

Southgate Congregational Church Burial Register

1786-1837

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
Anne	Adey			15/04/1784	54Y	Female			St. Michael's, Gloucester	
Sarah	Harrison		buried	08/02/1786		Female				
John	Perkins		interred	07/03/1786	infant	Male				
Agnes	Miller		interred	18/05/1786		Female				
Mrs	Trinder		interred	19/10/1786		Female				
	Perris		interred	05/09/1787						
Sarah	Bond		buried	17/10/1787		Female				
Miriam	Weaver		buried	02/03/1788		Female				
Isaac	Rowland		buried	19/12/1788		Male		William and Ann Rowland		
Margaret	Watts		buried	19/12/1788		Female				
Thomas	Loch		interred	11/01/1789		Male				
	Thomson		interred	11/01/1789						
	Loid		buried	12/01/1789						
Richard	Nichols		interred	31/03/1789		Male				
John	Cox		interred	31/08/1790		Male				
Henry	Bowles		interred	07/09/1790		Male		Charles and Elizabeth Bowles		
?	Lasts		interred	01/10/1790	child	?		William Lasts		
?	Lasts		interred	01/10/1790	child	?		William Lasts		
Ann	Adley		interred	16/11/1790		Female				
Isaac	Purcer		interred	20/01/1791		Male				
	Lewes		interred	05/09/1791		Male		Thomas and Elizabeth Lewes		
Elizabeth	Lewes		interred	23/09/1791		Female		Thomas and Elizabeth Lewes		
Danial	Perkins		interred	30/09/1791		Male		Danial and Glister Perkins		
William	Cox		interred	30/02/1792		Male				
Thomas	Gravn		interred	06/04/1792		Male				
Sarah	Perkins			21/02/1793	4M	Female			St. Owens, Gloucester	
Samuel	Smith		interred	18/05/1793	3Y 10M	Male			St. Michael's, Gloucester	
Sarah	Maycock			04/05/1794	50Y	Female			St. Michael's, Gloucester	
Katherine	Taylor			02/06/1794	76Y	Female			St. Owens, Gloucester	
Mary	Sparrowhawke			12/03/1795	73Y	Female			St. Owens, Gloucester	
David	Roberts			01/09/1795	44Y	Male			Stroud	
Mary	Nale			15/02/1796	6M	Female			St. Owens, Gloucester	
Thomas	Whitehead			18/05/1796	12Y	Male			St. John's, Gloucester	
Olive	Gill			01/07/1796	76Y	Female			St. John's, Gloucester	
Leonard	Paytt			07/07/1796	6D	Male			St Mary de Crypt, Gloucester	
Elizabeth	Perris			15/07/1796	78Y	Female			St Mary de Crypt, Gloucester	
William	Pytt			29/07/1796	15Y	Male			St Mary de Crypt, Gloucester	
William	Butt			18/08/1796	70Y	Male			St. John's, Gloucester	
Elizabeth	Poulson			26/08/1796	70Y	Female			St. Owens, Gloucester	
George	Perkins			30/11/1796	7Y 9M	Male			St. Owens, Gloucester	

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
Thomas	Ashburn			20/12/1796	49Y	Male			St. Michael's, Gloucester	
Hannah	Lewis			19/02/1797	3Y	Female			St. Michael's, Gloucester	
Thomas	Lewis			24/03/1797	40Y	Male			St. Michael's, Gloucester	
Mary	Watts			10/07/1797	67Y	Female			St. Owens, Gloucester	
Elizabeth	Watts			22/10/1798	56Y	Female			St. Owens, Gloucester	
William	Cox			15/02/1799	67Y	Male			Holy Trinity, Gloucester	
Elizabeth	Perris			11/04/1799	15Y	Female			St. Michael's, Gloucester	
Mary	Watkins			30/06/1799	15Y	Female			St. John's, Gloucester	
John	Adey Junior			25/10/1799	27Y	Male			St. Keunswick	
William	Warwick			16/01/1800	26Y	Male			St. Michael's, Gloucester	
John	Coley			17/01/1800	13M	Male			St. Catherine, Gloucester	
John	Lairet			09/02/1800	74Y	Male			St. Margarets	
Elizabeth	Everard			13/03/1800	85Y	Female				
May	Harmar			10/04/1800	68Y	Female			St. Catherine, Gloucester	
Mary	Cornell			23/04/1800	77Y	Female			St. Michael's, Gloucester	
Thomas	Orpin			15/05/1800	10Y	Male			St. Michael's, Gloucester	
James	Waite			04/06/1800	5W	Male			St. Owens, Gloucester	
Mary	Lesley			23/08/1800	5M	Female			St. John's, Gloucester	
Elizabeth	Chandler			31/08/1800	80Y	Female			St. Michael's, Gloucester	
Mary	Harman			27/11/1800	45Y	Female			St. Catherine, Gloucester	
William	Smith			30/11/1800	2Y 3M	Male			St. Michael's, Gloucester	
Charlotte	Bishop			07/08/1801	2Y 6M	Female			St. Owens, Gloucester	
Sarah	Floyd			24/09/1801	81Y	Female				
Hariot	Mason			19/01/1802	6M	Female			St. Nicholas, Gloucester	
Elizabeth	Cox			09/02/1802	69Y	Female			Holy Trinity, Gloucester	
Mary	Hitchings			15/02/1802	19Y	Female			St Mary de Crypt, Gloucester	
Sarah	Vaile			11/03/1802	18M	Female			St. Owens, Gloucester	
Thomas	Church			18/03/1802	76Y	Male			St. Michael's, Gloucester	
Mary	Coley			28/07/1802	8D	Female			St. Catherine, Gloucester	
Steph	Smith			22/02/1803	5M				St. Michael's, Gloucester	
William	Bourne			24/03/1803	17M	Male			Holy Trinity, Gloucester	
Thomas	Harman			31/03/1803	70Y	Male			St. Catherine, Gloucester	
Henry	Butler			12/08/1803	76Y	Male			St. Michael's, Gloucester	
Margaret	Hughes			15/11/1803	77Y	Female			St Mary de Crypt, Gloucester	
Ann	Pytt			12/02/1804	20Y	Female			St Mary de Crypt, Gloucester	
Elizabeth	Cox			20/09/1804	45Y	Female			Holy Trinity, Gloucester	
Thomas	Gill			07/12/1804	23Y	Male			St. John's, Gloucester	
Mary	Trap…			25/12/1804	43Y	Female			St. John's, Gloucester	
Mary	Wheeler		buried	27/12/1804	80Y	Female			St. Nicholas, Gloucester	
Catherine	Price		buried	01/03/1805	31Y	Female			Littleworth near Gloucester	
Mary Ann	Thompson		buried	16/07/1805	10W	Female		G and Ann Thompson	Gloucester	
Thomas	Adey		buried	02/08/1805	27Y	Male	Lieutenant of the South Gloucester Militia			Lieutenant of the South Gloucester Militia
John	Smith		buried	21/10/1805	14M	Male		Samuel and Hannah Smith	St. Michael's, Gloucester	
Mary	Smith	Old burying ground	buried	12/11/1805	10M	Female			St. Michael's, Gloucester	

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
John	Pytt		buried	29/11/1805	19Y	Male			St. Aldates	
William	Smith		buried	02/03/1806	3Y	Male		Samuel and Hannah Smith	St. Michael's, Gloucester	Samuel and Hannah Smith
Samuel	Keern		buried	02/04/1806	79Y	Male			Workhouse	
George	Bishop		buried	09/04/1806	2Y	Male			St. Owens, Gloucester	
Eliza	Waite		buried	07/12/1806	3D	Female			Littleworth near Gloucester	
Elizabeth	Aviary		buried	27/02/1807	24Y	Female			St. Catherine, Gloucester	
John	Warwick		buried	05/03/1807	35Y	Male			St. Michael's, Gloucester	
William	Rickets		buried	05/04/1807	58Y	Male			St. Owens, Gloucester	
Mary	Dowell		buried	02/06/1807	70Y	Female			Workhouse	
Catherine	Price		buried	30/07/1807	12Y	Female			St. Nicholas, Gloucester	
Joseph	Bourne		buried	11/12/1807	7W	Male			St. Owens, Gloucester	
Cornelius	Winter	Vault - privately owned	interred vault	19/01/1808	65Y	Male	Minister of the Independent Chapel		Ind. Chapel	Minister of the Independent Chapel
Henrietta	Thompson		buried	17/02/1808	8M	Female			Littleworth near Gloucester	
John	Smith		buried	05/04/1808	1M	Male			St. Michael's, Gloucester	
John	Watts		buried	25/04/1808	72Y	Male			St. Bartholomews	
Mary	Bourne		buried	05/05/1808	6M	Female			St. Owens, Gloucester	
Ann	Mitchel		buried	15/05/1808	3Y 9M	Female			St. Owens, Gloucester	
Thomas	Orpin		buried	19/06/1808	48Y	Male			St. John's, Gloucester	
Ann	Radnall		buried	24/11/1808	63Y	Female			Littleworth near Gloucester	
James	Pynock	Old Ground	buried	29/01/1809	51Y	Male			St. John's, Gloucester	
Mary	Perris	Old Ground	buried	30/03/1809	58Y	Female			St. Michael's, Gloucester	
Elizabeth	Waite	New Ground	buried	11/09/1809	32Y	Female			Littleworth near Gloucester	
Mary	Phillpots	Old Ground	buried	22/11/1809	3M	Female			St Mary de Crypt, Gloucester	
Samuel	Maycock		buried	08/12/1809	68Y	Male			St. Nicholas	
Elizabeth	Ellerhost	New Ground	buried	26/03/1810	64 years	Female			St Mary de Crypt, Gloucester	
Elizabeth	Bourne	New Ground	buried	19/06/1810	8 months	Female		William and Jane Bourne	St. Owens, Gloucester	
Ann	Mason	New Ground	buried	21/11/1811	40 years	Female			St. Owens, Gloucester	
Jane	Watts	New Ground	buried	24/12/1811	68 years	Female			St. Owens, Gloucester	"died in Kimbreas, in the parish of st owens"
John	Perrin	New Ground	buried	26/03/1812	12 years	Male	pupil	William Perrin	Kerryswood, Wiltshire	"Pupil of Wm Bishop the undersigned"
William	Tanner	New Ground	buried	17/05/1812	5 months	Male			St. Owens, Gloucester	
Elizabeth	Warwick	New Ground	buried	28/06/1812	61 years	Female			St. Michael's, Gloucester	
Maria	Aviary	New Ground	buried	02/07/1812	2 years 5 months	Female			St. Michael's, Gloucester	
Richard	Warwick	New Ground	buried	19/07/1812	66 years	Male			St. Michael's, Gloucester	
Sarah	Barr	New Ground	buried	12/08/1812	20 years	Female			Holy Trinity, Gloucester	
William	Wheeler	New Ground	buried	11/10/1812	20 years	Male			Littleworth near Gloucester	
William	Joy	Old Ground	buried	12/11/1812	67 years	Male			Littleworth near Gloucester	
?	Church	-	buried	04/01/1813	93 years	Male			St. Michael's, Gloucester	
Richard	Whittard	New Ground	buried	17/01/1813	8 months	Male			St. Michael's, Gloucester	
Mary	Jones	New Ground	buried	28/02/1813	28 years	Female			St. Nicholas, Gloucester	
William	Curtis	New Ground	buried	22/08/1813	6 weeks	Male			St. Nicholas, Gloucester	
Anne	Smith	New Ground	buried	04/11/1813	19 years	Female			St. Mary de Grace, Gloucester	

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
Elizabeth Naughn	Wheeler	Old Ground	buried	10/12/1813	2 years	Female			St. Nicholas, Gloucester	
Ann	Garn	New Ground	buried	17/01/1814	80 years	Female			St. John's, Gloucester	
Thomas	Curtis	-	buried	07/10/1814	1 month	Male			St. Nicholas, Gloucester	
Nathanial	Washbourne	The ?Difsentiany Meeting burial ground	buried	01/02/1815	4 months	Male			St Mary de Crypt, Gloucester	NOT buried at southgate street
John	Roberts	Old Ground	buried	20/04/1815	23 years	Male			Infirmary In-patient	Patient of the infirmary
Sarah	Hayward	Old Ground	buried	02/06/1815	23 years	Female			St. John's, Gloucester	
John	Stratford	New Ground	buried	24/09/1815	1 year	Male			St Mary de Crypt, Gloucester	
Mary	Adey	Old Ground	buried	23/01/1816	66 years	Female			St. Nicholas, Gloucester	
William	Medhurst	New Ground	buried	06/02/1816	23 years	Male			Barton street, Gloucester	
Mary	Weaver	Old Ground	buried	13/06/1816	67 years	Female			Barton street, Gloucester	
John	Allgood	New Ground	buried	02/08/1816	46 years	Male			Holy Trinity, Gloucester	
Mary	Lancaster	Old Ground	buried	16/09/1816	38 years	Female			St. Michael's, Gloucester	
Charles	Sparrow	New Ground	buried	08/10/1816	3 years	Male			St Mary de Crypt, Gloucester	
Lavnia Frances	Newby	Old Ground	buried	11/10/1816	2 years	Female		Mary Newby	?, gloucestershire	
Thomas Adey	Martin	Old Ground	buried	16/11/1816	9 months	Male			St. Mary de Lode, Gloucester	
John	Herbert	New Ground	buried	21/11/1816	61 years	Male	day master cap		South Gloucester Militia	"Day Master Captain of the South gloucester Militia"
John	Jones	New Ground	buried	16/12/1816	50 years	Male			St. Nicholas, Gloucester	
George	Cale	Old Ground	buried	29/01/1817	65 years	Male			Holy Trinity, Gloucester	
Ann	Thompson	New Ground	buried	25/03/1817	43 years	Female			St. Nicholas, Gloucester	
Elizabeth	Clark	New Ground	buried	04/04/1817	53 years	Female			St. Michael's, Gloucester	
John	Cue	New Ground	buried	24/04/1817	4 months	Male			Holy Trinity, Gloucester	
Sarah	Wood	New Ground	buried	17/05/1817	81 years	Female			Norfolk Buildings, Gloucester	
Elizabeth	Whitehead	New Ground	buried	19/11/1817	79 years	Female			St. John's, Gloucester	
Margarett	Mills	New Ground	buried	24/12/1818	60 years	Female			St. Michael's, Gloucester	
William	Page	Old Ground	buried	25/02/1819	2 years	Male			Spa, Gloucester	Extra parocheal district
Mary Ann	Carol	New Ground	buried	21/05/1819	3 months	Female			Littleworth near Gloucester	
Mary	Cleveland	Old Ground	buried	25/07/1819	25 Years	Female			St. John's, Gloucester	
Sarah	lattimer	New Ground	buried	21/10/1819	1 month	Female			St Mary de Crypt, Gloucester	
Susanna	White	New Ground	buried	19/12/1819	50-60years	Female			Barton street, Gloucester	"aged between 50 and 60"
Joseph	Drew	New Ground	buried	31/12/1819	70 years	Male			St. Nicholas, Gloucester	
George Box	Drayton	New Ground	buried	19/01/1820	7 months	Male			St. John's, Gloucester	
Hesther	Perkins	New Ground	buried	21/01/1820	62 years	?			St. Owens, Gloucester	
John	Adey	Old Ground	buried	28/01/1820	76 years	Male			St. Michael's, Gloucester	
Elizabeth	Lawrence	New Ground	buried	09/02/1820	63 years	Female			St Mary De Crypt, Gloucester	
Sarah	Joy	Old Ground	buried	10/03/1820	86 years	Female			Littleworth near Gloucester	
Rev. Ebenerzor	Cornell	New Ground	buried	20/04/1820	83 years	Male			St. Michael's, Gloucester	
F.M	Barnard	New Ground	buried	21/04/1820	18 years	Female		Thomas Barnard	St. Mary de Lode, Gloucester	"daughter of Mr Tho. Barnard of the hamlet St. Mary De Lode, living beyond Barton, Pike"
Elizabeth	Lambard	in [?] Rev. Tallamy's Brick Grave	buried	15/05/1820	73 years	Female			St. Nicholas, Gloucester	"Of Bartholamews hospital.. Buried in the Independent Meeting - in [?] Rev. Tallamy's Brick Grave"

