A clinical and archaeological study of Schmorl's Nodes: using clinical data to understand the past

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VOLUME II (Chapters 6-8, Bibliography and Appendices)

Chapter 6: Results: clinical and archaeological

6.1 Introduction

The results of the clinical data are easier to evaluate, as known numbers of people with complete vertebral columns were available for analysis (Appendix 3, Table 6.1). The archaeological data availability varied because overall preservation, completeness of the vertebral column, and the number of other elements present for each skeleton (Appendix 3, Table 6.2) was different for each of the samples studied. The viability of the skeletal samples was constrained by the need to have complete thoracic and lumbar vertebral columns to test several of the hypotheses (Fig. 6.1). With the cemetery boundaries not always having been ascertained, nor the number of individuals interred within that boundary, determining the representative nature of the samples was difficult.

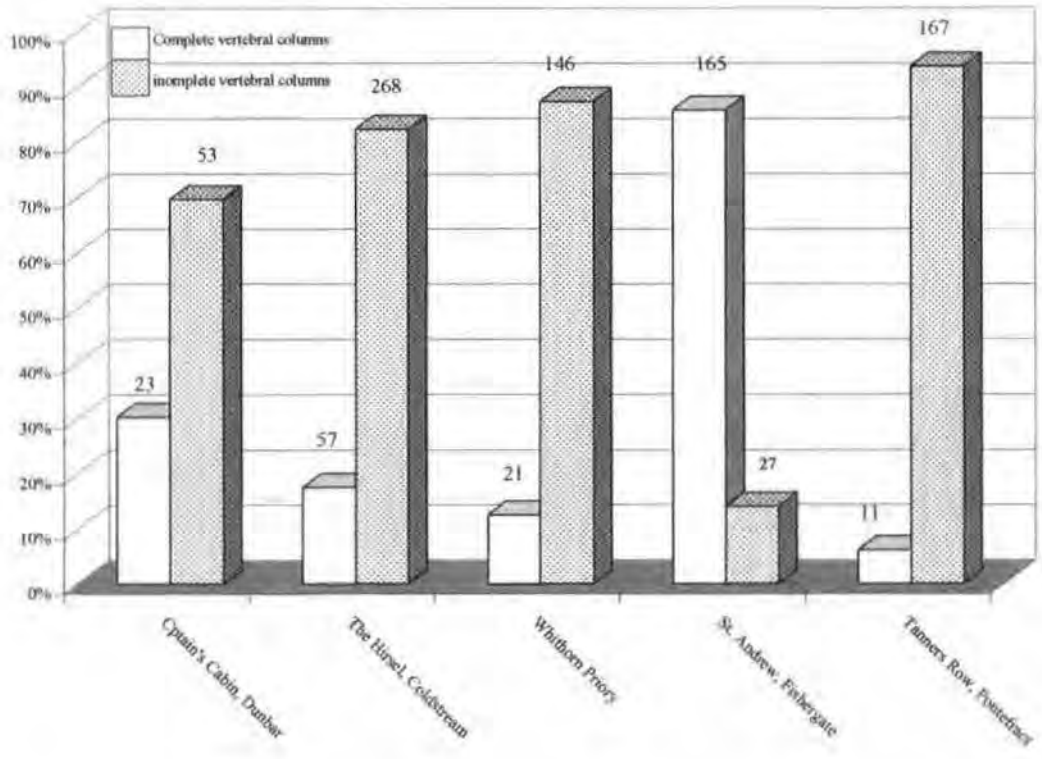

Figure 6.1 The viability of the archaeological samples: the percentages show the individuals with and without thoracic and lumbar vertebral columns

To compare and contrast samples containing both small and, large numbers of individuals found positive for Schmorl's nodes required a method which was consistent and easily understood. The method chosen used the viable archaeological vertebral columns as the whole sample in each instance, and the vertebral columns found positive for Schmorl's nodes as the percentage of that whole. Percentages were used throughout with graphs and bar charts used as visual presentations of the data produced. Where a percentage is given it is immediately followed by the number of individuals represented by the preceding percentage, this number always being enclosed in brackets. The same method was used to present the clinical samples, with those vertebral columns found positive for Schmorl's nodes presented as percentages of each whole sample.

Using chi squared ($\chi 2$) to prove statistical significance at a 95% level of confidence for any of the hypotheses tested in this thesis was felt to be of little use where numbers were so small. $\chi 2$ was therefore only used to look at the possibility of males and females in each sample, having an equal chance of being affected by Schmorl's nodes.

6.1.1 Schmorl's nodes (clinical and archaeological)

Schmorl's nodes were observed amongst the individuals studied in each clinical and archaeological sample. The percentages produced for the clinical samples were reached using the numbers of patients who presented for radiographic imaging within each sample as the total for each sample (Appendix 3, Table 6.1). Frequencies for each of the archaeological samples were calculated using both the number of individuals excavated and the number of individuals studied (Appendix 3, Table 6.2). The 1994-5 Pinderfields Hospital sample produced a 5% (70) positive sample for Schmorl's nodes from 1,461 patients who were examined by plain film radiography of the thoracic and lumbar spine. The

second clinical sample, 1995 Pinderfields Hospital, consisted of 1,374 individuals which produced a 3% (40). The third sample (Royal Hospital for Sick Children, Edinburgh) comprising a total sample of 442 individuals which produced a 5% (22) frequency. Amalgamating each of the Pinderfields Hospital samples with half of the Royal Hospital for Sick Children, Edinburgh sample showed no significant increase in the presentation rate of Schmorl's nodes when compared to the separate sample rates.