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
Elizabeth	Rickets	New Ground	buried	14/01/1821	72 years	Female			St. Owens, Gloucester	
?	Whitehead	New Ground	buried	22/02/1821	82 years	?			St. John's, Gloucester	
Caroline	Tucker	New Ground	buried	25/11/1821	1 year	Female			St. Nicholas, Gloucester	
Elizabeth	Watts	New Ground	buried	04/12/1821	43 years	Female			St. Owens, Gloucester	"Wife of Samuel Watts"
Hannah	Smith	New Ground	buried	20/03/1822	23 years	Female			St. Mary de Grace, Gloucester	Wife of Samuel Smith
Franices	Barnard	New Ground	buried	31/03/1822	38 years	Female			St Mary de Crypt, Gloucester	lodged there
Daniel	Perkins	New Ground	buried	12/04/1822	63 years	Male			St. Owens, Gloucester	
Joseph Naughn	Wheeler	Old Ground	buried	29/04/1822	2 years 3 months	Male			St. Nicholas, Gloucester	
?	Pytt	New Ground	buried	21/05/1822	79 years	Male			St Mary De Crypt, Gloucester	
William	Smith	New Ground	buried	24/07/1822	70 years	Male			Barton street, Gloucester	
Benjamin	Pollard	New Ground	buried	05/08/1822	69 years	Male			Spa , Gloucester	
Thomas	Smith	Old Ground	buried	26/08/1822	43 years	Male		-	Barton street, Gloucester	
Mathew	Hampton	Old Ground	buried	14/10/1822	29 years	Male		-	Castle Precincts, Gloucester	
Henry	Warwick	New Ground	buried	29/11/1822	29 years	Male		-	St. Michael's, Gloucester	
Sarah	Case	New Ground	buried	03/12/1822	52 years	Female		-	St. Michael's, Gloucester	
Ann	Williams	Old Ground	buried	01/03/1823	43 years	Female			St. Mary de Lode, Gloucester	
Mary-Ann	Wright	New Ground	buried	13/04/1823	19 years	Female			St. Mary de Grace, Gloucester	
Caroline	Kent	Old Ground	buried	18/04/1823	?	Female			St. Owens, Gloucester	
Mary	Thomas	New Ground	buried	29/09/1823	54 years	Female			St. Mary de Lode, Gloucester	
Charles	Turk	New Ground	buried	10/10/1823	6 days	Male		-	Littleworth near Gloucester	
Mary	Green	New Ground	buried	21/11/1823	46 years	Female		-	St. Owens, Gloucester	
Elizabeth	?Orpim	Old Ground	buried	02/12/1823	75 years	Female		-	St. Catherine, Gloucester	
Ann	Smith	New Ground	buried	19/12/1823	70 years	Female		-	Barton street, Gloucester	Wife of William Smith buried 24th July 1822
?Brice	Smith	New Ground	buried	19/12/1823	64 years	Female		-	Barton street, Gloucester	
John	Rees	New Ground	buried	11/02/1824	2 years	Male		-	St. John's, Gloucester	
Mary	Purser	New Ground	buried	22/02/1824	22 years	Female		-	Quedgeley gloucestershire	
John	Leach	Old Ground	buried	18/03/1824	6 months	Female		-	Littleworth near Gloucester	"NB/ This ought to have been at the top of the page WB"
Joseph	?vict	New Ground	buried	19/03/1824	30 years	Male		-	St. Nicholas, Gloucester	
Charles	Wheeler	Old Ground	buried	09/04/1824	58 years	Male		-	St. Nicholas, Gloucester	
James	Cook	New Ground	buried	10/05/1824	61 years	Male		-	St. John's, Gloucester	
Elizabeth	Purser	New Ground	buried	04/07/1824	30 years	Female		-	Quedgeley gloucestershire	
Mary Ann	Gittens	In the Alley	buried	30/09/1824	9 years	Female		-	St. Michael's, Gloucester	

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments

Samuel	Weaver	Old Ground	buried	17/10/1824	85 years	Male		-	Barton street, Gloucester	"NB/ this corpse was carried through the Southway. The wall has been walled up for years. From [blank] until this day all corpses had been carried through the East way which was the original way, the Dead had been carried that way only from about 1690 until 1735 when Robert Watts gave the South Road from which year until [blank] the Dead had been carried both ways, but as above stated from[blank] until this 17 October the original way had been altogether removed & the Dead only carried the East way, until Mrs Mary Cornell arose, who was the first Proprietor of that Land that forbid the Dead to be carried out the East way, and oblifed the trustees to open the wall in the South way, the
George	Wright	New Ground	buried	02/11/1824	27 years	Male		-	Barton street, Gloucester	
Sarah	Purser	New Ground	buried	29/11/1824	28 years	Female		-	Quedgeley gloucestershire	
John	Perris	New Ground	buried	01/02/1825	73 years	Male		-	St. Owens, Gloucester	
Harriet	?Ockford	Old Ground	buried	04/02/1825	38 years	Female		-	St. John's, Gloucester	
Mary	Page	Old Ground	buried	21/06/1825	32 years	Female		-	Littleworth near Gloucester	
Ruth	Perriman	New Ground	buried	11/09/1825	56 Years	Female		-	St. Owens, Gloucester	
Sarah	Perris	New Ground	buried	11/09/1825	78 years	Female		-	St. Owens, Gloucester	
Jemima	Thomson	New Ground	buried	16/11/1825	17 years	Female		-	St. Michael's, Gloucester	
Thomas	Grimes	New Ground	buried	24/02/1826	26 years	Male		-	St John the baptist, Gloucester	
?	Haslem	New Ground	buried	24/02/1826	59 years	Male		-	St Mary De Crypt, Gloucester	
Betsy	Leach	Old Ground	buried	03/07/1826	3 months	Female		-	Littleworth near Gloucester	
Arthur	Jenkins	New Ground	buried	24/11/1826	81 years	Male		-	Barton street, Gloucester	
Mary	Cook	New Ground	buried	04/12/1826	19 years	Female		-	St. John's, Gloucester	
Anne Jones	Gittens	In the Alley	buried	14/02/1827	9 months	Female		-	St. Michael's, Gloucester	
Anna	Stratford	New Ground	buried	04/03/1827	2 years 10 months	Female		-	St Mary de Crypt, Gloucester	
Sarah	Allgood	New Ground	buried	29/03/1827	22 years	Female		-	College Yard, Gloucester	
William	Green	-	buried	05/05/1827	43 years	Male		-	Littleworth near Gloucester	
John	Tucker	New Ground	buried	13/05/1827	13 months	Male		-	St. Nicholas, Gloucester	
George	Harmer	New Ground	buried	21/08/1827	66 years	Male		-	Burley Lodge, near Lincoln Hampton, Gloucester	
Ann	Bowler	Old Ground	buried	01/11/1827	56 years	Female		-	Littleworth near Gloucester	
no name	Flowers	New Ground	buried	10/11/1827	6 months	?		-	Littleworth near Gloucester	
First name	**Surname**	**Burial location**	**Interred/buried**	**Date of burial**	**Age**	**Sex**	**Occupation**	**Issue of**	**Abode**	**additional comments**

Abraham	Richards	New Ground	buried	05/12/1827	7 months	Male		-	St. John's, Gloucester	
Ann	Reeves	New Ground	buried	09/01/1828	6 months	Female		-	near Gloucester	
William	Gray	Baptist Burial Ground	buried	14/01/1828	33 years	Male		-	near Gloucester	
John	Elliot	New Ground	buried	31/01/1828	56 years	Male		-	St. John's, Gloucester	
Amelia	Kendall	New Ground	buried	22/04/1828	60 years	Female		-	St. Nicholas, Gloucester	Wife of William Kendall
Jane	Lennox	New Ground	buried	27/06/1828	45 years	Female		-	Over near Gloucester	
Mrs	Hall	New Ground	buried	16/10/1828	54 years	Female		-	St. Nicholas, Gloucester	
Elizabeth	Green	New Ground	buried	31/10/1828	31 years	Female		-	South Hamlet near Gloucester	
John	Osborne	Old Ground	buried	05/01/1829	65 years	Male		-	St Mary de Crypt, Gloucester	
William	Reeves	New Ground	buried	17/01/1829	5 months	Male		-	Littleworth near Gloucester	
George	Purser	New Ground	buried	26/01/1829	22 years	Male		-	Quedgeley gloucestershire	
James	Grimes	New Ground	buried	10/02/1829	16 months	Male		-	St. Nicholas, Gloucester	
Elizabeth	Aviary	New Ground	buried	19/02/1829	82 years	Female		-	St. Catherine, Gloucester	
Elizabeth	Hendcock	New Ground	buried	25/03/1829	85 years	Female		-	St. Nicholas, Gloucester	
Catherine	Page	Old Ground	buried	07/04/1829	1 year	Female		-	Littleworth near Gloucester	
Charlotte	Allgood	New Ground	buried	29/04/1829	28 years	Female		-	The college precincts, Gloucester	
Sarah	Stratford	New Ground	buried	18/05/1829	24 years	Female		-	St Mary de Crypt, Gloucester	
Ann	Stock	New Ground	buried	23/06/1829	31 years	Female		-	Bristol	
Henrietta	Miur	New Ground	buried	09/08/1829	9 days	Female		-	St Mary de Crypt, Gloucester	
Jacob	Shearman	Old Ground	buried	16/08/1829	3 months	Male		-	Sudbrook near Gloucester	
Caroline	Corey	Old Ground	buried	30/10/1829	10 months	Female		-	Littleworth near Gloucester	
William Linsey	Purser	New Ground	buried	25/02/1830	20 years	Male		-	Quedgeley gloucestershire	
Fredrick	Green	New Ground	buried	16/03/1830	2 3/4 years	Male		-	St. John's, Gloucester	
Charles	Gibbs	New Ground	buried	09/04/1830	64 years	Male		-	Barton St Mary's near Gloucester	
Ann	Cook	Old Ground	buried	08/06/1830	33 years	Female		-	Barton St Mary's near Gloucester	
Hannah	Pytt	New Ground	buried	15/07/1830	74 years	Female		-	St Mary de Crypt, Gloucester	
William	Cox	Old Ground	buried	10/09/1830	55 years	Male		-	St. Michael's, Gloucester	
Ann	Wright	Old Ground	buried	20/01/1831	14 years	Female		-	St Mary de Crypt, Gloucester	from staffordshire staying in Gloucester
Thomas	Grimes	New Ground	buried	20/01/1831	9 months	Male		-	St. Nicholas, Gloucester	
Ann	Highwood	New Ground	buried	21/01/1831	32 years	Female		-	?	
Hannah	Gardner	New Ground	buried	07/02/1831	62 years	Female		-	St. John's, Gloucester	
Jane	Moarne	"in the independent chapel"	buried	19/02/1831	56 years	Female		-	St. Owens, Gloucester	the comment was underlined but the
John	Collinwood	New Ground	buried	14/03/1831	71 years	Female		-	Barton St Mary's near Gloucester	
William	Tidmarsh	Old Ground	buried	22/03/1831	27 months	Male		-	St. Nicholas, Gloucester	
Henry	Newman Thompson	New Ground	buried	07/04/1831	16 years	Male		-	St. Mary de Grace, Gloucester	
Martha	Pain	New Ground	buried	20/04/1831	78 years	Female		-	?	
Tha	Ricketts	New Ground	buried	23/05/1831	6 months	?		-	St. John's, Gloucester	
Hannah	Perris	New Ground	buried	06/06/1831	55 years	Female	Wife of John	-	St. Owens, Gloucester	
William	Butt	Old Ground	buried	28/11/1831	64 years	Male		-	Holy Trinity, Gloucester	
Selma	Tidmarsh	New Ground	buried	16/01/1832	3 years	Female		-	St. Nicholas, Gloucester	
Mary Ann	Peckmore	New Ground	buried	22/02/1832	6 months	Female		-	Barton St Mary's near Gloucester	
Mary Ann	Morgan	New Ground	buried	10/03/1832	10 years	Female		-	St. Owens, Gloucester	
Elizabeth	Cook	New Ground	buried	19/03/1832	46 years	Female		-	St. Owens, Gloucester	

First name	Surname	Burial location	Interred/buried	Date of burial	Age	Sex	Occupation	Issue of	Abode	additional comments
William	Bishop	-	-	29/07/1832	67 years	Male	Pastor of this church	-	St. Owens, Gloucester	
Samuel	Oakley	New Ground	buried	08/08/1832	48 year	Male		-	St. Nicholas, Gloucester	
Francis Sarah	Hall	New Ground	buried	22/09/1832	3 months 6 days	Female		James and Sarah Hall	Spa Hamlet near Gloucester	
William Linsey	Graves	New Ground	buried	17/11/1832	58 years	Female		-	St. Nicholas, Gloucester	
Mary Ann	Hughes	New Ground	buried	28/12/1832	23 years	Female		-	St. Mary de Grace, Gloucester	
Elizabeth jane	Eastermeadsea	-	-	09/02/1833	nearly 10 ?years	Female		John and Ann Eastermeadsea	St Mary de Crypt, Gloucester	
Julia	Hall	-	-	30/03/1833	7 years	Female	-	James and Sarah Hall	Gloucester	
James Edward McCartney	Gittens	-	-	29/08/1833	6 years	Male	-	James and Caroline Gittins	worcester street, gloucester	
John	Pinder	-	-	09/10/1833	77 years	Male		-	-	
Mary	Stratford	New Ground	buried	30/11/1833	78 years	Female		-	St. Owens, Gloucester	
Mary	Sparrow	-	-	05/01/1834	2 years	Female	-	Paul and Fanny Sparrow	St. John's, Gloucester	
Robert	?Kendale			27/01/1834	30 years	Male	diaper	-	Aldgate st., Gloucester	
Ann	Eastmead	-	-	26/02/1834	75 years	Female		-	Gloucester	
Anna	Meadows	-	-	23/03/1834	57 years	Female	Printer	-	Gloucester	
?	Cox	-	-	14/08/1834	74 years	?		-	St. Nicholas, Gloucester	
John	Eastmead	-	-	22/10/1834	75 years	Male	shoemaker	-	Gloster	
Charles	Hannon Thomspon	-	-	20/12/1834	23 years	Male		-	St. John's, Gloucester	
Sarah	Cook	-	-	14/01/1835	73 years	Female	-	-	St. John's, Gloucester	
Robert	Williams	-	-	14/02/1835	62 years	Male	-	-	Wotton near, Gloucester	
?William	Gardner	-	-	12/03/1835	?50 years	Male	-	-	Alvin Street, Gloucester	
Sarah	?Joy	-	-	22/03/1835	?55 years	Female	-	-	Worcester Street, Gloucester	
Mary	Edwards	-	-	12/05/1835	91 years	Female	-	-	From Wales	
John	Gain	-	-	01/12/1835	62 years	Male	Woolstapler	-	Northgate Street, Gloucester	
Delia	Page	-	-	12/03/1836	56 years	Female	-	-	Littleworth near Gloucester	
Elizabeth	Butt	-	-	04/04/1836	2 years	Female	-	-	St Mary De Crypt, Gloucester	
Ann	Horne	-	-	20/07/1836	2 years and 3 months	Female	her father, a cooper	Wiliam and Anne Horne	Southgate Street, Gloucester	
?	Jacob	-	-	07/08/1836	50 years	?	?	-	Worcester Street, Gloucester	
Mary	Smith	-	-	10/12/1836	75 years	Female	-	-	Alvin Street, Gloucester	
?	Brickerton Gitterant	-	-	18/02/1837	15 years	?	?	James and Caroline Gittins	Wotton near, Gloucester	
Daniel	Hall	-	-	26/05/1837	14 months	Male	-	William Hall and his wife	Gloucester	
Ellen	Marsh	-	-	26/05/1837	11 weeks	Female	-	Charles and Mary Marsh	stroud road, gloucester	
Henry	Sparrow	-	-	01/06/1837	14 months	Male	carpenter	Paul and Fanny Sparrow	St. John's, Gloucester	
Charles	Sparrow	-	-	02/07/1837	3 years	Male	-	Paul and Fanny	St. John's, Gloucester	

Appendix 2:

Gloucester 13/83 Skeleton Summary Sheets

Gloucester 13/83

LJMU BOX	Gloucester Skeleton Number	Form used
GLA-0001	II118a	SUBADULT
GLA-0001	II118b	SUBADULT (Skull only)
GLA-0001	II133	Adult
GLA-0001	II163	SUBADULT
GLA-0001	II166	SUBADULT
GLA-0001	II167	SUBADULT
GLA-0001	III168	Adult
GLA-0002	II176	Adult
GLA-0002	III179	Adult
GLA-0003	III183	Adult
GLA-0004	II191	Adult
GLA-0005	III199	Adult
GLA-0006	III200	Adult
GLA-0007 GLA-0036	II206	Adult
GLA-0007	III201	Adult
GLA-0008	II207	Adult
GLA-0009	II208	Adult
GLA-0010	II217	Adult
GLA-0010	III212	Adult
GLA-0011	II218a	SUBADULT
GLA-0011	II218**b**	SUBADULT
GLA-0011	II218c	SUBADULT
GLA-0011	II218d	SUBADULT (Skull only)
GLA-0011	II224	Adult
GLA-0011	II227	Adult
GLA-0012	II228	SUBADULT
GLA-0012	II229	SUBADULT
GLA-0012	II235	SUBADULT
GLA-0012	III230	Adult
GLA-0013	II237	SUBADULT
GLA-0013	II244	Adult
GLA-0014	II246	SUBADULT
GLA-0014	II247	SUBADULT
GLA-0014	III248	Adult
GLA-0015	II249	Adult
GLA-0015	II250	Adult
GLA-0016	II252	SUBADULT
GLA-0016	II253	SUBADULT
GLA-0016	II256	SUBADULT
GLA-0016	II257	Adult
GLA-0017	II259	Adult
GLA-0018	III262	SUBADULT
GLA-0018	III264	Adult
GLA-0019	III269	Adult
GLA-0019	III282	SUBADULT
GLA-0019	III284	Adult
GLA-0020	II295	Adult

LJMU BOX	Gloucester Skeleton Number	Form used
GLA-0020a	III290	Adult
GLA-0021	III311	Adult
GLA-0022	III334	Adult
GLA-0022	III335	Adult
GLA-0023	III346	SUBADULT
GLA-0023	III362b	SUBADULT
GLA-0023	III362a	Adult
GLA-0024	III364	Adult
GLA-0024	III486	Adult
GLA-0025	III487	Adult
GLA-0025	III502	Adult
GLA-0025	III532	Adult
GLA-0026	III535	Adult
GLA-0026	III560	Adult
GLA-0027	III723	Adult
GLA-0027	III781	Adult
GLA-0028	III789	Adult
GLA-0029	III799	Adult
GLA-0030	III814	ADULT
GLA-0031	II243	Adult (Skull only)
GLA-0032	II283	Adult (Skull only)
GLA-0033	III322	Adult (Skull only)
GLA-0034	III612	Adult (Skull & C1)
GLA-0035	III725	Adult (Skull only)
GLA-0037	I103	Adult (Skull only)
GLA-0038	II157	Adult (Skull only)
GLA-0039	III150	Adult (Skull only)
GLA-0040	III507	Adult (Skull only)
GLA-0041	III660	Adult (Skull only)
GLA-0042	III681	Adult (Skull only)
GLA-0046	V U/SA	Adult (Skull only)
GLA-0047	V U/SB	Adult (Skull only)
GLA-0048	V U/SC	Adult (Skull only)
GLA-0049	V U/SD	Adult (Skull only)
GLA-0050	V U/SE	Adult (Skull only)

Gloucester 13/83 Skeleton Summary Form - Adult

LJMU Box Number	
Gloucester Skele. Number	
Trench Number	
Date	
Preservation	
Age	
Sex	
Stature	
Non metric traits/ pathology	
Additional notes	

Radiographs needed: Y/N – If yes which elements: ____

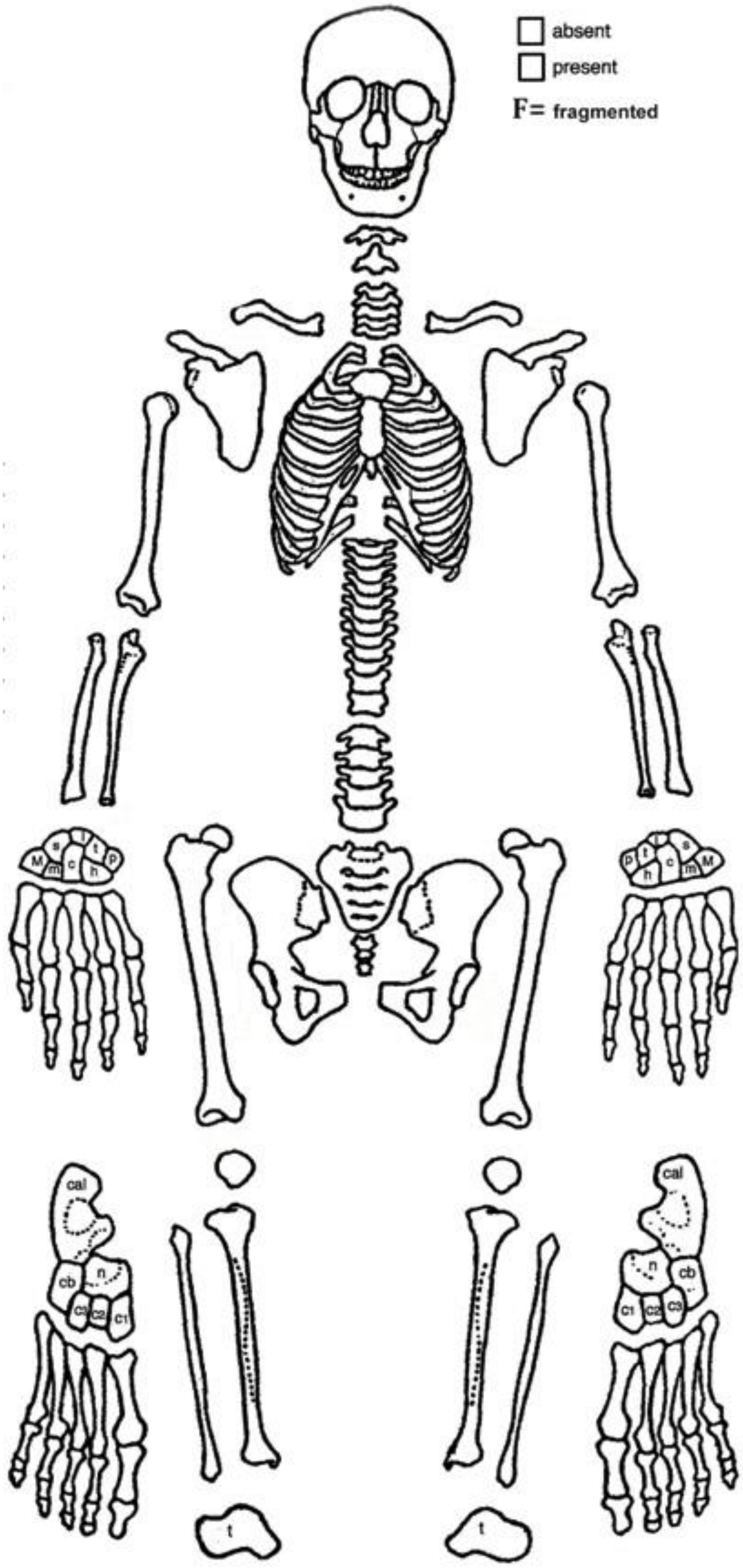
Gloucester 13/83 Skeletal Collection

LJMU Box number: ________________

Gloucester Skeleton Number_______________

Trench number: _________________

Notes -



SKELETAL INVENTORY AND ANTEMORTEM TRAUMA AND PATHOLOGY

If none but element present enter a number sign (1) in the box If element is missing enter symbol (0) in box.

Stage of condition: #.1 (Active), #.2 (Healing), #.3 (Healed)

Co	Trauma	Congenital	Joint disease	Infectious	Metabolic	Neoplastic
	10. Fracture	20. Dysplasia	30. Osteoarthritis	40.	50. Paget's	60. Osteoma
	11. Dislocation	21. Spina bifida	31. Ankylosing spondylitis	41. Periostitis	51. Cribra Orbitalia	69. Othe
	12. Amputation	22. Lumbarisation	32. Pseudoarthrosis	42. Tuberculosis	52. Porotic	
	19. Other	23.	33. Scoliosis	43. Leprosy	53.	
		24. Cleft palate	34. Kyphosis	44. Treponem	54. Rickets	
		25. Spondylolysis	35. Lordosis	49. Othe	59. Other Metabolic	
		29. Other	36. Schmorls Nodes			
			37. DISH			
			39. Other joint			

	Cranium
	Frontal
	L. Parietal
	R. Parietal
	Occipital
	L. Temporal
	R. Temporal
	L. Zygomatic
	R. Zygomatic
	L. Maxilla
	R. Maxilla
	L. Palatine
	R. Palatine
	L. Nasal
	R. Nasal
	L. Ethmoid
	R. Ethmoid
	L. Lacrimal
	R. Lacrimal
	Vomer
	Sphenoid

	Mandible
	R. Corpus
	L. Corpus
	R. Ramus
	L. Ramus

	Post-cranium
	Hyoid
	Manubrium
	Sternal Body
	Xiphoid
	Cervical 1
	Cervical 2
	Cervical 3
	Cervical 4
	Cervical 5
	Cervical 6
	Cervical 7
	Thoracic 1
	Thoracic 2
	Thoracic 3
	Thoracic 4
	Thoracic 5
	Thoracic 6
	Thoracic 7
	Thoracic 8
	Thoracic 9
	Thoracic 10
	Thoracic 11
	Thoracic 12
	Lumbar 1
	Lumbar 2
	Lumbar 3
	Lumbar 4
	Lumbar 5
	Sacrum
	Coccyx

Left		Right		
				Rib 1
				Rib 2
				Rib 3
				Rib 4
				Rib 5
				Rib 6
				Rib 7
				Rib 8
				Rib 9
				Rib 10
				Rib 11
				Rib 12

		Clavicle
		Scapula
		Humerus
		Ulna
		Radius
		Scaphoid
		Lunate
		Triquetral
		Pisiform
		Trapezium
		Trapezoid
		Capitate
		Hamate
		MTC 1
		MTC 2
		MTC 3
		MTC 4
		MTC 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Left	Right	
		Ilium
		Ischium
		Pubis
		Femur
		Patella
		Tibia
		Fibula
		Calcaneus
		Talus
		Navicular
		Cuboid
		Med. Cuneiform
		Mid. Cuneiform
		Lat. Cuneiform
		MTT 1
		MTT 2
		MTT 3
		MTT 4
		MTT 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Overall completeness (%): ___________

Dental inventory

Codes

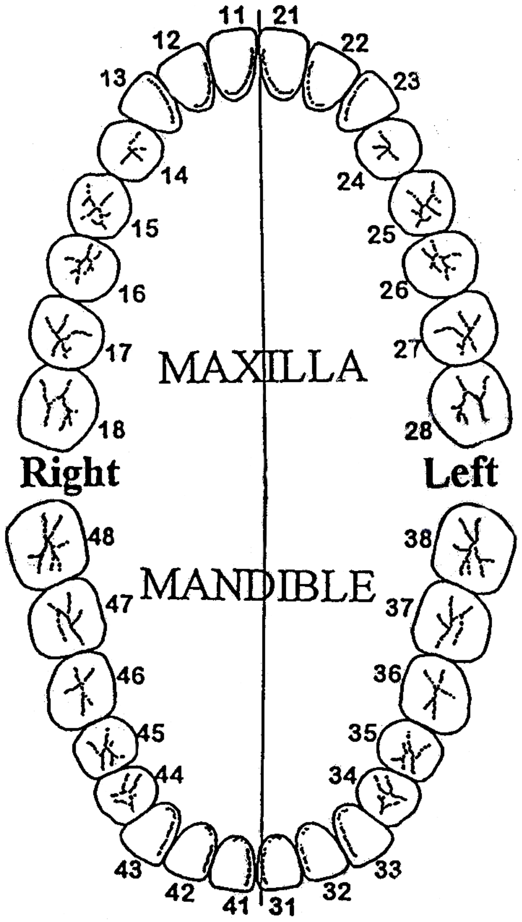
0 – Tooth present

/ - Postmortem tooth loose (PMTL)

Dental Pathology (if present) 1- Antemortem tooth loose (AMTL)

2 – Caries

3 - Calculous



Skeleton number	
Date	
Recorded by	
Checked by	
Loose teeth	
Additional notes	

Permanent Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
11						
12						
13						
14						
15						
16						
17						
18						
21						
22						
23						
24						
25						
26						
27						
28						
31						
32						
33						
34						
35						
36						
37						
38						
41						
42						
43						
44						
45						
46						
47						
48						

Biological profile assessment

Sex estimation

Non-metric traits

Bone	Trait	Female		Indeterminate	Male		Method
Innominate	Greater sciatic notch	1	2	3	4	5	Walker (2005)
	Preauricular sulcus	Present			Absent		Bruzek (2002)
	Sub-pubic concavity	1	2	3	4	5	Klales *et al.* (2012) Phenice (1969)
	Medial aspect of the i-p ramus	1	2	3	4	5	Klales *et al.* (2012) Phenice (1969)
	Ventral Arc	1	2	3	4	5	Klales *et al.* (2012) Phenice (1969)
	Subpubic angle	Wide		Intermediate	Narrow		Ferembach *et al.* (1980) Bass (2005)
Sacrum	Curvature	Straight		Intermediate	Curved		Bass (2005)
Cranium	Supra-orbital Ridge	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Supra-orbital Margin	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Mastoid Process	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Nuchal Crest	1	2	3	4	5	Buikstra and Ubelaker (1994)
Mandible	Mental Eminence	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Gonial Angle	>124°		Intermediate	<125°		Buikstra and Ubelaker (1994)
	Mental aversion	Absent		Intermediate	Present		Buikstra and Ubelaker (1994)

Sex:

Metric measurements:

Bone	Trait	Female	Intermediate	Male	Method
Humerus	Vertical head diameter	<43mm	43-47mm	>47mm	Stewart (1979) Bass (2005)
Scapula	Glenoid fossa height	<34mm	34-36mm	>36mm	Parsons(1914)
Radius	Radial head	<21mm	22-23mm	>24mm	Berrizbeitia (1995)
Femur	Femoral head	<43.5mm	43.5-46.5mm	>46.5mm	Stewart (1979)
	Bicondylar Width	<74mm	74-76mm	>76mm	Parsons(1914)

Sex:

FINAL SEX ESTIMATION:

Age estimation:

Bone	**Trait**	**Side**	**Description**	**Phase**	**Age range**	**Method**
Rib	**Sternal Rib end**					Iscan *et al.* (1984) M Iscan *et al.* (1985) F
Innominate	**Auricular Surface**	Left				Lovejoy *et al.* (1985)
		Right				Lovejoy *et al.* (1985)
	Pubic symphysis	Left				Suchey-Brookes
		Right				
Clavicle	**Medial clavicle**	Left				Webb and Suchey (1985) Scheuer *et al.* (2000)
		Right				Webb and Suchey (1985) Scheuer *et al.* (2000)
Illium	**Anterior illiac Crest**	Left				Webb and Suchey (1985)
		Right				Webb and Suchey (1985)
Maxilla	**Dental Attrition**	Left				Lovejoy (1985)
Mandible	**Dental Attrition**	Right				Lovejoy (1985)

Cranial suture scoring:

	Suture site							**Composite Score**
Vault	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Lateral- anterior	**6**	**7**	**8**	**9**	**10**			
Palatal	**11**	**12**	**13**	**14**				
Endocranial	**15**	**16**	**17**					

Age range:

FINAL AGE ESTIMATION:

Stature estimation

Bone	**Side**	**Maximum Length (cm)**	**Formula**	**Minimum (cm)**	**Maximum (cm)**	**Method**
Humerus						Trotter (1970)
Radius						Trotter (1970)
Ulna						Trotter (1970)
Femur						Trotter (1970)
Tibia						Trotter (1970)
Fibula						Trotter (1970)

FINAL STATURE ESTIMATION:

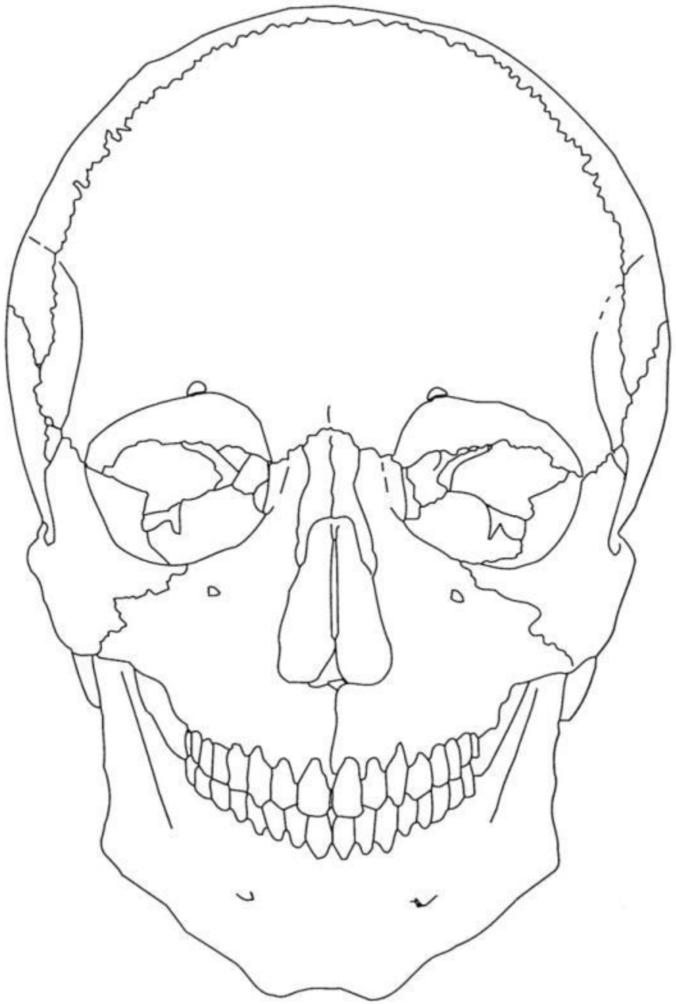
13/83 Gloucester Skeletal Collection

Adult Skull Diagrams

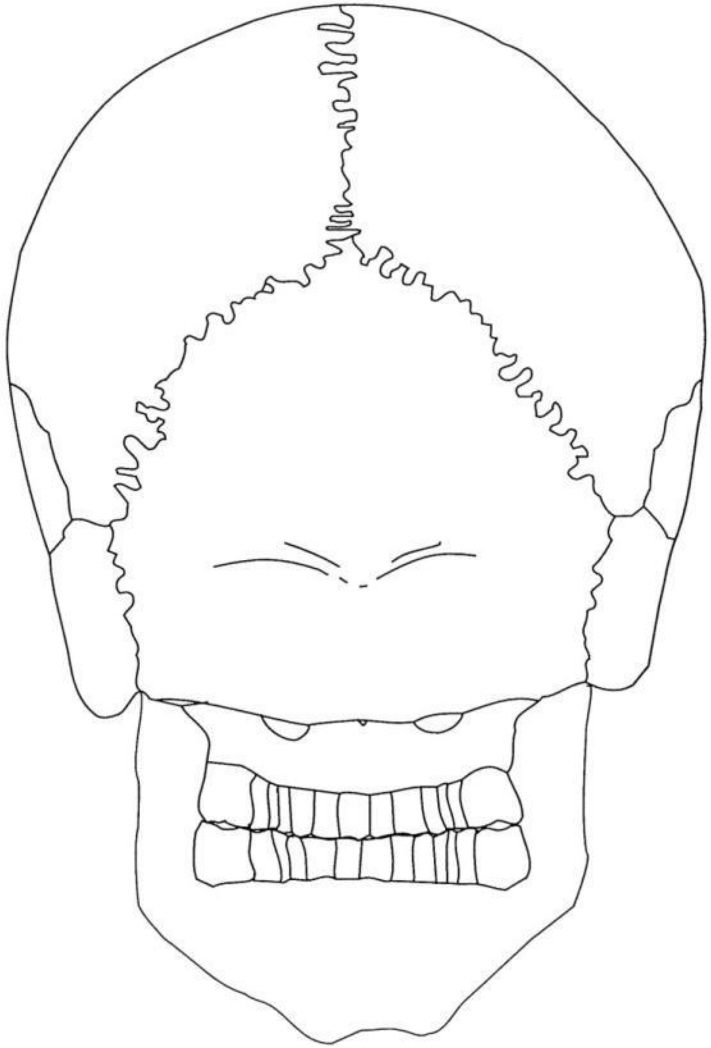
LJMU Box Number	
Gloucester Skele. Number	
Trench Number	
Date	
Preservation	
Age	
Sex	
Non metric traits/ pathology	
Additional notes	