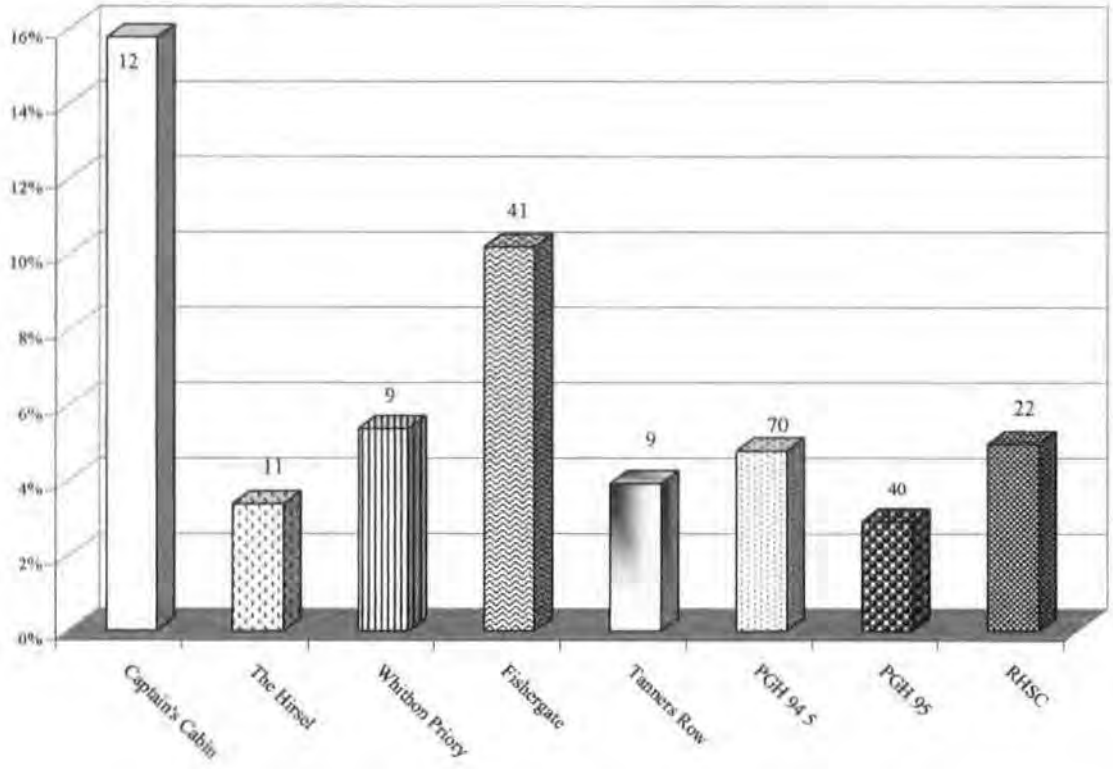

Figure 6.2 The percentages of individuals affected with at least one Schmorl's node for each clinical and archaeological sample

The two rural archaeological samples (The Hirsel, Coldstream and Tanners Row, Pontefract) showed very similar rates; these frequencies increase significantly when only the vertebral columns with their complete compliment of thoracic and lumbar vertebra were considered (Appendix 3, Table 6.2). Using the total number of individuals excavated for each archaeological sample as the whole, the Hirsel site produced a 3%

(11) rate, and the Tanners Row site produced a 4% (7) rate. Urban Whithorn Priory and St. Andrew, Fishergate produced slightly higher rates 8% (9), and 12% (41), respectively. Captain's Cabin, the military site, had a much higher prevalence of Schmorl's nodes at 18% (12).

Using the total number of excavated skeletons to estimate the frequency for Schmorl's nodes in each archaeological sample the rates reflected those of the clinical samples, the rates increased dramatically (Appendix 3, Table 6.5). Fishergate produced the smallest increase at 24% (an increase of only 4%), while Tanners Row, Pontefract produced the greatest increase at 64% (an increase of 60%), each of these results being dependent upon the state of preservation within the samples studied.

6.1.2 Superior and inferior vertebral end plate frequency of Schmorl's nodes

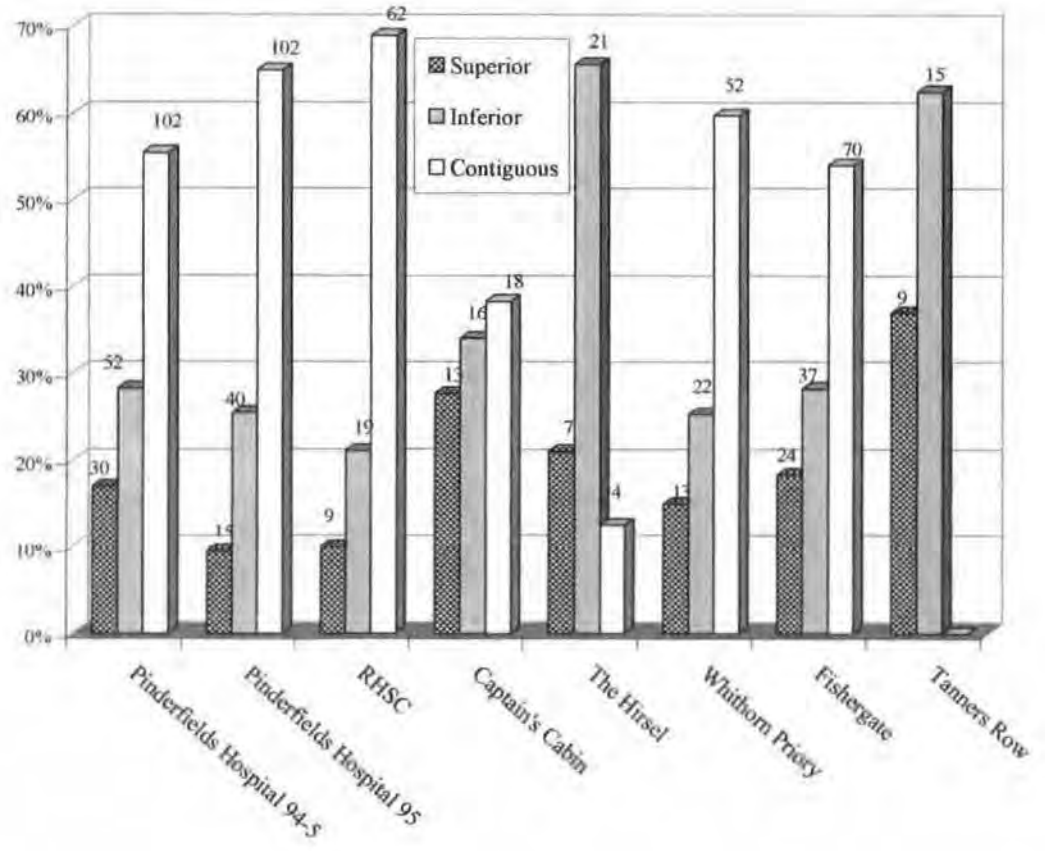

Figure 6.3 Numbers and percentages for superior, inferior and contiguous vertebral end plate intrusions by Schmorl's nodes

Vertebral end plate weakness and Schmorl's nodes have been treated as two separate entities for the purposes of this research, but historically they are believed to be interdependent, but the first hypothesis (Chapter 1: 37) sets out to discover whether this is true or false. Superior and inferior end plate disruption by Schmorl's nodes was assessed, and a third category, that of contiguous vertebral surface involvement, was added (Appendix 3, Table 6.3) as it was a common recurring feature (Fig. 6.3). This category represented Schmorl's nodes in apposing vertebrae.