Gloucester 13/83 Skeletal Collection **LJMU BOX NUMBER: GLA-_______________**

Gloucester Skeleton Number:



ANTERIOR VIEW



POSTERIOR VIEW

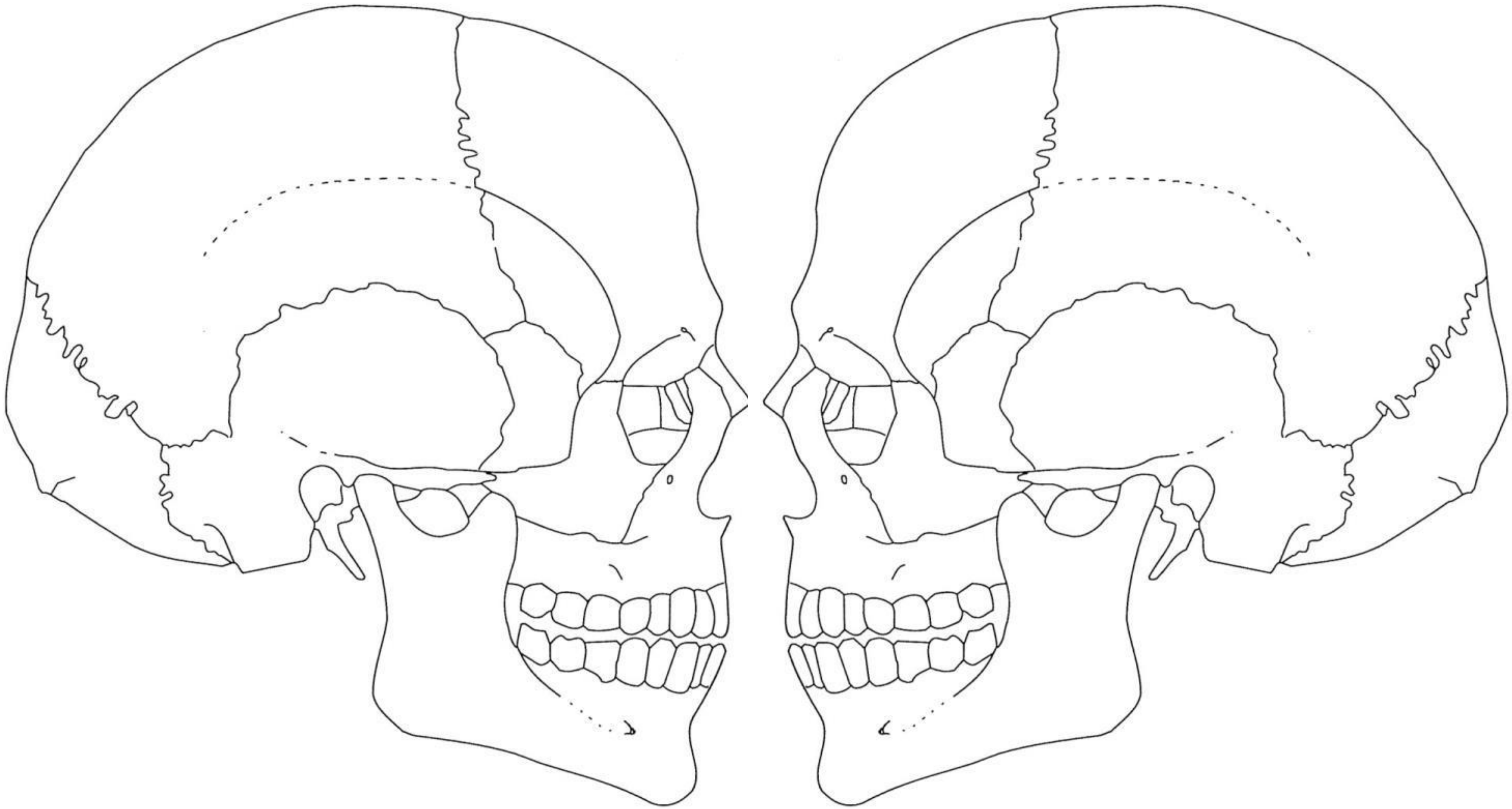
Recorded by: __________________________________

Date: ________________________

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-________________

Gloucester Skeleton Number:



RIGHT LATERAL VIEW

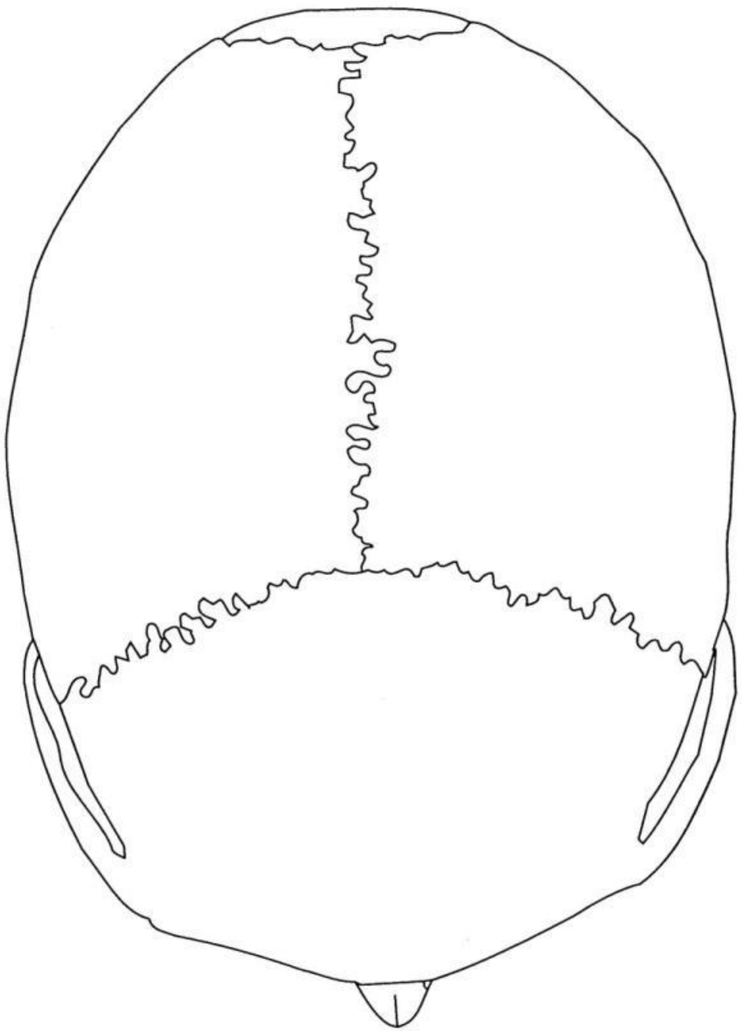
LEFT LATERAL VIEW

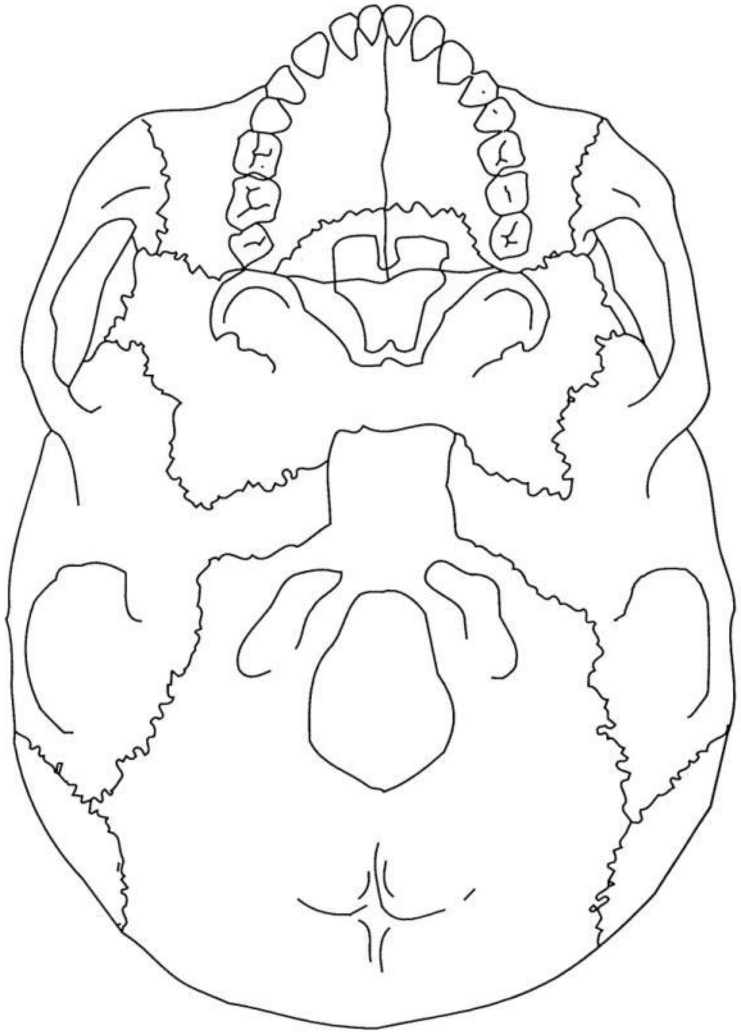
Recorded by: ____________________________________

Date: ________________________

Gloucester 13/83 Skeletal Collection **LJMU BOX NUMBER: GLA-**

Gloucester Skeleton Number:





SUPERIOR VIEW **INFERIOR VIEW**

Recorded by: ______________________ **Date:** ______________

Gloucester 13/83 Skeletal Collection **LJMU BOX NUMBER: GLA-**

Gloucester Skeleton Number:

SKELETAL INVENTORY AND ANTEMORTEM TRAUMA AND PATHOLOGY

If none but element present enter a number sign (1) in the box If element is missing enter symbol (0) in box.

Codes	Trauma	Congenital	Joint disease	Infectious	Metabolic	Neoplastic
	10. Fracture	20. Dysplasia	30. Osteoarthritis	40. Osteomyeliti	50. Paget's Disease	60. Osteoma
	11. Dislocation	21. Spina bifida	31. Ankylosing spondylitis	41. Periostitis	51. Cribra Orbitalia	69. Other neoplasm
	12. Amputation	22. Lumbarisation	32. Pseudoarthrosis	42. Tuberculosis	52. Porotic hyperostosis	
	19. Other Traum	23. Sacralisation	33. Scoliosis	43. Leprosy	53. Osteoporosis	
		24. Cleft palate	34. Kyphosis	44. Treponemal disease	59. Other Metabolic	
		25. Spondylolysis	35. Lordosis	49. Other Infectious		
		29. Other congenital	36. Schmorls Nodes			
			37. DISH			
			39. Other joint disease			

Stage of condition: #.1 (Active), #.2 (Healing), #.3 (Healed)

	Cranium
	Frontal
	L. Parietal
	R. Parietal
	Occipital
	L. Temporal
	R. Temporal
	L. Zygomatic
	R. Zygomatic
	L. Maxilla
	R. Maxilla
	L. Palatine
	R. Palatine
	L. Nasal
	R. Nasal
	L. Ethmoid
	R. Ethmoid
	L. Lacrimal
	R. Lacrimal
	Vomer
	Sphenoid

	Mandible
	R. Corpus
	L. Corpus
	R. Ramus
	L. Ramus

	Post-cranium
	Hyoid
	Manubrium
	Sternal Body
	Xiphoid
	Cervical 1
	Cervical 2
	Cervical 3
	Cervical 4
	Cervical 5
	Cervical 6
	Cervical 7
	Thoracic 1
	Thoracic 2
	Thoracic 3
	Thoracic 4
	Thoracic 5
	Thoracic 6
	Thoracic 7
	Thoracic 8
	Thoracic 9
	Thoracic 10
	Thoracic 11
	Thoracic 12
	Lumbar 1
	Lumbar 2
	Lumbar 3
	Lumbar 4
	Lumbar 5
	Sacrum
	Coccyx

Left		Right		
				Rib 1
				Rib 2
				Rib 3
				Rib 4
				Rib 5
				Rib 6
				Rib 7
				Rib 8
				Rib 9
				Rib 10
				Rib 11
				Rib 12

		Clavicle
		Scapula
		Humerus
		Ulna
		Radius
		Scaphoid
		Lunate
		Triquetral
		Pisiform
		Trapezium
		Trapezoid
		Capitate
		Hamate
		MTC 1
		MTC 2
		MTC 3
		MTC 4
		MTC 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Left	Right	
		Ilium
		Ischium
		Pubis
		Femur
		Patella
		Tibia
		Fibula
		Calcaneus
		Talus
		Navicular
		Cuboid
		Med. Cuneiform
		Mid. Cuneiform
		Lat. Cuneiform
		MTT 1
		MTT 2
		MTT 3
		MTT 4
		MTT 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Overall completeness (%): ____________

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

Dental inventory

Codes

0 – Tooth present

/ - Postmortem tooth loose (PMTL)

Dental Pathology (if present)

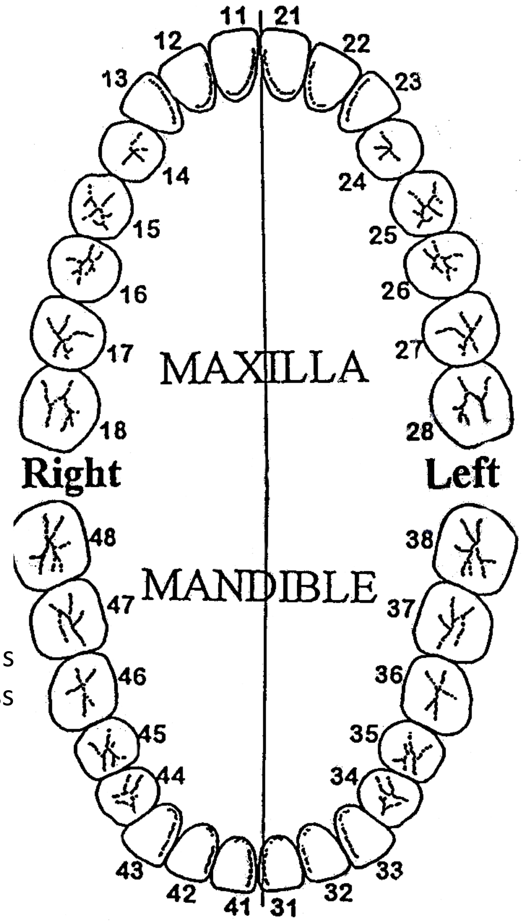
1- Antemortem tooth loose (AMTL)

2 – Caries

3 - Calculous

4 – Abscess

5 – Liner enamel hypoplasia (LEH)



Skeleton number	
Date	
Recorded by	
Checked by	
Loose teeth	
Additional notes	

Recorded by: ______________________

Date: ______

Gloucester 13/83 Skeletal Collection LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

Permanent Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 AMTL = 1 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
11						
12						
13						
14						
15						
16						
17						
18						
21						
22						
23						
24						
25						
26						
27						
28						
31						
32						
33						
34						
35						
36						
37						
38						
41						
42						
43						
44						
45						
46						
47						
48						

Recorded by: ______________________ **Date:** ______________________

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-______________

Gloucester Skeleton Number:

Biological profile assessment

Sex estimation

Non-metric traits

Bone	Trait	Female		Indeterminate	Male		Method
Cranium	Supra-orbital Ridge	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Supra-orbital Margin	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Mastoid Process	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Nuchal Crest	1	2	3	4	5	Buikstra and Ubelaker (1994)
Mandible	Mental Eminence	1	2	3	4	5	Buikstra and Ubelaker (1994)
	Gonial Angle	>124°		Intermediate	<125°		Buikstra and Ubelaker (1994)
	Mental aversion	Absent		Intermediate	Present		Buikstra and Ubelaker (1994)

Sex:

FINAL SEX ESTIMATION:

Age estimation:

Cranial suture scoring:

	Suture site							Composite Score
Vault	1	2	3	4	5	6	7	
Lateral- anterior	6	7	8	9	10			
Palatal	11	12	13	14				
Endocranial	15	16	17					

Age range:

Dental Attrition:

Bone	Trait	Description	Phase	Age range	Method
Maxilla	Dental Attrition				Lovejoy (1985)
Mandible	Dental Attrition				Lovejoy (1985)

FINAL AGE ESTIMATION:

Recorded by: ____________________ **Date:** ____________________

13/83 Gloucester Skeletal Collection

Gloucester Skeleton Summary Form –Subadult

Skeleton Number	
GLC Box Number	
Date	
Preservation	
MNI	
Age	
Non metric traits/ pathology	
Additional notes	

Sharon Martin

LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

Gloucester 13/83 Skeletal Collection

Subadult Skeletal Diagram

LJMU Box number:

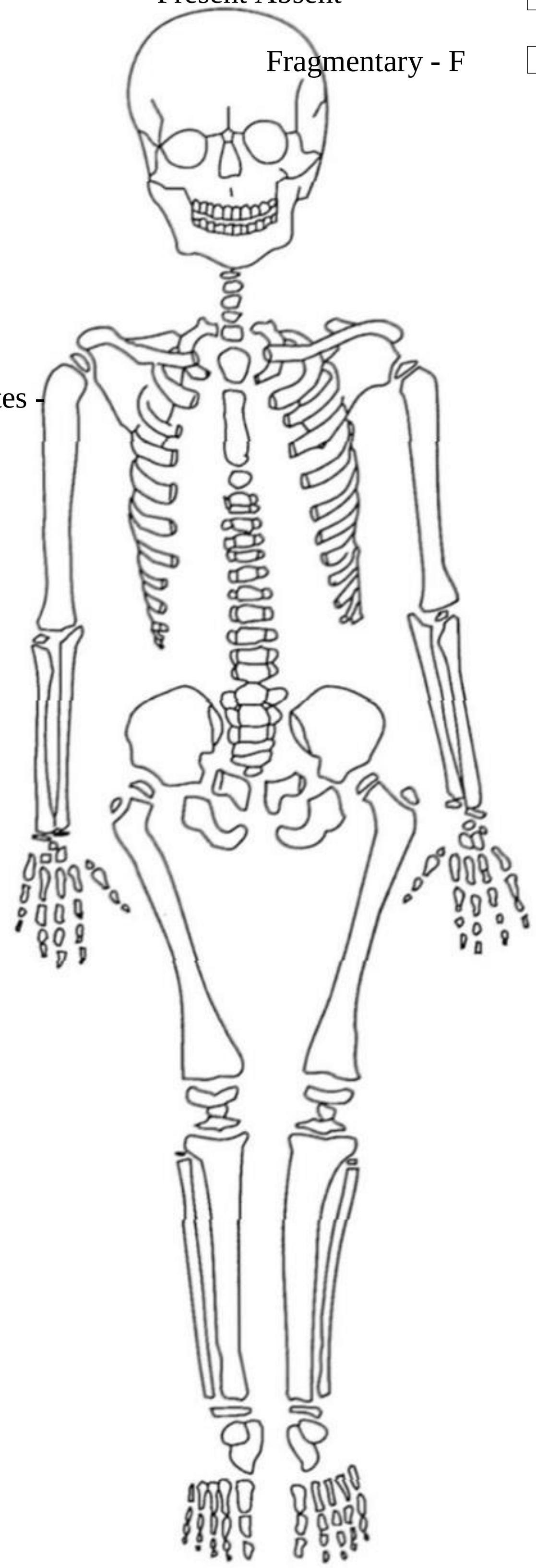
Gloucester Skeleton Number: _ Trench number:

Recorder: Sharon Martin Date :

Present Absent

Fragmentary - F

Notes -



Recorded by: **Date:**

Gloucester 13/83 Skeletal Collection **LJMU BOX NUMBER: GLA-**

Gloucester Skeleton Number:

SKELETAL INVENTORY AND ANTEMORTEM TRAUMA AND PATHOLOGY

If none but element present enter a number sign (1) in the box If element is missing enter symbol (0) in box.

Stage of condition: #.1 (Active), #.2 (Healing), #.3 (Healed)

Codes	Trauma	Congenital	Joint disease	Infectious	Metabolic	Neoplastic
	10. Fracture	20. Dysplasia	30. Osteoarthritis	40. Osteomyelitis	50. Paget's Disease	60. Osteoma
	11. Dislocation	21. Spina bifida	31. Ankylosing spondylitis	41. Periostitis	51. Cribra Orbitalia	69. Other neoplasm
	12. Amputation	22. Lumbarisation	32. Pseudoarthrosis	42. Tuberculosis	52. Porotic hyperostosis	
	19. Other Trauma	23. Sacralisation	33. Scoliosis	43. Leprosy	53. Osteoporosis	
		24. Cleft palate	34. Kyphosis	44. Treponemal disease	59. Other Metabolic	
		25. Spondylolysis	35. Lordosis	49. Other Infectious		
		29. Other congenital	36. Schmorls Nodes			
			37. DISH			
			39. Other joint disease			

	Cranium
	Frontal
	L. Parietal
	R. Parietal
	Occipital
	L. Temporal
	R. Temporal
	L. Zygomatic
	R. Zygomatic
	L. Maxilla
	R. Maxilla
	L. Palatine
	R. Palatine
	L. Nasal
	R. Nasal
	L. Ethmoid
	R. Ethmoid
	L. Lacrimal
	R. Lacrimal
	Vomer
	Sphenoid

	Mandible
	R. Corpus
	L. Corpus
	R. Ramus
	L. Ramus

	Post-cranium
	Hyoid
	Manubrium
	Sternal Body
	Xiphoid
	Cervical 1
	Cervical 2
	Cervical 3
	Cervical 4
	Cervical 5
	Cervical 6
	Cervical 7
	Thoracic 1
	Thoracic 2
	Thoracic 3
	Thoracic 4
	Thoracic 5
	Thoracic 6
	Thoracic 7
	Thoracic 8
	Thoracic 9
	Thoracic 10
	Thoracic 11
	Thoracic 12
	Lumbar 1
	Lumbar 2
	Lumbar 3
	Lumbar 4
	Lumbar 5
	Sacrum
	Coccyx

Left		Right		
				Rib 1
				Rib 2
				Rib 3
				Rib 4
				Rib 5
				Rib 6
				Rib 7
				Rib 8
				Rib 9
				Rib 10
				Rib 11
				Rib 12

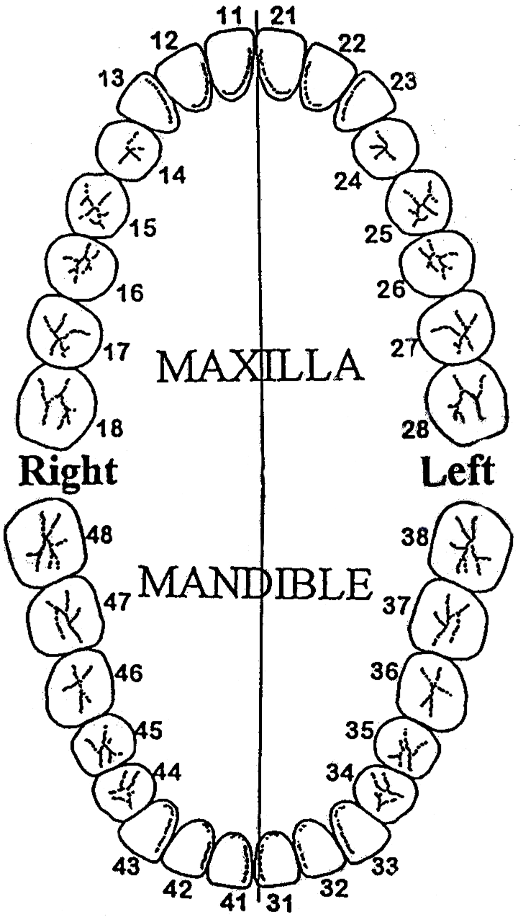
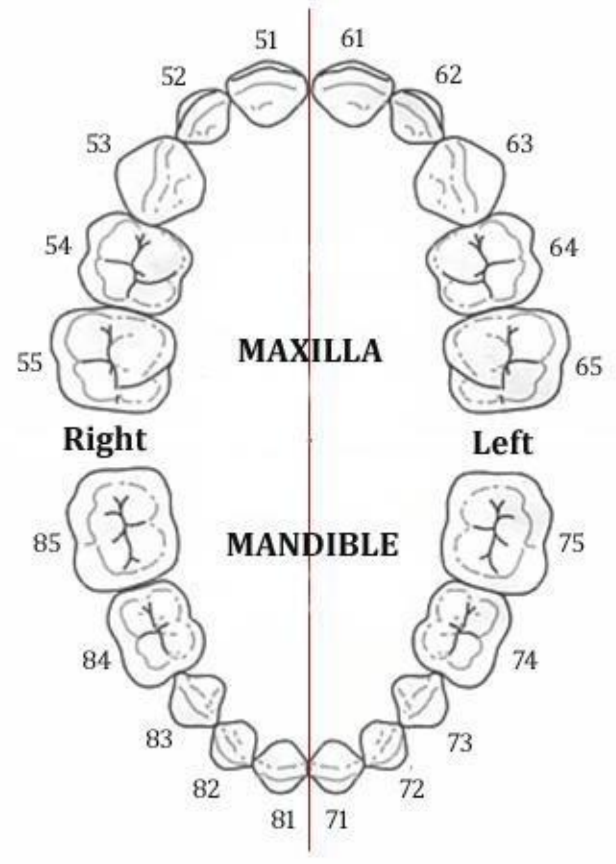
		Clavicle
		Scapula
		Humerus
		Ulna
		Radius
		Scaphoid
		Lunate
		Triquetral
		Pisiform
		Trapezium
		Trapezoid
		Capitate
		Hamate
		MTC 1
		MTC 2
		MTC 3
		MTC 4
		MTC 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Overall completeness (%)

Left	Right	
		Ilium
		Ischium
		Pubis
		Femur
		Patella
		Tibia
		Fibula
		Calcaneus
		Talus
		Navicular
		Cuboid
		Med. Cuneiform
		Mid. Cuneiform
		Lat. Cuneiform
		MTT 1
		MTT 2
		MTT 3
		MTT 4
		MTT 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Recorded by: **Date:**

Subadult Dental information

Adult	Subadult
	

Codes

0 – Tooth present

/ - Postmortem tooth loose (PMTL)

Dental Pathology (if present)

1- Antemortem tooth loose (AMTL) 2 – Caries

3- Calculous

4– Abscess

5– Liner enamel hypoplasia (LEH)

LJMU Box number	GLA-
Gloucester Skeleton Number	
Trench Number	
Date	
Recorded by	Sharon Martin
Loose teeth	
Additional notes	

Recorded by: ______________________ **Date:** __________

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

Permanent Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
11						
12						
13						
14						
15						
16						
17						
18						
21						
22						
23						
24						
25						
26						
27						
28						
31						
32						
33						
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35						
36						
37						
38						
41						
42						
43						
44						
45						
46						
47						
48						

Recorded by: ______________________ **Date:** __________

Gloucester 13/83 Skeletal Collection LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

Deciduous Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
51						
52						
53						
54						
55						
61						
62						
63						
64						
65						
71						
72						
73						
74						
75						
81						
82						
83						
84						
85						

Recorded by: ______________________ **Date:** __________

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:

AGE ESTIMATION:

Epiphyseal Closure (Schaefer *et al.* , 2009)

1. No union

2. Partial union

3. complete union

4. Not Examined 5=absent

	SCORE		SCORE
Pars lateralis-pars squama		Iliac crest	
Lateralis-squama-basilaris		Proximal Humerus	
Basilar Suture		Distal Humerus	
Cervical Vertebrae Body-Arch		Proximal Ulna	
Cervical Vertebral Rim		Distal Ulna	
Thoracic Vertebrae Body-Arch		Proximal Radius	
Thoracic Vertebral Rim		Distal Radius	
Lumbar Vertebrae Body-Arch		Distal MTC's	
Lumbar Vertebral Rim		Proximal Femur	
Sacral Segments 1-2		Distal Femur	
Sacral Segments 2-3		Proximal Tibia	
Sacral Segments 3-4		Distal Tibia	
Ischium-Pubis		Proximal Fibula	
Ischium-Pubis-Ilium		Distal Fibula	
Ischial Tuberosity		Distal MTT's	

AGE ESTIMATION (RANGE) ______________________________

Skeletal Measurements (Schaefer *et al.* , 2009)

Element Measured	Measurement (mm)	Age Range

AGE ESTIMATION (RANGE) ______________________________

FINAL AGE ESTIMATION:

Recorded by: ______________________________ **Date:** ______________

13/83 Gloucester Skeletal Collection

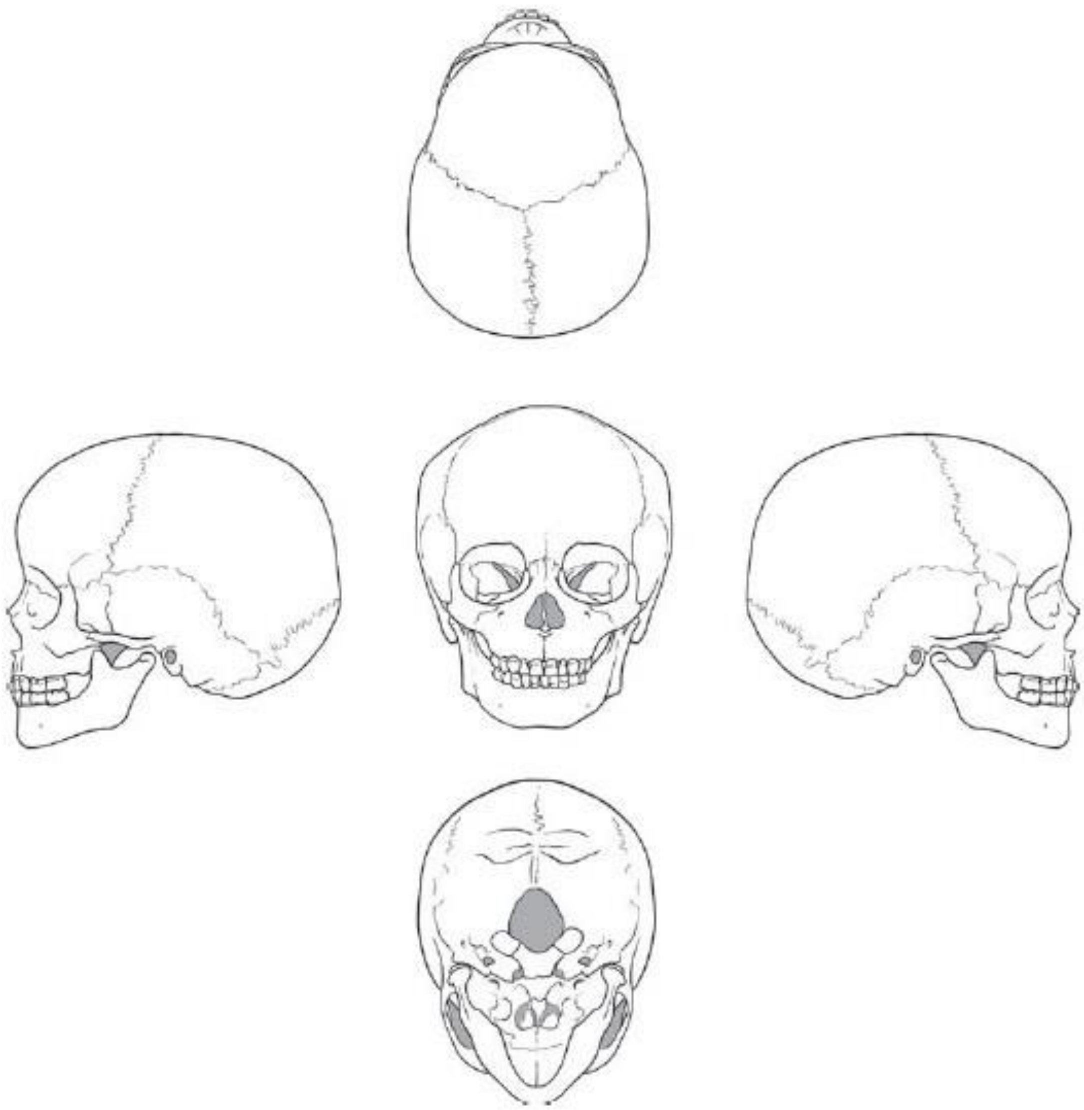
Subadult Skull Diagrams

LJMU Box number	GLA-
Gloucester Skeleton Number	
Trench Number	
Date	
Recorded by	Sharon Martin
Estimated completeness (%)	
Pathologies	
Additional notes	

Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-

Gloucester Skeleton Number:_______________



Gloucester 13/83 Skeletal Collection

LJMU BOX NUMBER: GLA-
Gloucester Skeleton Number:_______________

SKELETAL INVENTORY AND ANTEMORTEM TRAUMA AND PATHOLOGY

If none but element present enter a number sign (1) in the box If element is missing enter symbol (0) in box.
Stage of condition: #.1 (Active), #.2 (Healing), #.3 (Healed)

Codes	Trauma	Congenital	Joint disease	Infectious	Metabolic	Neoplastic
	10. Fracture	20. Dysplasia	30. Osteoarthritis	40. Osteomyeliti	50. Paget's Disease	60. Osteoma
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	12. Amputation	22. Lumbarisation	32. Pseudoarthrosis	42. Tuberculosis	52. Porotic hyperostosis	
	19. Other Traum	23. Sacralisation	33. Scoliosis	43. Leprosy	53. Osteoporosis	
		24. Cleft palate	34. Kyphosis	44. Treponemal disease	59. Other Metabolic	
		25. Spondylolysis	35. Lordosis	49. Other Infectious		
		29. Other congenital	36. Schmorls Nodes			
			37. DISH			
			39. Other joint disease			