6.2 Vertebral end plate weakness frequency: subadult

On analysis, the subadult individuals of both clinical and archaeological samples did not provide the expected proliferation of centrally placed Schmorl's nodes. Protrusion of the nucleus pulposus through the central area of the vertebral end plate was rarely observed during this research giving little support to the theory that the notochord leaves a weakened central area within the neonatal end plate which persists into adulthood.

6.2.1 Clinical data

(i) Pinderfields Hospital

Only two clinical patients (BA170 and CB132) with possible end plate weakness from the 1994-5 Pinderfields Hospital sample satisfied the subadult criterion, one being 15 years old and the other 19 years old (Appendix 7, Table 6.22b). Both of these patients were female, and had Schmorl's nodes on contiguous end plates, from the inferior end plate of the 12^{th} thoracic vertebra to the superior end plate of the 2^{nd} lumbar vertebra. In each case, the Schmorl's nodes were positioned posteriorly, and each female had suffered low back pain with no lower limb problems or pain, or loss of feeling. No indication of previous injury was given, but it was not excluded due to the Schmorl's

nodes being posteriorly positioned within contiguous end plates, and being *rough* in type. The 1995 Pinderfields Hospital sample also produced two female patients, one aged 15 years, and the other aged 19 years (Appendix 7, Table 6.23). The younger patient (AB537) was found to have Schmorl's nodes at all levels from the 12th thoracic vertebra to the 4th lumbar vertebra, and irregular end plates. A case history of low back pain, without lower limb involvement, was recorded on the radiography request form. Early Scheuermann's disease was the reported diagnosis from the radiographic images taken of the lumbar vertebrae of the second patient (BC585); this patient was requested to return for radiographic imaging of the thoracic spine to confirm the initial radiology diagnosis. According to the hospital records, she had not returned for further radiographic imaging over the following four years. The diagnosis of irregular end plates, which involved the whole surface (Fig. 3.8), were not convincing as they were not finely focused intrusions. Scheuermann's disease involves the antero-superior and antero-inferior end plates of the vertebrae and not the whole surface area of the vertebral body as seen in this patient's radiographic images of the lumbar spine. These subadults showed no centrally place Schmorl's nodes and therefore are not indicative of an end plate weakness produced by incomplete regression of the notochord.

(ii) Royal Hospital for Sick Children

Only 5% (22) of paediatric patients requiring thoracic and/or lumbar spine plain film imaging in the Royal Hospital for Sick Children, were reported positive for Schmorl's nodes over a two-year period. One child (121YZ) was diagnosed with spondylolysis, spondylolisthesis, and Schmorl's nodes, at the levels of the 5th lumbar vertebra, and the 1st sacral segment, after a fall. Nine other children between the ages of 9 and 16 years were diagnosed with Schmorl's nodes, each having fallen from a height and landed on their feet, or bottom. Six children who presented with back pain were found to have

anterior Schmorl's nodes at three vertebral levels on superior and inferior end plates; the reporting Radiologist classed this as Scheuermann's disease. Two children (101MN and 123DE) presented with low back pain, and loss of lumbar lordosis, and both were reported positive for Schmorl's nodes. Three remaining children with Schmorl's nodes were suffering from congenital conditions:

- (308PQ) non-progressive ataxia
- (122BA) fronto-metaphyseal dysplasia
- (121TU) spinal dysraphism

Each of these children had reduced bone mineral density and may have suffered end plate weakness either from incomplete notochord regression or impaired cortical and subchondral deposition, but this was not reported by the radiologist, or was clearly visible on the radiographic images.

The vertebral columns of 23% (5) of the paediatric patients reported positive for centrally placed Schmorl's nodes; these included 123AB recorded as having a 'tender' back, and 160CD, 170BC, 372FG and 373GH (back pain after falling from a height). The only patient possibly suffering from end plate weakness was 123AB, who had suffered no injury and whose history specifically reported on localized pain at the level of the Schmorl's nodes.

6.2.2 Archaeological samples

Preservation of subadult vertebral columns amongst the archaeological samples varied greatly (Appendix 3, Table 6.5), with Tanners Row producing only a 13% (2) usable

subadult population due to adverse burial conditions, and St. Andrew Fishergate an 82% (23) viability rate.

Captain's Cabin and Whithorn Priory each produced a single person with centrally formed Schmorl's nodes which provided evidence of possible end plate weakness caused by incomplete regression of the notochord. Captain's Cabin produced one subadult (Sk 71), 12 to 18 years of age, with possible vertebral end plate weakness; this person was affected by Schmorl's nodes which were *rough* and centrally positioned. The first intrusion was positioned almost centrally in the superior end plate of the 9th thoracic vertebra, and the second intrusion formed a triangle composed of three pin-like holes on the inferior end plate of the 10th thoracic vertebrae. Whithorn Priory had only one subadult (Sk 460), 12 to 20 years of age, who was affected by centrally placed Schmorl's nodes on the superior end plates of the 12th thoracic to the 3rd lumbar vertebrae.

St. Andrew, Fishergate produced three skeletons which were possibly positive for vertebral end plate weaknesses. The first individual (SK 190), 16 to 20 years of age had a *smooth* shallow posterior depression, or healed Schmorl's node, placed anteriorly to the posterior cortical wall within the superior end plate of the 1st lumbar vertebra. Spina bifida occulta was observed in the posterior sacral segments and 5th lumbar vertebra of the second vertebral column of SK 268, 18 to 25 years of age, with three small holes placed centrally within the inferior end plate of the 8th thoracic vertebra, and one large, *rough*, posteriorly positioned Schmorl's node within the superior end plate of the 11th thoracic vertebra. A third incomplete vertebral column (SK 435) of an individual 20 to 25 years of age was recorded as possibly having weak end plate areas; shallow, *rough* Schmorl's nodes in the facing end plates from the 1st to 4th lumbar vertebrae were all

centrally positioned, but they also involved the posterior areas of the vertebral bodies. The surviving elements of this individual were all very light compared to the majority of skeletons within this sample. The frequency of centrally placed Schmorl's nodes in each vertebral column which may represent end plate weakness caused by incomplete notochord regression are set out in Appendix 3, table 6.6.

6.3 Schmorl's nodes: symptomatic or asymptomatic?

Quickly resolved acute pain is soon forgotten, but chronic pain is a debilitating symptom of soft tissue or bony disease or disorder. In the clinical groups, the patients provided case histories during examination and prior to radiographic imaging, and therefore symptoms were given as part of the reasoned request for thoracic and lumbar spine radiographic imaging. The vertebral columns of several individuals in the archaeological samples studied contained vertebral alterations and congenital abnormalities that mirrored those of individuals in the clinical samples, who complained of acute localised pain, or chronic localised pain at the levels at which Schmorl's nodes were diagnosed.

6.3.1 Clinical data

(i) Pinderfields Hospital

In the 1994-5 Pinderfields Hospital sample of patients affected by Schmorl's nodes, back pain was mentioned on the radiographic request cards of 61% (43), while the 1995 Pinderfields Hospital sample had a 73% (29) indication of back pain (Appendix 8, Tables 6.30a; 6.30b; 6.31). One patient (GF324) had Schmorl's nodes in facing end plates from the inferior end plate of the 10^{th} thoracic vertebra to the superior end plate of the 1^{st} lumbar vertebra, all in association with sclerosis. In the report from a follow-

up examination, requested because of continuing back pain, the loss of disc height from the 9th thoracic vertebra to the 3rd lumbar vertebra was reported as "still existing". *Rough*, posterior, Schmorl's nodes (Fig. 5.20) were now visible on facing surfaces of all vertebrae from the inferior end plate of the 9th thoracic vertebra to the 2nd lumbar vertebra on the radiographic images. A 24 year old female patient (DC122) with low back pain had sclerotic changes to the end plates from the 10th thoracic vertebra to the 3rd lumbar vertebra, and a large, *rough*, posterior Schmorl's node in the inferior end plate of the 12th thoracic vertebra. A very specific indication of pain was given for one female patient (JH979), who had loss of intervertebral disc height, and a single Schmorl's node in the inferior end plate of the 1st lumbar vertebra; "the pain starts at the level of the 2nd lumbar vertebra". These examples were repeated throughout the clinical groups from Pinderfields Hospital.

(ii) Royal Hospital for Sick Children

Irregular end plates (Fig. 6.4) and Schmorl's nodes were regularly reported when paediatric patients had been admitted with acute back pain. Irregular end plates were the most commonly recurring reported bony alteration to the vertebral columns at 68% (15) (Fig. 6.4). A 15-year-old female patient (346XY) had three request cards, and three sets of radiographic images taken over a period of one year, giving a progression of vertebral end plate changes in relation to trauma induced Schmorl's nodes. The first report stated that "the antero-inferior border of the 2nd lumbar vertebra and the antero-superior border of the 4th lumbar vertebra had sequestrated bony fragments, with limbus vertebra, which may be due to anterior protrusion of the nucleus pulposus into the vertebral body between the end plate and the body surface". This report has the following comment added by the reporting radiologist, "The significance is uncertain in relation to the patient's symptoms". The follow up report gave anterior narrowing of the

disc space at the levels of the 2nd and 3rd lumbar vertebrae, with anterior Schmorl's nodes, as the cause of continuing low back pain. Eleven months later, in the final report there was acknowledgement of healing at the levels of the 2nd and 3rd lumbar vertebrae. A Schmorl's node was now visible within the antero-inferior border of the 3rd lumbar vertebra, facing the Schmorl's node in the anterior superior end plate of the 4th lumbar vertebra, which, in the report, was suggested as the cause of continuing pain, no other disorder or disease other than those already discussed was reported or observed.

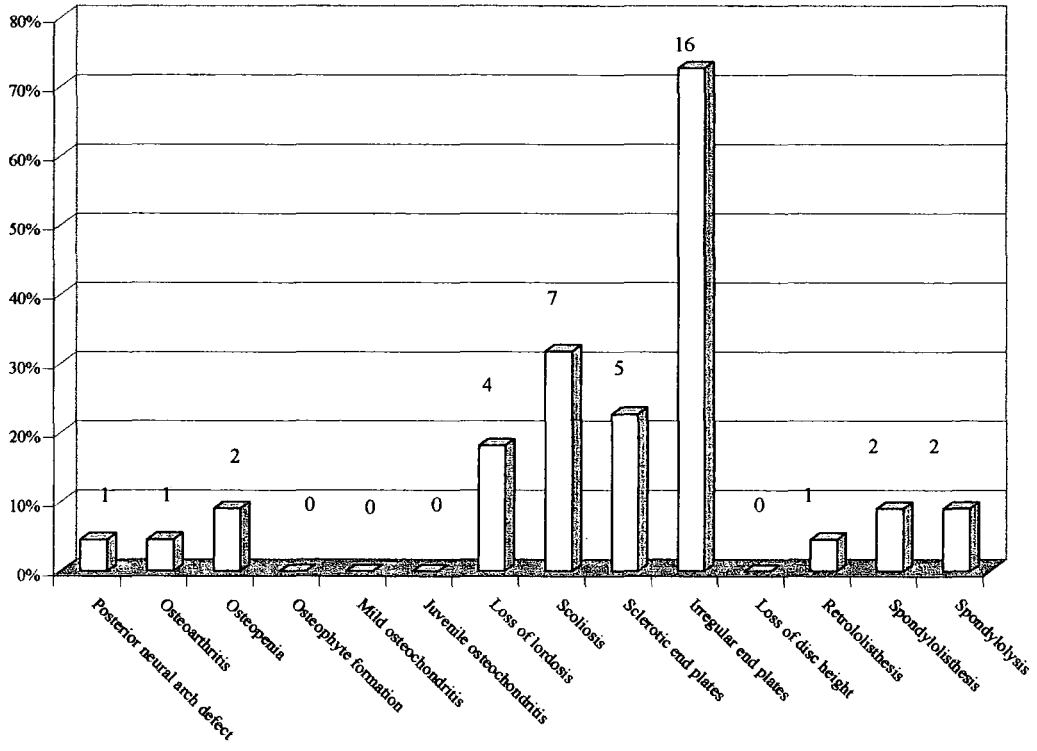

Figure 6.4 The Royal Hospital for Sick Children: disorders and diseases associated with individuals with Schmorl's nodes.

Another female paediatric patient (160CD) suffered from radiating back pain after falling from a height was reported as having, "Minor irregularity of the end plates of the lumbar vertebrae in keeping with Schmorl's nodes. The superior end plate of the 4th lumbar vertebra showed an anterior defect. This may be a limbus variant or a more anteriorly placed Schmorl's node". Only one child (5%) of the total number of patients

reported as being positive for Schmorl's nodes did not have back pain. No indication of pain was given for child 308PQ with thoracic kyphosis and scoliosis, and rotation of the vertebrae in the mid-thoracic region, accompanied by *rough* (Fig. 5.20), anterior Schmorl's nodes in both superior and inferior end plates at several levels. Transitional vertebrae accounted for 14% (3) of the children admitted with back pain, and 18% (4) with spondylolysis and spondylolisthesis.