	Cranium
	Frontal
	L. Parietal
	R. Parietal
	Occipital
	L. Temporal
	R. Temporal
	L. Zygomatic
	R. Zygomatic
	L. Maxilla
	R. Maxilla
	L. Palatine
	R. Palatine
	L. Nasal
	R. Nasal
	L. Ethmoid
	R. Ethmoid
	L. Lacrimal
	R. Lacrimal
	Vomer
	Sphenoid

	Mandible
	R. Corpus
	L. Corpus
	R. Ramus
	L. Ramus

	Post-cranium
	Hyoid
	Manubrium
	Sternal Body
	Xiphoid
	Cervical 1
	Cervical 2
	Cervical 3
	Cervical 4
	Cervical 5
	Cervical 6
	Cervical 7
	Thoracic 1
	Thoracic 2
	Thoracic 3
	Thoracic 4
	Thoracic 5
	Thoracic 6
	Thoracic 7
	Thoracic 8
	Thoracic 9
	Thoracic 10
	Thoracic 11
	Thoracic 12
	Lumbar 1
	Lumbar 2
	Lumbar 3
	Lumbar 4
	Lumbar 5
	Sacrum
	Coccyx

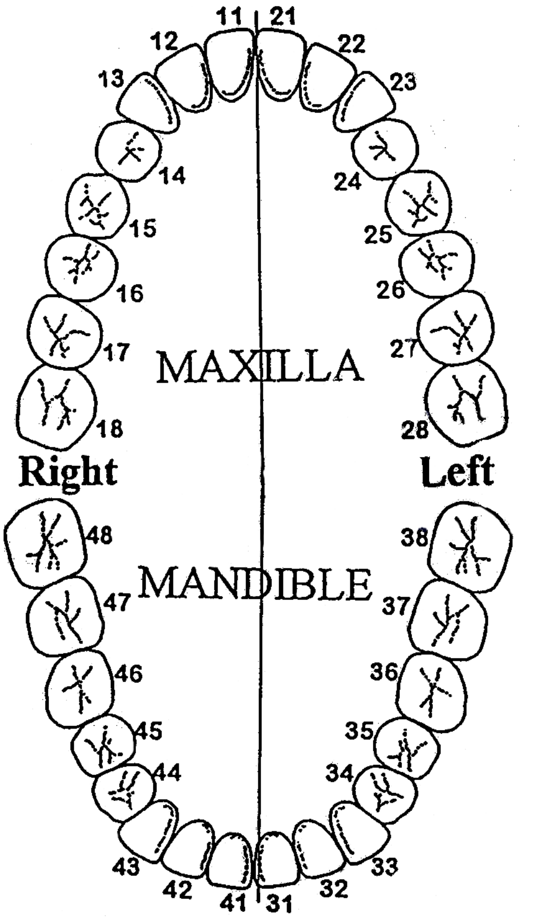
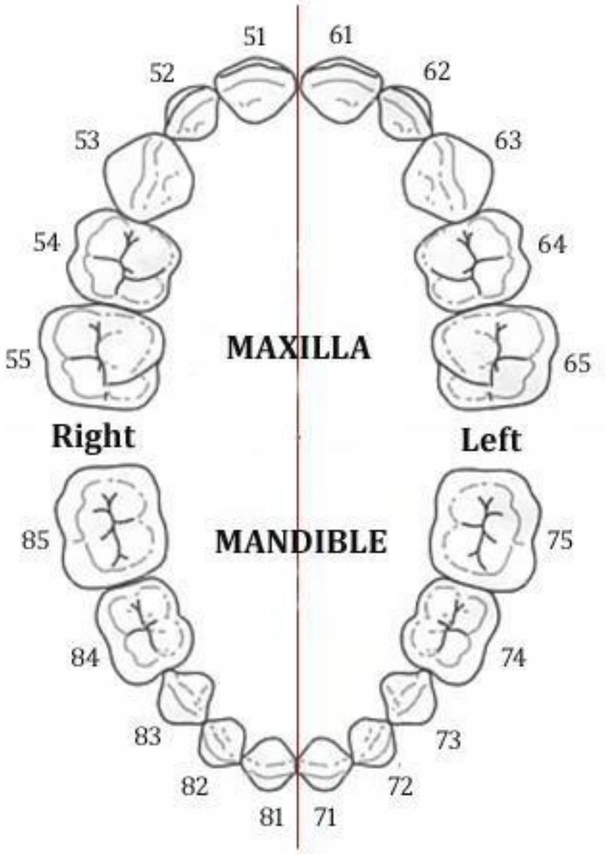
Left		Right		
				Rib 1
				Rib 2
				Rib 3
				Rib 4
				Rib 5
				Rib 6
				Rib 7
				Rib 8
				Rib 9
				Rib 10
				Rib 11
				Rib 12

		Clavicle
		Scapula
		Humerus
		Ulna
		Radius
		Scaphoid
		Lunate
		Triquetral
		Pisiform
		Trapezium
		Trapezoid
		Capitate
		Hamate
		MTC 1
		MTC 2
		MTC 3
		MTC 4
		MTC 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Left	Right	
		Ilium
		Ischium
		Pubis
		Femur
		Patella
		Tibia
		Fibula
		Calcaneus
		Talus
		Navicular
		Cuboid
		Med. Cuneiform
		Mid. Cuneiform
		Lat. Cuneiform
		MTT 1
		MTT 2
		MTT 3
		MTT 4
		MTT 5
		Prox. Ph's
		Middle Ph's
		Distal Ph's

Overall completeness (%): _______________

Subadult Dental information

Adult	Subadult
	

Codes

0 – Tooth present

/ - Postmortem tooth loose (PMTL)

Dental Pathology (if present)

1- Antemortem tooth loose (AMTL) 2 – Caries

3- Calculous

4– Abscess

5– Liner enamel hypoplasia (LEH)

LJMU Box number	GLA-
Gloucester Skeleton Number	
Trench Number	
Date	
Recorded by	Sharon Martin
Loose teeth	
Additional notes	

Recorded by: ___________________________________ **Date:** ______________

Gloucester 13/83 Skeletal Collection **LJMU BOX NUMBER: GLA-**
Gloucester Skeleton Number:________________

Permanent Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
11						
12						
13						
14						
15						
16						
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18						
21						
22						
23						
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43						
44						
45						
46						
47						
48						

Recorded by: ____ **Date:** ______________

Deciduous Dentition

	Dental Inventory/ Pathology Codes (tick if present)					
Tooth number	Present=0 PMTL = /	AMTL = 1	Caries = 2	Calculus = 3	Abscess = 4	LEH = 5
51						
52						
53						
54						
55						
61						
62						
63						
64						
65						
71						
72						
73						
74						
75						
81						
82						
83						
84						
85						

Appendix 3:

Examples from Gloucester City Museum excavation records

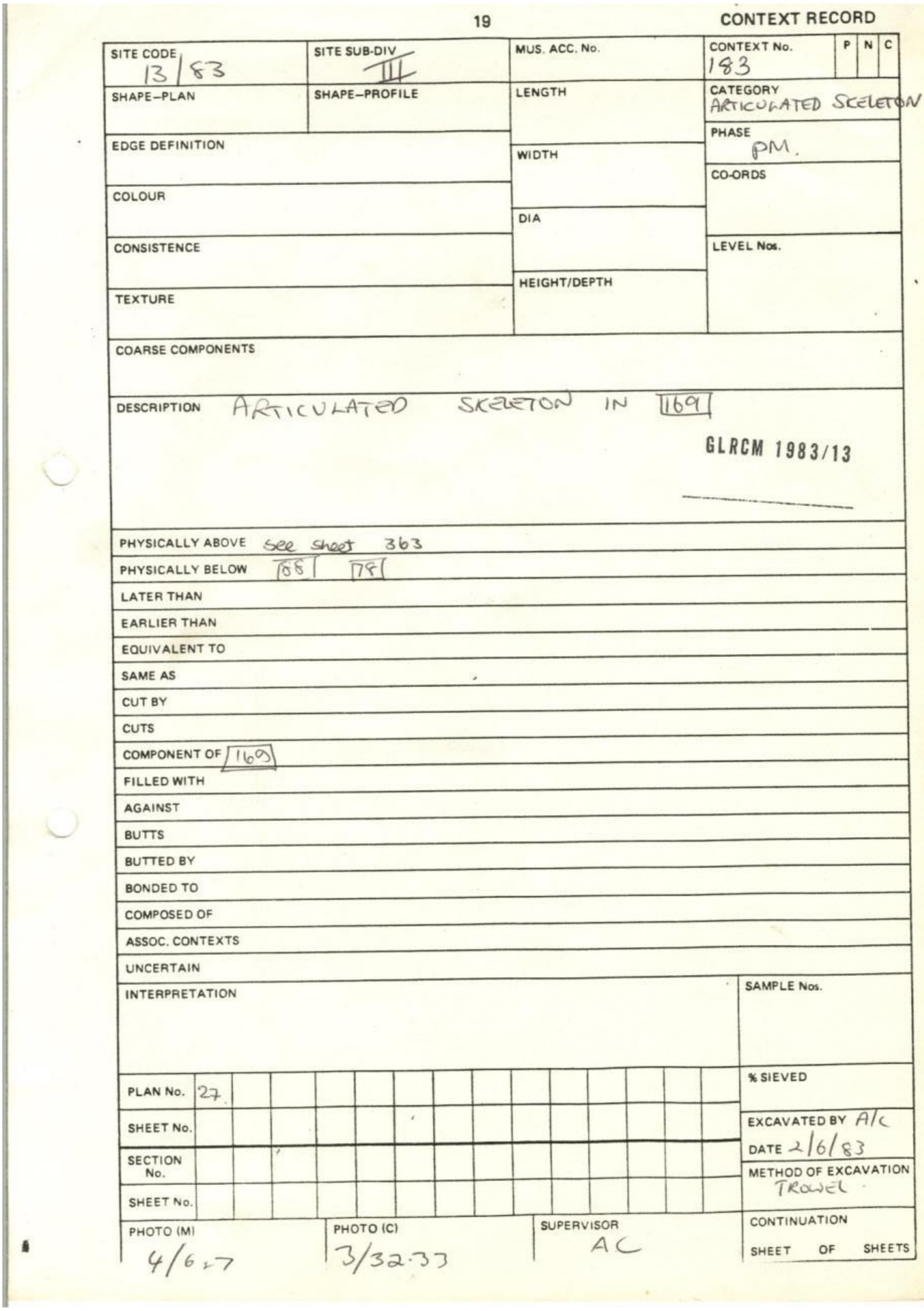
Example of 13/83 Context Register

Contexts 199-232

	TYPE	PLAN	TRENCH	SECTION	PHASE	TAKEN BY	DATE
199	SKELETON		III		PM.	SM SJ.	7/6/83.
200	SKELETON	35	III		PM.	NH SJ	7/6/83.
201	SKELETON	34.	III		PM.	SJ NH AC	7/6/83
202	FILL		II		XI b	MP	8.6.83
203	FILL		II		XI b	MP.	8.6.83
204	SKULL		III		PM.	MP.	8.6.83
205	Brick feature ~~SKULL~~	33.	I		XI c.	VY. ~~[illegible]~~	8/6/83. ~~[illegible]~~
206	Skeleton		II		XI b		
207	Skeleton		II		XI b		
208	Skeleton.		II		XI b		
209	Layer.		III		PM.	AC.	8/6/83.
210	Layer		I		X c.	PJI.	
211	Floor.	17	I		II	BTW.	
212	Skeleton. ~~Skull~~		III		PM.	MP.	9.6.83
213	Fill.	17	I		XI a.	BTW	9/6/83
214	Layer.		I		X c.	NST.	
215	Layer.		I		X c.	NST.	
216	Grave cut/fill.		II		XI b	MP.	
217	Grave cut/fill.		II		XI b	DR.	9/6/83
218	Disturbed burial		II		XI b		
219	Layer.	17	I		XI a.	BTW	9/6/83.
220	Grave cut/fill.		III		PM.		9/6/83.
221	Layer	~~[illegible]~~	II		XI a	MP	
222	Cut/fill.		II		XI b	Jacqui	9/6/83
223	Grave cut/fill.		III		PM.		
224	Skeleton.		II		XI b		
225	Coffin fittings		II		XI b	~~[illegible]~~	
226	Layer.		I		X c.	VY	
227	Skeleton.		II		XI b	MP.	
228	Skeleton		II		XI b	Tony & Sharon	10/6/83.
229	Cut/fill (grave)		II		XI b		
230	Skeleton.		III		M?	AC	10/6/83.
231	Cut/fill (grave)		III		M?	AC.	10/6/83
232	Layer.		I		X c.	VY	10/6/83.

Example of 13/83 Skeleton Context Sheet

Skeleton Context sheet for III183



19

CONTEXT RECORD

SITE CODE 13/83	SITE SUB-DIV III	MUS. ACC. No.	CONTEXT No. 183 (P N C)
SHAPE–PLAN	SHAPE–PROFILE	LENGTH	CATEGORY ARTICULATED SKELETON
EDGE DEFINITION		WIDTH	PHASE PM.
COLOUR		DIA	CO-ORDS
CONSISTENCE		HEIGHT/DEPTH	LEVEL Nos.
TEXTURE			

COARSE COMPONENTS

DESCRIPTION ARTICULATED SKELETON IN 169

GLRCM 1983/13

PHYSICALLY ABOVE See sheet 363

PHYSICALLY BELOW 188 178

LATER THAN

EARLIER THAN

EQUIVALENT TO

SAME AS

CUT BY

CUTS

COMPONENT OF 169

FILLED WITH

AGAINST

BUTTS

BUTTED BY

BONDED TO

COMPOSED OF

ASSOC. CONTEXTS

UNCERTAIN

INTERPRETATION

SAMPLE Nos.

PLAN No. 27

SHEET No.

SECTION No.

SHEET No.

% SIEVED

EXCAVATED BY A/C

DATE 2/6/83

METHOD OF EXCAVATION TROWEL

PHOTO (M)	PHOTO (C)	SUPERVISOR	CONTINUATION
4/6,7	3/32.33	AC	SHEET OF SHEETS

Skeleton context sheet for III322 (missing post-crania from LJMU skeletal material).

19

CONTEXT RECORD

SITE CODE: 13/83
SITE SUB-DIV: III
MUS. ACC. No.:
CONTEXT No.: 322 (P | N | C)

SHAPE–PLAN:
SHAPE–PROFILE:
LENGTH:
CATEGORY: BURIAL

PHASE: PM

EDGE DEFINITION:
WIDTH:
CO-ORDS:

COLOUR: GLRCM 1983/13

DIA:

CONSISTENCE: ————————

LEVEL Nos.:

HEIGHT/DEPTH:

TEXTURE:

COARSE COMPONENTS:

DESCRIPTION:
Human skeleton at west end of trench – to south of centre. In (308) Some bones removed during excavation

PHYSICALLY ABOVE:
PHYSICALLY BELOW: 308
LATER THAN:
EARLIER THAN:
EQUIVALENT TO:
SAME AS:
CUT BY: 308
CUTS:
COMPONENT OF: 308
FILLED WITH:
AGAINST:
BUTTS:
BUTTED BY:
BONDED TO:
COMPOSED OF:
ASSOC. CONTEXTS:
UNCERTAIN:

INTERPRETATION:
Skeleton (Human)

SAMPLE Nos.:

% SIEVED:

PLAN No.: 70
SHEET No.:
SECTION No.:
SHEET No.:

EXCAVATED BY: AC SJ
DATE: 22/6/83

METHOD OF EXCAVATION: TROWEL

PHOTO (M): 8/9-10
PHOTO (C): 7/A-20
SUPERVISOR:

CONTINUATION
SHEET OF SHEETS

Fill-context sheet for skeleton III183

19

CONTEXT RECORD

SITE CODE 13/83	SITE SUB-DIV III	MUS. ACC. No.	CONTEXT No. 169 (P N C)
SHAPE–PLAN	SHAPE–PROFILE	LENGTH 2.5M.	CATEGORY CUT/FILL (GRAVE?)
EDGE DEFINITION CLEAR		WIDTH 55 cm	PHASE PM
COLOUR BLACK.		DIA	CO-ORDS
CONSISTENCE GLRCM 1983/13		HEIGHT/DEPTH	LEVEL Nos. See plan 19
TEXTURE			

COARSE COMPONENTS LOOSE BLACK SOIL / POTTERY / CHALK.

DESCRIPTION EAST END OF TRENCH.
Grave containing skeleton 183

GLRCM 1983/13

PHYSICALLY ABOVE 310/325/329/342/343/346/347/351/352/358/359/389

PHYSICALLY BELOW 78 88

LATER THAN

EARLIER THAN

EQUIVALENT TO

SAME AS

CUT BY

CUTS (200)

COMPONENT OF

FILLED WITH 183

AGAINST

BUTTS

BUTTED BY

BONDED TO

COMPOSED OF

ASSOC. CONTEXTS

UNCERTAIN

INTERPRETATION

SAMPLE Nos.

PLAN No.	27													
SHEET No.														
SECTION No.														
SHEET No.														