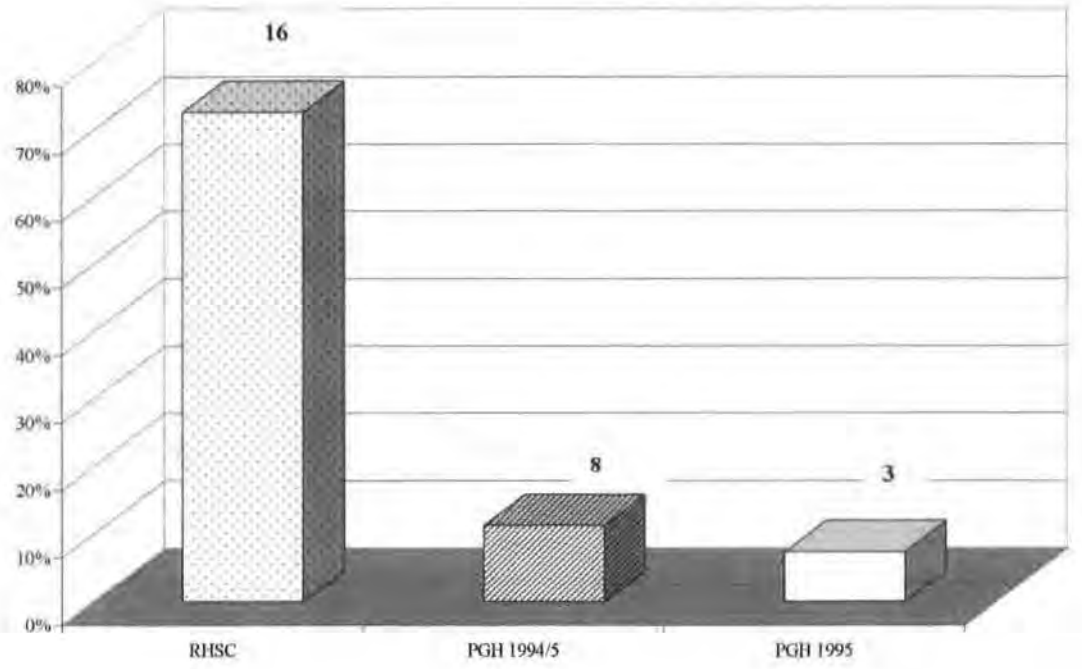

Figure 6.5 Numbers and percentages for individuals with irregular end plates where Schmorl's nodes had been diagnosed in the clinical samples

Scheuermann's disease, with accompanying *rough* anterior Schmorl's nodes, was diagnosed in 27% (6) of pain sufferer. Another 27% (6) were suffering from acute back pain, having fallen or jumped from a height. When admitted through the accident and emergency department, all had at least one Schmorl's node and several had sclerotic end plates. One other subadult suffering low back pain was diagnosed with loss of lordosis, thoracic scoliosis to the right and lumbar scoliosis to the left side. Smooth Schmorl's nodes (Fig. 5.21) were observed from the 1st to 3rd lumbar vertebrae. Patients diagnosed

with Scheuermann's disease, and patients admitted after falling from a height and reported as affected by Schmorl's nodes, were all reported as having irregular end plates.

Those patients without irregular end plates are listed below:

- 123AB scoliosis and lordosis
- 121TU congenital defects at lumbar vertebrae one and two (spinal dysraphism)
- 123DE asymmetry of leg length
- 101MN transitional vertebra
- 353ST exaggerated lordosis
- 122BA congenital defects of lumbar vertebrae

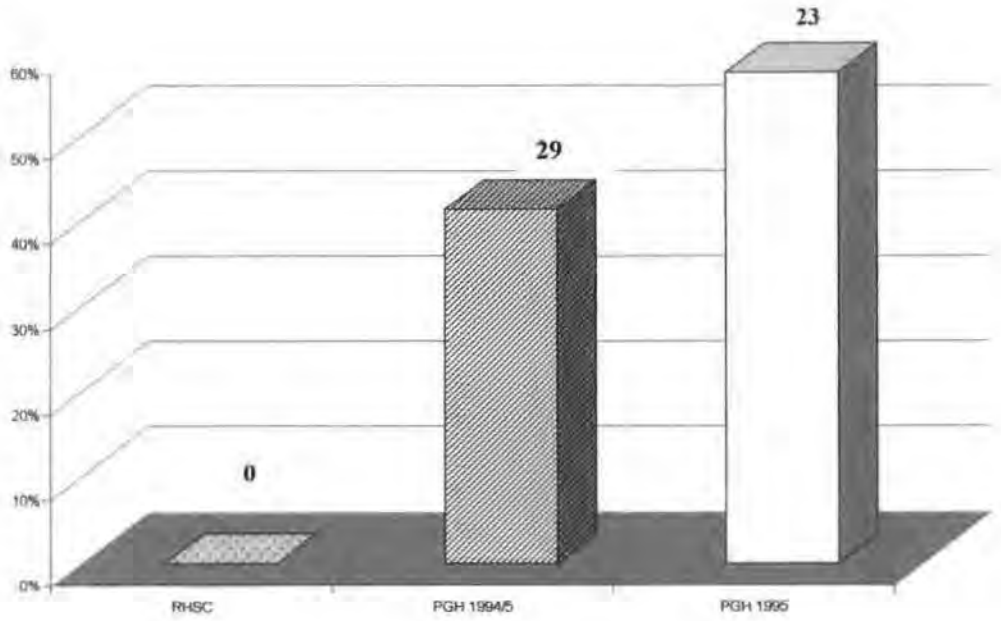

Figure 6.6 Numbers and percentages for individuals with reduced intervertebral disc height where Schmorl's nodes had been diagnosed in the clinical samples

One of the greatest differences in disorders reported in association with Schmorl's nodes was the high percentage of patients positive for irregular end plates in the

subadult group (70% (15) of the sample (Fig. 6.7)), compared to the high percentage of intervertebral disc height reduction in Pinderfields Hospital groups (Fig. 6.8).

6.3.3 Archaeological samples

Archaeologically it is impossible to prove or disprove acute pain when Schmorl's nodes are present within the vertebral bodies. Chronic pain can be proved to be associated with Schmorl's nodes where osteoarthritis, osteophytic growth and loss of lordosis are observed in clinical samples and therefore may be assumed to have been suffered by past populations with similar skeletal alterations. This assumption must at best be a tentative observation where similar skeletal observations were made.

(i) Captain's Cabin, Dunbar

Captain's Cabin included one individual (Sk 4) aged to over forty-five who had Schmorl's nodes, but no other skeletal markers, while another individual (Sk. 21) had a large posteriorly placed *rough* Schmorl's node in the superior end plate of the 1st lumbar vertebra which had broken through the posterior wall of the vertebral body. This fractured cortex may have protruded into the posterior neural arch compressing the spinal cord and causing acute pain. No lower limbs were available for analysis to assess sided bony mass reduction, or asymmetrical bone diameters and lengths, due to lack of use. Ten other skeletons with Schmorl's nodes suffered from spinal osteoarthritis and osteophyte formation at the same levels. The osteophytes showed no relationship to the Schmorl's nodes, that is to say they did not follow any regular pattern of positioning in relation to each other. In association with Schmorl's nodes, osteoarthritis was the most prevalent disease at 50% (21) of individuals, closely followed by osteophyte formation at 45% (19 individuals). Spondylolisthesis was observed in 2% (1) of the sample; this individual was a 26 to 35 year old woman (Sk 68), who did not have accompanying

spondylolysis. This same female was one of the 21% (9) individuals with trabecular loss and was one of the 67% (6) of females in the group. Retrololisthesis was found in 5% (2) of the sample positive for Schmorl's nodes, with the same female (Sk 68) suffering from spondylolisthesis of the 5th lumbar vertebra and retrolisthesis at the levels of the 12th thoracic and 1st lumbar vertebrae. Loss of lumbar lordosis was observed in 26% (11) individuals with 64% (7) of women and 36% (4) of men affected, with all of the men also found positive for mild osteochondritis, osteophyte formation and osteoarthritis. Only 50% (3) of the female individuals with loss of lordosis suffered from the same three disorders. Scoliosis was recorded in 10% (4) of individuals and, of these four, 50% (2) suffered from loss of lordosis. Irregular end plates were only observed in one 26 to 35 year old male (Sk 38), and sclerotic end plates were not observed within any vertebral column where Schmorl's nodes were observed.

(ii) The Hirsel, Coldstream

Posterior neural arch defects were more prevalent in this sample than in any other; these included spina bifida occulta, bilateral spondylolysis, and one individual (Sk 37) where the posterior neural arch was absent (had not formed during embryonic development) (Fig. 3.17). All had lived into adulthood and only three were associated with Schmorl's nodes. A male individual (Sk 69) had bilateral spondylolysis of the 5th lumbar vertebra without any noticeable bony alterations to the superior surface of the first sacral segment. The posterior neural arch of individual Sk 69 did not appear to have fused with the vertebral body on reaching maturation, as smoothed surface contours were present and fracture lines at the pars interarticularis were absent. The *rough* posterior Schmorl's node present in the superior end plate of the 12th thoracic vertebra had fractured the posterior wall of the vertebra causing intrusion of the cortex into the neural arch space; this may have caused significant pain. Skeleton 85 had a single central to posterior,

shallow, *rough* Schmorl's node situated on the superior surface of the 2nd lumbar vertebra; this was associated with vertebral osteoporosis, and osteoarthritis. The most unusual features of the vertebral column of this individual (Sk 85) were the narrow, almost triangular vertebral bodies with increased vertical, height. Individual Sk 121 was a male with spina bifida occulta without flaring of the bone at the pars interarticularis, and a centrally positioned Schmorl's node at the level of the 12th thoracic vertebrae, neither condition showed any associated bony alterations which might have suggested pain. Spondylolisthesis was also present in male skeleton Sk 222 with 8th, 9th and 11th thoracic vertebrae having Schmorl's nodes; osteoporosis and osteoarthritis were also observed in all vertebrae. One skeleton (Sk 282), a male of at least 45 years of age, had *rough*, deep, inferior end plate Schmorl's nodes from the 5th thoracic vertebra to the 3rd lumbar vertebra. He may have suffered acute pain, although this cannot be proved; these Schmorl's nodes appeared to be similar in appearance and number to the paediatric clinical cases of Schmorl's nodes caused by impact injury. All other vertebral columns of individuals with Schmorl's nodes had osteoarthritis and osteophyte formation, the latter having no clear correlation in position or size with those vertebrae found positive for Schmorl's nodes. The male individuals showed a clear bias in osteoarthritis at 71% (20), compared to the female prevalence of 29% (8),

(iii) Whithorn Priory, Galloway

This sample had the highest percentage of subadults in the 11 to 20 year age group, with 30% (3) of all skeletons found positive for Schmorl's nodes, and another 10% (1) in the 20 to 25 year age group. All of the skeletons of <25 years of age suffered multiple levels of Schmorl's nodes, while those aged to >45 years of age suffered only one or two Schmorl's nodes, and never in contiguous vertebrae. An 11 to 20 year old individual (Sk 460) suffered Schmorl's node intrusions from the 12th thoracic vertebra

to the 3rd lumbar vertebra in the superior vertebral end plates. A fractured inferior end plate at the level of the 1st lumbar vertebra, and a Schmorl's node in the inferior end plate of the 12th thoracic vertebra may indicate impact injury; all Schmorl's nodes were placed centrally within the vertebral bodies. Skeleton Sk 508 had Schmorl's nodes at the levels of the 11th and 12th thoracic vertebrae, and second lumbar vertebra, positioned posteriorly. The 1st lumbar vertebra showed no end plate intrusion at the time of death. A 26 to 35 year old unsexed individual suffered multiple Schmorl's nodes in both superior and inferior end plates from the level of the 9th thoracic vertebra to the 5th lumbar vertebra. Deep, *rough* contiguous anterior Schmorl's nodes were present in the 4th and 5th lumbar vertebrae with osteophyte formation at the anterior body margins, as if to stabilize the joint. Multiple Schmorl's nodes from the 6th thoracic to the 4th lumbar vertebra were present in a subadult individual (Sk 552), with the exception of 7th and 9th thoracic, and 1st and 2nd lumbar vertebrae. There were Schmorl's nodes in contiguous endplates at several levels with fine multiple entry points on several surfaces, representative of Schmorl's nodes which appeared to be similar to bunches of grapes. Where the Schmorl's nodes were not placed centrally there was osteophyte formation along the end plate margin, lateral to the Schmorl's node. At the level of the 6th thoracic vertebra, the Schmorl's node had fractured the posterior cortical wall of the vertebral body intruding into the posterior spinal cord space. The last vertebral column was of a 21 to 25 year old robust male (Sk 554), who had consecutive superior and inferior end plate Schmorl's nodes from the 6th thoracic to the 5th lumbar vertebra (except the fourth lumbar vertebra). Again, the position of osteophytes, where present, were always on the lateral margins of the end plates nearest to the Schmorl's nodes when they were laterally positioned (diagrammatic recording). Multiple contiguous Schmorl's nodes were present in vertebral columns of some subadults in this group but they were not included in the data set because vertebral columns were incomplete.

(iv) St. Andrew, Fishergate, York

Forty-nine vertebral columns (30% of the recorded individuals) proved positive for Schmorl's nodes. Schmorl's nodes in facing end plates of several consecutive vertebrae, the minimum being four and the maximum twelve, affected only eleven individuals (22%).