% SIEVED

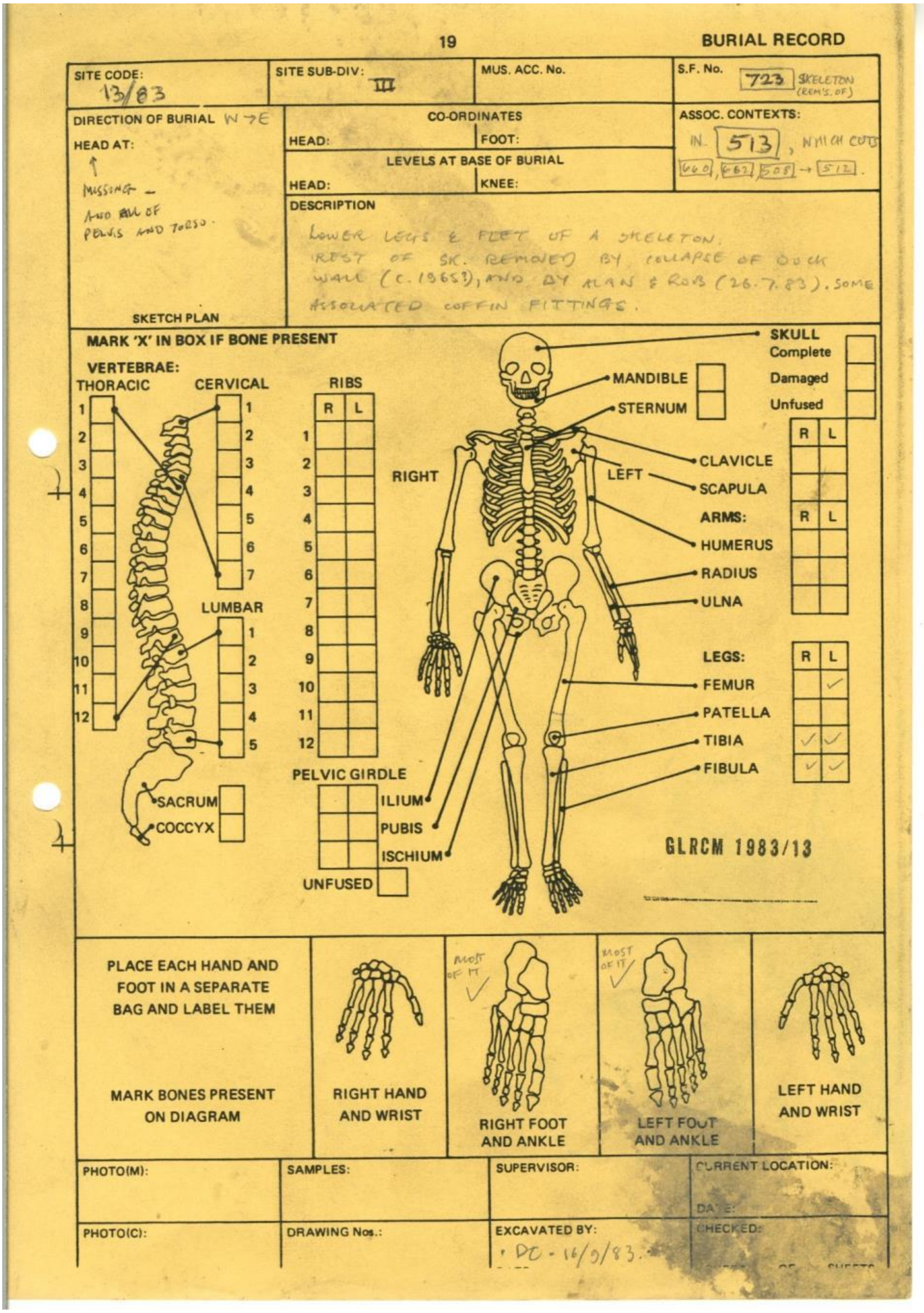
EXCAVATED BY A/C

DATE 1/6/83

METHOD OF EXCAVATION TROWEL.

PHOTO (M)	PHOTO (C)	SUPERVISOR	CONTINUATION
4/627	3/32-33		SHEET OF SHEETS

Skeleton burial record for III723


19

BURIAL RECORD

SITE CODE: 13/83
SITE SUB-DIV: III
MUS. ACC. No.
S.F. No. 723 SKELETON (REM'S. OF)

DIRECTION OF BURIAL W → E
HEAD AT: ↑ MISSING – AND ALL OF PELVIS AND TORSO.
SKETCH PLAN

CO-ORDINATES
HEAD: FOOT:
LEVELS AT BASE OF BURIAL
HEAD: KNEE:

ASSOC. CONTEXTS: IN 513, WHICH CUTS 660, 662, 508 → 512.

DESCRIPTION
LOWER LEGS & FEET OF A SKELETON.
REST OF SK. REMOVED BY COLLAPSE OF DOCK WALL (c. 1965?), AND BY ALAN & ROB (26.7.83). SOME ASSOCIATED COFFIN FITTINGS.

MARK 'X' IN BOX IF BONE PRESENT

VERTEBRAE:
THORACIC 1 2 3 4 5 6 7 8 9 10 11 12
CERVICAL 1 2 3 4 5 6 7
LUMBAR 1 2 3 4 5
SACRUM
COCCYX

RIBS (R L) 1 2 3 4 5 6 7 8 9 10 11 12

PELVIC GIRDLE
ILIUM
PUBIS
ISCHIUM
UNFUSED

RIGHT LEFT

SKULL Complete Damaged Unfused
MANDIBLE
STERNUM

	R	L
CLAVICLE		
SCAPULA		

ARMS:	R	L
HUMERUS		
RADIUS		
ULNA		

LEGS:	R	L
FEMUR		✓
PATELLA		
TIBIA	✓	✓
FIBULA	✓	✓

GLRCM 1983/13

PLACE EACH HAND AND FOOT IN A SEPARATE BAG AND LABEL THEM

MARK BONES PRESENT ON DIAGRAM

RIGHT HAND AND WRIST

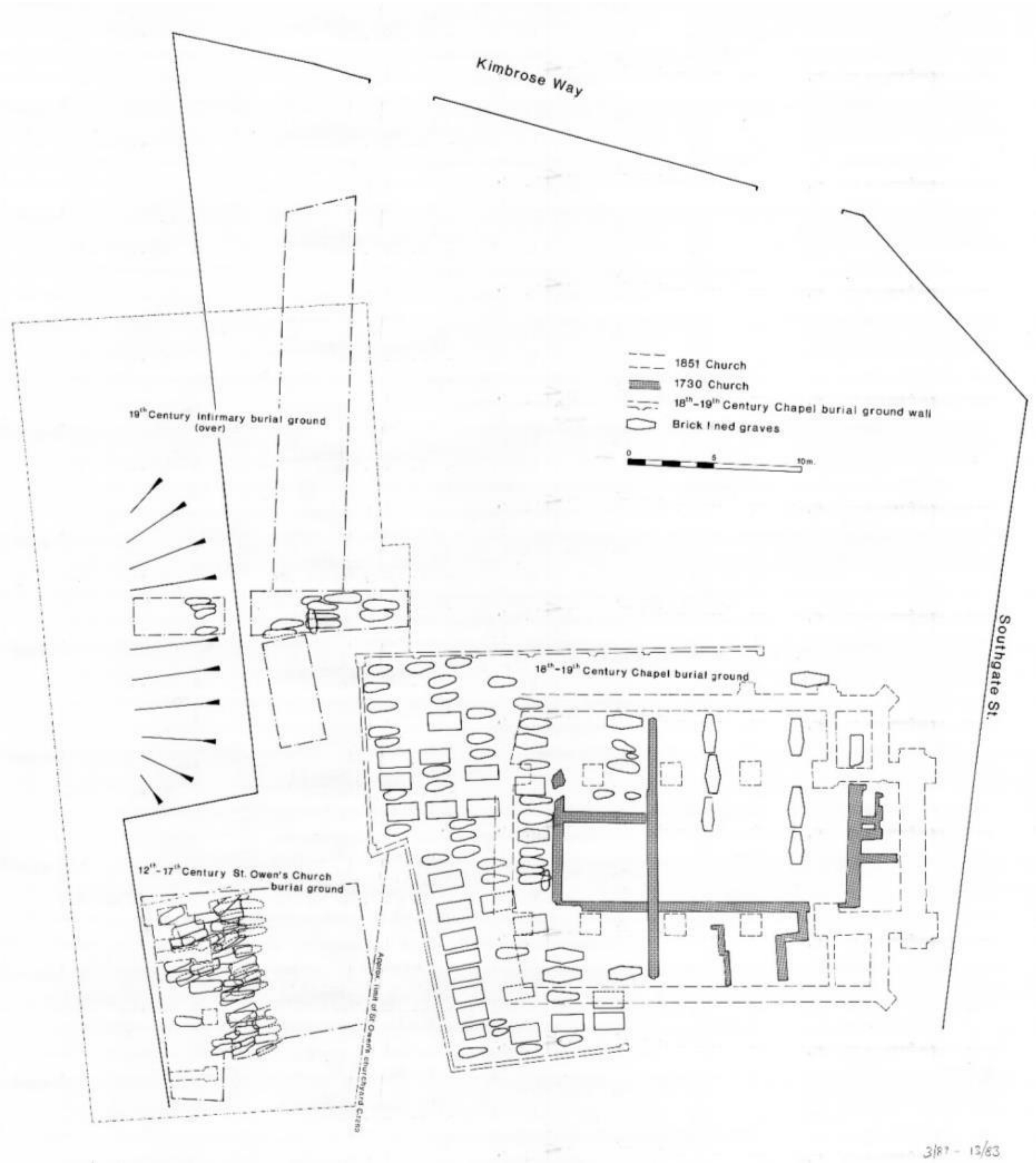
RIGHT FOOT AND ANKLE — MOST OF IT ✓

LEFT FOOT AND ANKLE — MOST OF IT ✓

LEFT HAND AND WRIST

PHOTO(M):
SAMPLES:
SUPERVISOR:
CURRENT LOCATION:
DATE:
PHOTO(C):
DRAWING Nos.:
EXCAVATED BY: DC - 16/9/83.
CHECKED:
SHEET OF SHEETS

Excavation plan of combined 3/89 and 13/83 burials



Appendix 4: Miscellaneous Data Figures and Table

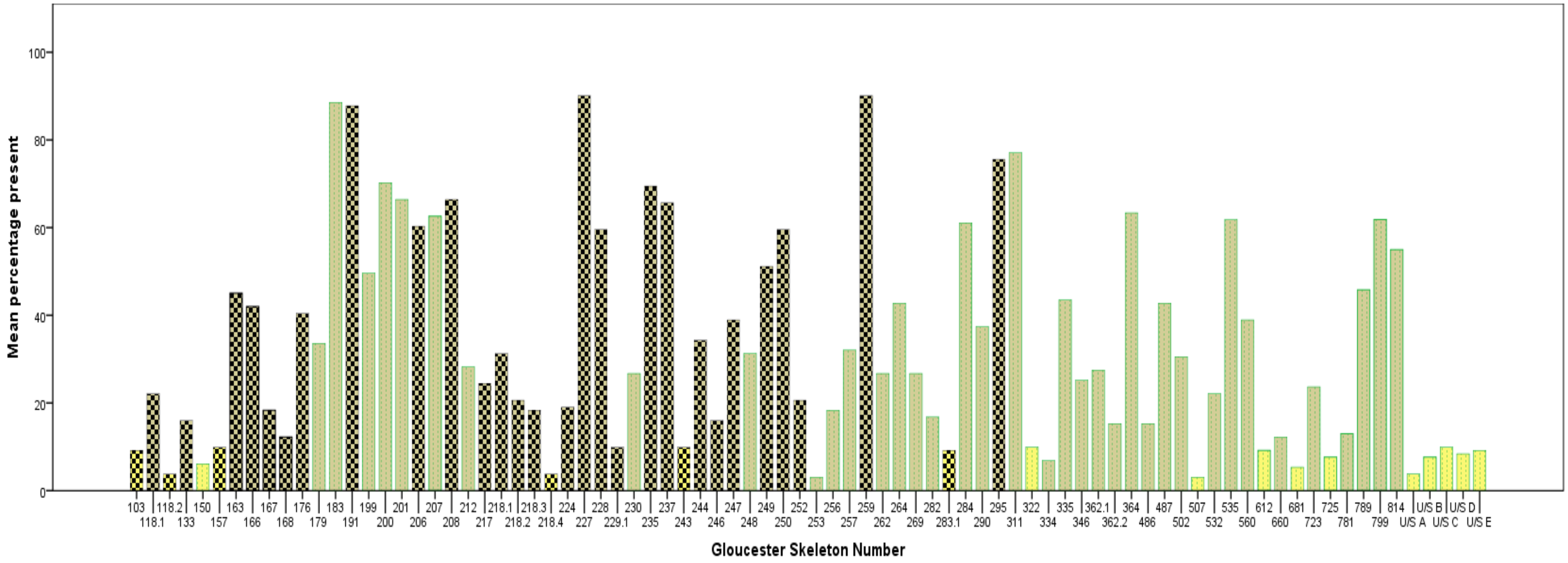


Figure 44: Percentage of skeletal elements recovered per skeleton out of a possible 131 elements scored. Bars with a yellow background indicate individuals with skull or cranium only, bars with check pattern indicate individuals from Southgate Congregational Church and bars with green dots indicate individuals from Gloucester Infirmary.

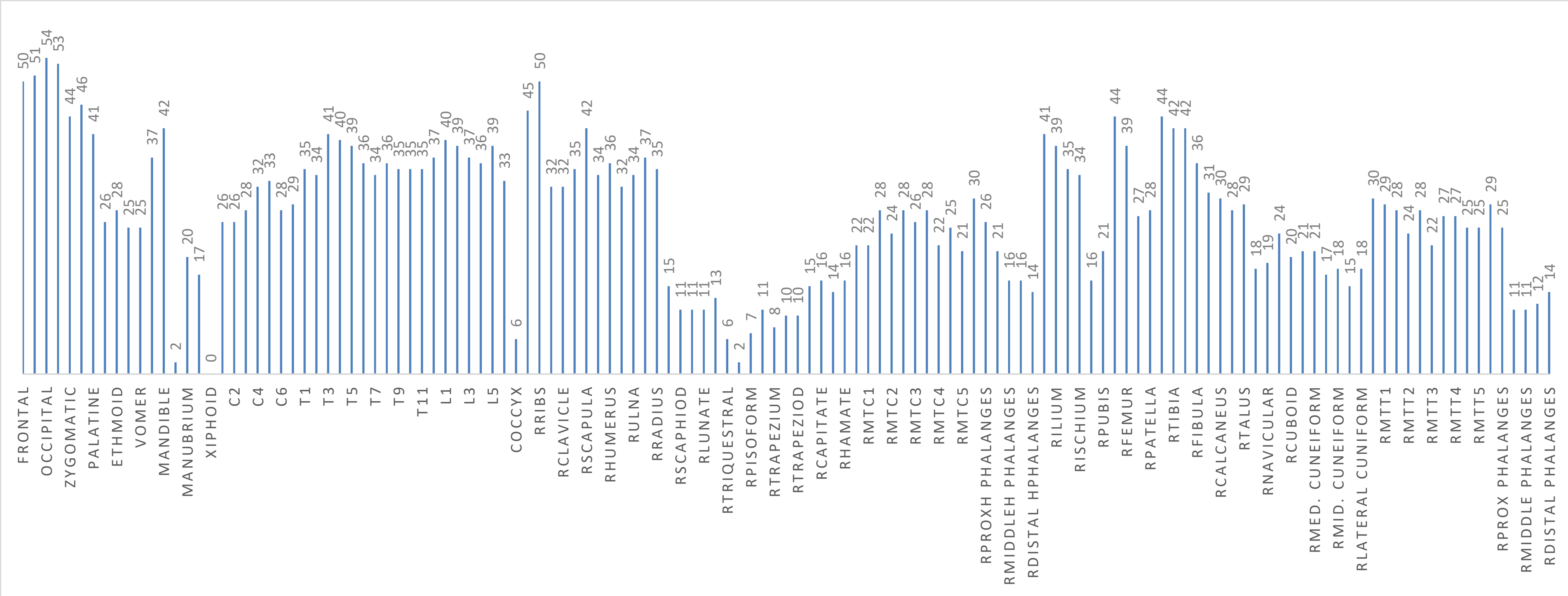


Figure 45: Total number of skeletal elements recovered within the 13/83 skeletal assemblage (n=82). This includes paired elements such as the occipital bones and grouped elements such as the left ribs and proximal, middle and distal phalanges.

Table 37: Age at death estimations for excavated individuals from the SCC and Infirmary burials.