Sk 7: A male aged 36 to 45 years was affected by rough, posterior Schmorl's nodes in facing end plates from the 4th to the 9th thoracic vertebrae. Mild osteochondritis was present, and scoliosis with a curve to the right was observed.

Sk 14: A male aged 26 to 35 years suffered from scoliosis with the thoracic spine curving to the left, osteophyte formation on the right side of the vertebral bodies, and mild osteochondritis at all levels of the thoracic spine. Centrally positioned Schmorl's nodes from the 5th to the 9th thoracic affected all vertebrae and there was sacralisation of the 5th lumbar vertebra's right lateral pedicle.

Sk 30: A male aged 26 to 35 years was affected by *rough,* posterior Schmorl's nodes in facing end plates of the 1st to 4th lumbar vertebrae; again mild osteochondritis was present and the posterior longitudinal ligament was calcified from the 5th to the 12th thoracic vertebra.

Sk 41: A 26 to 35 year old male was affected by central and posterior Schmorl's nodes from the 6th thoracic vertebra to 5th lumbar vertebra, in facing end plates. These large, *rough,* and deep Schmorl's nodes were accompanied by mild osteochondritis. At the level of the 2nd lumbar vertebra, the Schmorl's node had broken through the cortical bone of the body's posterior wall, intruding into the posterior neural arch space.

Sk 145: A female aged 26 to 35 years was affected by *rough*, posterior Schmorl's nodes in facing end plates from the 9th thoracic vertebra to the 3rd lumbar vertebra, excepting the tenth thoracic vertebra. Again, scoliosis was observed with a curve to the right.

Sk 184: A male aged 36 to 45 was affected by *rough* and *smooth* Schmorl's nodes positioned both centrally and posteriorly from the 2nd thoracic vertebra to the 12th thoracic vertebra.

Sk 226: A male aged 26 to 35 years was affected by *smooth*, posterior Schmorl's nodes from the 10th to the 12th thoracic vertebrae. Scoliosis was observed with the curve convex to the right.

Sk 231: A male aged >45 years, was affected by *smooth* Schmorl's nodes from the 12th thoracic vertebra to the 4th lumbar vertebra, with spinal osteoporosis and mild osteochondritis.

Sk 289: A male aged 35 to 45 years was affected by *rough*, deep, Schmorl's nodes from the 9th thoracic to the 2nd lumbar vertebra, positioned centrally and posteriorly. At the 10th and 11th thoracic vertebrae the Schmorl's nodes in the facing end plates had fractured the cortical bone of the posterior vertebral bodies, impinging on the neural arch spaces.

Sk 328: A female aged 26 to 35 years, was affected by shallow, *rough*, central, and posteriorly positioned Schmorl's nodes from the 8th to 12th thoracic vertebrae with superior and inferior end plate involvement.

Sk 414: A male aged 26 to 35 years with *smooth*, centrally placed Schmorl's nodes in facing end plates from the 11^{th} thoracic to the 2^{nd} lumbar vertebra.

(v) Tanners Row, Pontefract

Only one or two vertebrae within each vertebral column were positive for Schmorl's nodes within this sample, and only single end plates were involved. This sample had a higher rate of associated osteoporosis than any other archaeological sample

6.4 Schmorl's nodes and their relationship to age

6.4.1 Clinical and archaeological data

Unexpectedly the youngest age range and the oldest age range did not produce the greatest number of Schmorl's nodes. One exception to this was the Hirsel sample where the individuals in the >45 years age range had the greatest number of Schmorl's nodes and these were mainly in the thoracic spine, which matched the Captain's Cabin sample in the levels affected but not the age range. The RHSC and both Pinderfields Hospital samples had a constant greatest level of Schmorl's nodes at the level of the 1^{st} lumbar vertebra through all the age ranges.

(i) 1994-5 Pinderfields Hospital sample and the Royal Hospital for Sick Children I

The decision to place half of the Royal Hospital for Sick Children sample with the adult population of the 1994-5 Pinderfields Hospital sample (Fig. 6.9), when testing this hypothesis, was done in order to provide a subadult population which no longer occurs naturally in modern medical practice (Fig. 6.7). Paediatric medicine is now accepted as best practice for subadult patients, where they are treated as individuals with their own diseases and disorders, their own treatments and recovery rates. This group of 1994-5

Pinderfields Hospital patients and half of the Royal Hospital for Sick Children sample gave a total sample of 1682 patients and 5% (70) of the individuals were reported as having Schmorl's nodes. The age group with the highest percentage of vertebral columns found positive for Schmorl's nodes was the >45 year age group at 32% (26) (Appendix 3, Table. 6.7). This age group was composed of 14 females (54%), 12 males 46%. Only 2% (2) of children in the 6 to 10 year age group had Schmorl's nodes, while the 11 to 15 year age group made up 12% (10), and the 16 to 20 year age group made up just 1% (1) of the total.

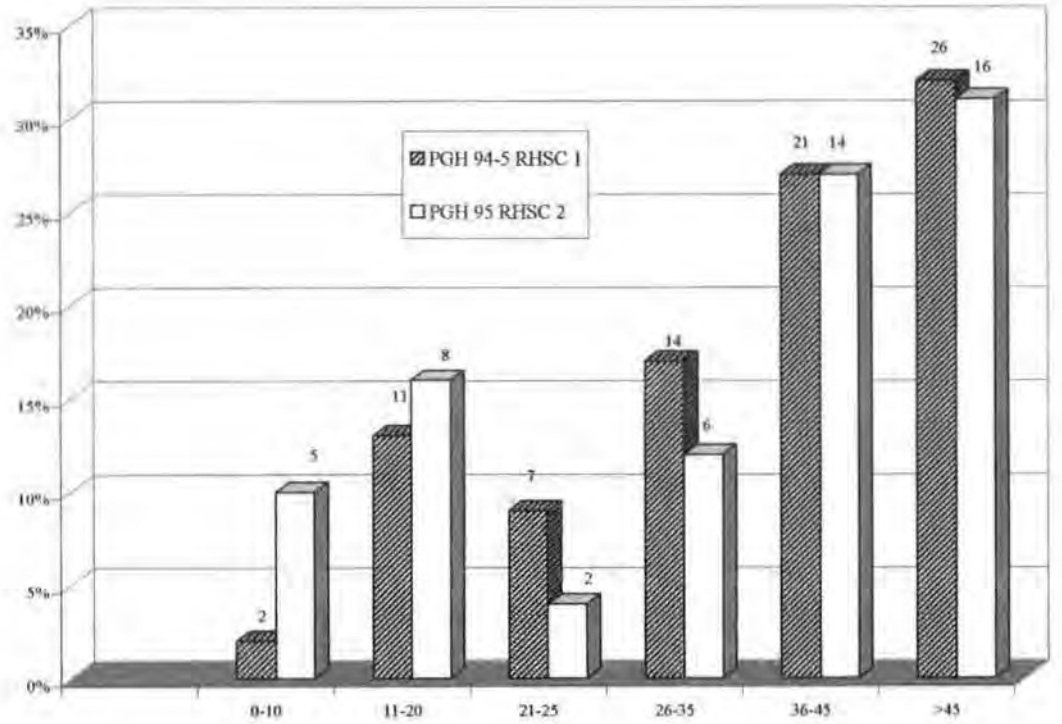

Figure 6.7 Age groups in which Schmorl's nodes were first reported within the 1994-5 Pinderfields Hospital and RHSC I sample, and the 1995 Pinderfields Hospital and RHSC II sample