		Location														
		SCC					GI					Total				
		Female	Male	Indeterminate	Not Assessed	**SCC Total**	Female	Male	Indeterminate	Not Assessed	**GI Total**	Female	Male	Indeterminate	Not Assessed	**Total**
Subadult (0-17 yrs)	0-2	-	-	-	14	**14**	-	-	-	1	**1**	-	-	-	15	**15**
	3-8	-	-	-	2	**2**	-	-	-	1	**1**	-	-	-	3	**3**
	9-14	-	-	-	2	**2**	-	-	-	2	**2**	-	-	-	4	**4**
	15-17	-	-	-	1	**1**	-	-	-	2	**2**	-	-	-	3	**3**
	Group Total	-	-	-	19	**19**	-	-	-	6	**6**	-	-	-	25	**25**
Young adult (18-29 years)	18-24 years	-	1	-	-	**1**	2	5	-	-	**7**	2	6	-	-	**8**
	25-29 years	2	1	-	-	**3**	2	4	-	-	**6**	4	5	-	-	**9**
	Group Total	2	2	-	-	**4**	4	9	-	-	**13**	6	11	-	-	**17**
Mid-adult (30-49 years)	30-34	1	-	-	-	**1**	1	4	-	-	**5**	2	4	-	-	**6**
	35-39	2	-	-	-	**2**	1	6	-	-	**7**	3	6	-	-	**9**
	40-44	-	-	-	-	**-**	-	5	-	-	**5**	-	4	-	-	**4**
	45-49	1	2	-	-	**3**	-	6	-	-	**6**	1	8	-	-	**9**
	Group Total	4	2	-	-	**6**	2	21	-	-	**23**	6	22	-	-	**29**
Old adult (50+)	50-54	1	1	-	-	**2**	-	-	-	-	**-**	1	1	-	-	**2**
	55-59	-	1	-	-	**1**	-	-	-	-	**-**	-	1	-	-	**1**
	60+	2	-	-	-	**2**	-	-	-	-	**-**	2	-	-	-	**2**
	Group Total	3	2	-	-	**5**	-	-	-	-	**-**	3	2	-	-	**5**
Unassessed adult		0	2	-	1	**3**	-	1	2	-	**3**	-	4	1	1	**6**
	Total (n=82)	**9**	**8**	**-**	**20**	**37**	**6**	**31**	**2**	**6**	**45**	**15**	**39**	**1**	**26**	**82**

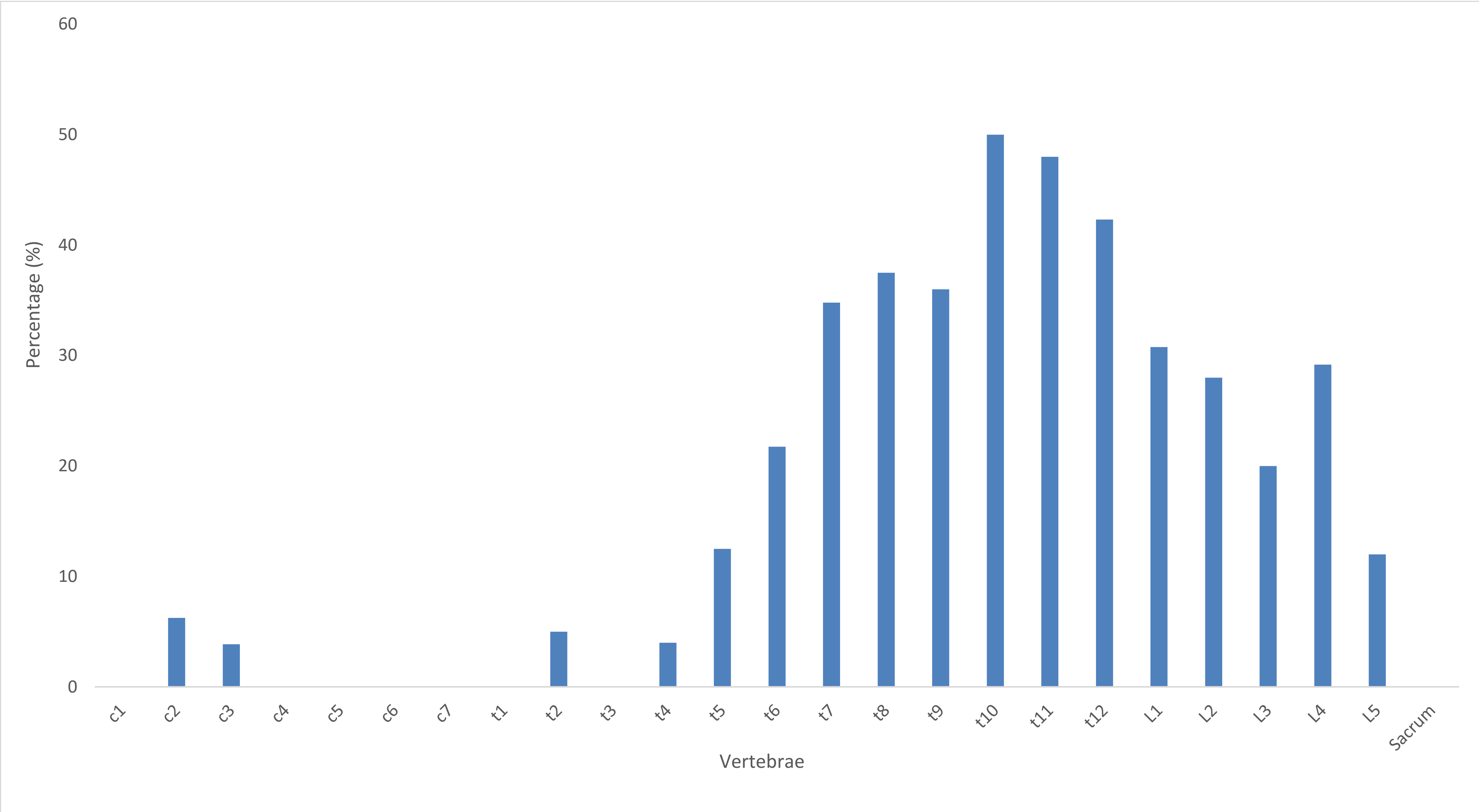


Figure 46: Frequency of Schmorl's nodes at each vertebral level in retained adult vertebrae of13/83

Appendix 5:

Summary Data and Biological profiles of the 13/83 Skeletal collection

BIOLOGICAL PROFILES								***DENTAL***	***SKELETAL PATHOLOGIES***					
Gloucester Skeleton Number	Location	Trench Number	Age Category	Gen Sex	Sex Category	Sub-Age Catogory	Mean Stature (cm)	Dental path	Trauma	Congenital	Joint	Infectious	Metabolic	Neoplastic
103	Church	I	Mid-adult (30-49 years)	Female	Possible female	30-34 years	-	AMTL, Caries	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
118.1	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
118.2	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
133	Church	II	Mid-adult (30-49 years)	Female	Probable Female	35-39 years	159.55	NO dental	No Trauma	No Congenital	OA, Schmorls node	No Infection	No Metabolic	No Neoplastic
150	Infirmary	III	Young Adult (18-29 years)	Male	Probable Male	25-29 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	Porotic hyperostosis	No Neoplastic
157	Church	II	Young Adult (18-29 years)	Female	Probable Female	25-29 years	-	AMTL, Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
163	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
166	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
167	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	3-8 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
168	Infirmary	III	Young Adult (18-29 years)	Male	Possible male	18-24 years	169.63	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
176	Church	II	Old Adult (50+)	Female	Probable Female	60+ years	158.97	NO dental	No Trauma	No Congenital	Osteoarthritis	No Infection	No Metabolic	No Neoplastic
179	Infirmary	III	Young Adult (18-29 years)	Male	Probable Male	25-29 years	169.22	Caries, Calculus	Fracture	No Congenital	Schmorls Node, other joint	Periostitis	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
183	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	35-39 years	170.18	AMTL, Caries, Calculus	No Trauma	Spondylolysis	Schmorls Node, other joint	Other infection	Porotic hyperostosis	No Neoplastic
191	Church	II	Young Adult (18-29 years)	Male	Possible male	18-24 years	167.56	AMTL, Caries, Calculus, LEH	No Trauma	No Congenital	Schmorls Node	No Infection	Rickets/ Osteomalacia	No Neoplastic
199	Infirmary	III	Mid-adult (30-49 years)	Indeterminate	Indeteminate	40-44 years	163.56	Caries, Calculus	No Trauma	No Congenital	OA, Schmorls node, DDD	No Infection	No Metabolic	No Neoplastic
200	Infirmary	III	Young Adult (18-29 years)	Female	Probable Female	25-29 years	170.10	AMTL, Caries, Calculus, LEH	No Trauma	No Congenital	OA, Schmorls node, Other Joint	Periostitis, Other infection	No Metabolic	No Neoplastic
201	Infirmary	III	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	15-17 years	169.34	Caries, Calculus, LEH	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
206	Church	II	Old Adult (50+)	Female	Possible female	60+ years	164.8	AMTL, Caries, Calculus, Abscess, LEH	No Trauma	Other Congenital	No Joint Path	Periostitis, Other infection	No Metabolic	No Neoplastic
207	Church	II	Old Adult (50+)	Male	Probable Male	50-54 years	165.42	AMTL, Caries, Calculus, Abscess	No Trauma	No Congenital	DDD, Other joint	Periostitis	Porotic hyperostosis	Osteoma
208	Church	II	Mid-adult (30-49 years)	Male	Probable Male	45-49 years	169.224	AMTL, Caries, Calculus	Fracture	No Congenital	Schmorls Node	Periostitis	No Metabolic	No Neoplastic
212	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	40-44 years	177.326	AMTL, Caries, Calculus, LEH	Fracture	No Congenital	Schmorls Node	No Infection	Porotic hyperostosis	Osteoma, Other neoplastic
217	Church	II	Young Adult (18-29 years)	Female	Probable Female	25-29 years	164.78	Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
218.1	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
218.2	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
218.3	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
218.4	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
224	Church	II	Unassessed adult	Indeterminate	Not assessed	undefined	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
227	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	15-17 years	153.08	Caries, Calculus	No Trauma	No Congenital	Other Joint condition	No Infection	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
228	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	Caries	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
229.1	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	3-8 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	Rickets/ Osteomalacia	No Neoplastic
230	Infirmary	III	Young Adult (18-29 years)	Female	Possible female	18-24 years	167.09	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
235	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	9-14 years	-	Caries, Calculus	No Trauma	No Congenital	Other Joint condition	No Infection	Porotic Hyperostosis, HVD	No Neoplastic
237	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	9-14 years	-	NO dental	No Trauma	No Congenital	No Joint Path	Periostitis	No Metabolic	No Neoplastic
243	Church	II	Mid-adult (30-49 years)	Female	Possible female	35-39 years	-	Antemortem Tooth Loss	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic

244	Church	II	Mid-adult (30-49 years)	Male	Probable Male	45-49 years	169.46	AMTL, Caries, Calculus	No Trauma	No Congenital	Osteoarthritis	Periostitis	Rickets/ Osteomalacia	Osteoma
246	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
247	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
248	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	45-49 years	175.17	AMTL, Caries, Calculus	Fracture	No Congenital	OA, Schmorls node	Periostitis	Porotic hyperostosis	No Neoplastic
249	Church	II	Old Adult (50+)	Male	Probable Male	55-59 years	169.22	present no pathology	Fracture	No Congenital	OA, DDD, other joint	Periostitis	Porotic hyperostosis	No Neoplastic
250	Church	II	Young Adult (18-29 years)	Male	Possible male	25-29 years	173.27	Caries, Calculus, LEH	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
252	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
253	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
256	Church	II	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
257	Church	II	Unassessed adult	Male	Possible male	undefined	167.07	NO dental	No Trauma	No Congenital	No Joint Path	Periostitis	No Metabolic	No Neoplastic
259	Church	II	Mid-adult (30-49 years)	Female	Possible female	45-49 years	163.03	Calculus	No Trauma	Sacralisation	OA, Other joint	Periostitis	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
262	Infirmary	III	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	9-14 years	-	NO dental	No Trauma	No Congenital	No Joint Path	Periostitis	No Metabolic	No Neoplastic
264	Infirmary	III	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	15-17 years	-	present no pathology	No Trauma	No Congenital	Osteoarthritis	Periostitis	No Metabolic	No Neoplastic
269	Infirmary	III	Mid-adult (30-49 years)	Male	Possible male	35-39 years	-	NO dental	No Trauma	No Congenital	OA, Schmorls node, DDD	No Infection	No Metabolic	No Neoplastic
282	Infirmary	III	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	0-2 years	-	present no pathology	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
283.1	Church	II	Unassessed adult	Male	Possible male	undefined	-	AMTL, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	Porotic hyperostosis	No Neoplastic
284	Infirmary	III	Young Adult (18-29 years)	Male	Probable Male	25-29 years	171.13	Calculus, LEH	Fracture	No Congenital	OA, Schmorls node, Other Joint	Periostitis	No Metabolic	No Neoplastic
290	Infirmary	III	Young Adult (18-29 years)	Female	Possible female	25-29 years	164.77	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
295	Church	II	Old Adult (50+)	Female	Probable Female	50-54 years	169.7	Antemortem Tooth Loss	No Trauma	No Congenital	Schmorls Node, DDD, other joint	No Infection	No Metabolic	No Neoplastic
311	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	40-44 years	172.94	AMTL, Caries, Calculus, LEH	No Trauma	Other Congenital	Osteoarthritis	Periostitis	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
322	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	40-44 years	-	AMTL, Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	Cribra Orbitalia	No Neoplastic
334	Infirmary	III	Mid-adult (30-49 years)	Male	Possible male	45-49 years	169.14	NO dental	No Trauma	No Congenital	Other Joint condition	Periostitis	No Metabolic	No Neoplastic
335	Infirmary	III	Young Adult (18-29 years)	Male	Probable Male	25-29 years	168.03	Calculus, LEH	No Trauma	Sacralisation	Schmorls Node, other joint	Periostitis	No Metabolic	No Neoplastic
346	Infirmary	III	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	3-8 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
362.1	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	35-39 years	172.71	AMTL, Caries, Calculus	No Trauma	No Congenital	OA, DDD	No Infection	Porotic hyperostosis	No Neoplastic
362.2	Infirmary	III	Young Adult (18-29 years)	Female	Probable Female	18-24 years	-	Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
364	Infirmary	III	Mid-adult (30-49 years)	Male	Possible male	40-44 years	169.224	NO dental	Fracture	No Congenital	OA, Schmorls Node, DDD, other joint	Periostitis	No Metabolic	No Neoplastic
486	Infirmary	III	Unassessed adult	Indeterminate	Indeteminate	undefined	158.08	NO dental	Fracture	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
487	Infirmary	III	Young Adult (18-29 years)	Male	Possible male	18-24 years	160.66	AMTL, Caries, Calculus, LEH	No Trauma	No Congenital	OA, DDD	Periostitis	Porotic hyperostosis	No Neoplastic
502	Infirmary	III	Mid-adult (30-49 years)	Female	Possible female	35-39 years	162.53	NO dental	No Trauma	No Congenital	OA, DDD	No Infection	No Metabolic	No Neoplastic
507	Infirmary	III	Mid-adult (30-49 years)	Male	Possible male	45-49 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	Cribria Orbitia, Porotic Hyperostosis	No Neoplastic
532	Infirmary	III	Unassessed adult	Male	Possible male	undefined	169.34	NO dental	No Trauma	No Congenital	Other Joint condition	Periostitis	No Metabolic	No Neoplastic
535	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	30-34 years	178.98	NO dental	No Trauma	Spina Bifida	No Joint Path	Periostitis	No Metabolic	No Neoplastic
560	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	35-39 years	163.75	NO dental	No Trauma	No Congenital	OA, Other joint	Periostitis	No Metabolic	No Neoplastic

612	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	45-49 years	-	AMTL, Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
660	Infirmary	III	Young Adult (18-29 years)	Male	Possible male	18-24 years	-	AMTL, Caries, Calculus, Abscess, LEH	No Trauma	No Congenital	Degenerative Disc Disease	No Infection	No Metabolic	No Neoplastic
681	Infirmary	III	Young Adult (18-29 years)	Male	Probable Male	18-24 years	-	Calculus	Fracture	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
723	Infirmary	III	Unassessed adult	Male	Possible male	undefined	177.66	NO dental	Other Trauma	No Congenital	OA, Other joint	No Infection	No Metabolic	No Neoplastic
725	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	45-49 years	-	Caries, Calculus, LEH	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
781	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	35-39 years	172.09	AMTL, Calculus	Fracture	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
789	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	35-39 years	165.622	Antemortem Tooth Loss	Fracture	Spodylolysis	OA, DDD, other joint	Periostitis	Porotic hyperostosis	No Neoplastic
799	Infirmary	III	Mid-adult (30-49 years)	Male	Probable Male	30-34 years	170.86	NO dental	Fracture	No Congenital	Schmorls Node	No Infection	No Metabolic	No Neoplastic
814	Infirmary	III	Young Adult (18-29 years)	Male	Possible male	18-24 years	174.55	NO dental	No Trauma	No Congenital	Other Joint condition	Periostitis	No Metabolic	No Neoplastic
U/S A	Infirmary	V	Mid-adult (30-49 years)	Female	Possible female	30-34 years	-	NO dental	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
U/S B	Infirmary	V	Mid-adult (30-49 years)	Male	Probable Male	30-34 years	-	AMTL, Abscess	No Trauma	No Congenital	No Joint Path	No Infection	Porotic hyperostosis	No Neoplastic
U/S C	Infirmary	V	Mid-adult (30-49 years)	Male	Probable Male	30-34 years	-	Caries, Calculus, LEH	No Trauma	No Congenital	No Joint Path	No Infection	Porotic hyperostosis	No Neoplastic
U/S D	Infirmary	V	Sub-adult (0-17 years)	Sub-adult/Unassessed	Not assessed	9-14 years	-	Caries, Calculus	No Trauma	No Congenital	No Joint Path	No Infection	No Metabolic	No Neoplastic
U/S E	Infirmary	V	Mid-adult (30-49 years)	Male	Possible male	45-49 years	-	Antemortem Tooth Loss	No Trauma	No Congenital	No Joint Path	No Infection	Porotic hyperostosis	No Neoplastic