A separate group of 21 to 25 year olds was formed, as the vertebral end plates have a variable fusion age of between 20 and 25 years of age; this produced a 9% (7) positive rate for Schmorl's nodes, but even with the addition of the first four age groups it only produced a 24% (20) rate. The 1 to 20 year old individuals provided only 15% (13) of the total Schmorl's node patients, or 17% (13) less than the > 45 year age group.

Adding the 21 to 25 year age group raises the percentage of Schmorl's node individuals to 24% (20) which still falls short of the >45 age group by 8% (6). Reversal of the male to female data was found within the 21 to 25 year age group where 29% (2) of females were affected compared to a 71% (5) of males.

(ii) 1995 Pinderfields Hospital and the Royal Hospital for Sick Children II

The 1995 Pinderfields Hospital sample was amalgamated with the second Royal Hospital for Sick Children sample to provide a subadult population which could not occur naturally due to the clinical requirement of specialist expertise for disease and disorders in subadults (Appendix 3, Tables 6.8). This was to look for any large variations within each of the age groups (Fig. 6.9). This group had an 8% (3) greater number of patients in the 6 to 10 year age group, 4% (6) less in the 11 to 15 year age group, and a 7% (3) greater number in the 16-20 year age group. The individuals in the 21 to 25 year age group showed a 5% (5) reduction when compared to the previous clinical sample; the 36 to 45 year age group again comprised 27% (14) of the total sample, with 79% (11) of females and 21% (3) of males affected.

Amalgamating the first five age groups ranging from 0 to 25 years, produced a significant 30% (15) of the total sample affected by Schmorl's nodes, or 3% (1) more than the 36 to 45 year age group. Ten percent (5) of the 0 to 10 year old group and 16% (8) of the eleven to twenty year old group (total 26%) was 1% (1) less than the frequency in the 36 to 45 year age group.

6.4.2 Archaeological data

(i) Captains Cabin

Twenty-five skeletons in this sample were complete enough to test this hypothesis with 52% (13) positive and 48% (12) negative for Schmorl's nodes (Fig. 6.10). No individual aged 0 to 10 years had Schmorl's nodes (Appendix 3, Fig. 6.9). The second decade had an 8% incidence (1) deep Schmorl's nodes with fine entry points in the end plates of the ninth and tenth thoracic vertebrae. The negative findings for the 21 to 25 year age group were the only negative result within the clinical and osteoarchaeological samples for this age group. The upward trend in the 36 to 45 year age group observed in the clinical samples was repeated here with a 46% (10) positive group. Skeletons aged at > 45 years showed a relatively low rate of only 15% (2), while the 26 to 35 age group gave the second highest rate of 31% (5).

(ii) The Hirsel

Eighteen vertebral columns derived for skeletons aged between 1 and 20 years but none had Schmorl's nodes, or end plate weakness in both decades (Appendix 3, Fig. 6.9). One vertebral column (Sk 190) in the 21 to 25 year age group had inferior endplate Schmorl's nodes in the 1st and 2nd lumbar vertebrae; this represented 10% of all Schmorl's nodes sufferers in this group. The highest rate of Schmorl's nodes (40% or 13) was in the >45 year old age group and not the 0 to 25 year old age group.

(iii) Whithorn Priory

Three skeletons (30%) positive for Schmorl's nodes aged between 11 and 20 years had multiple Schmorl's nodes in facing end plates; this presentation of multiple Schmorl's nodes could possibly place them in the acute traumatic group (Appendix 4, Fig. 6.15). One vertebral column (Sk 554) of a robust male (10%), in the 21-25 age group, was also found positive for Schmorl's nodes at multiple levels. All of these vertebral columns again mimicked the clinical acute trauma model, i.e. multiple Schmorl's nodes in

contiguous vertebrae. The 11 to 25 year age group composed 40% (4) of the positive sample, 10% more than the >45 year age group which was equal to the 30% (3) observed for individuals in the first two decades of life.

(iv) St. Andrew, Fishergate

Fishergate, with its urban status and medieval industrialised work force, had the lowest rates of Schmorl's nodes in its subadult population (0%). Adding the 21 to 25 age group into the subadult population produces a 2% (1) overall rate (Fig. 6.10). This was the lowest rate recorded within the archaeological samples studied (Appendix 3, Table. 6.9). Vertebral column 268 had only two *rough*, posteriorly placed Schmorl's nodes in the inferior end plates of the eighth and eleventh thoracic vertebrae. The only other disorder observed in this sample was spina bifida occulta of the sacral segments.

(v) Tanners Row

This sample had a 0% incidence for Schmorl's nodes in the first two decades of life and a 17% (1) rate for the 21 to 25 year age group. The female skeleton (Sk. 4) had two Schmorl's nodes which were *rough* and centrally positioned in the superior end plates of the 1st and 2nd lumbar vertebrae; these did not appear traumatic in origin.

6.4.3 Comparisons of Schmorl's nodes for defined age ranges: clinical and archaeological

(i) Prenatal to ten years of age

Without exception, the archaeological samples were negative for Schmorl's nodes within this age group (Appendix 3, Table 6.9). Clinical patients in this group presenting for radiographic imaging were diagnosed with congenital vertebral abnormalities,

Scheuermann's disease, or scoliosis where Schmorl's nodes were present. No subadults under six years of age in the RHSC sample were reported as positive for Schmorl's nodes. Subadults 6 to 10 years of age were observed as having a greater number of Schmorl's nodes in the inferior end plates of the vertebral bodies (Appendix 5, Fig. 6.28). Those subadults with altered curvature of the spine had all been radiographed at the request of their GP, following parental observation of altered curvature of their children's spines during bending and twisting as they were dressed, or undressed at bath time, or when getting up in the morning.

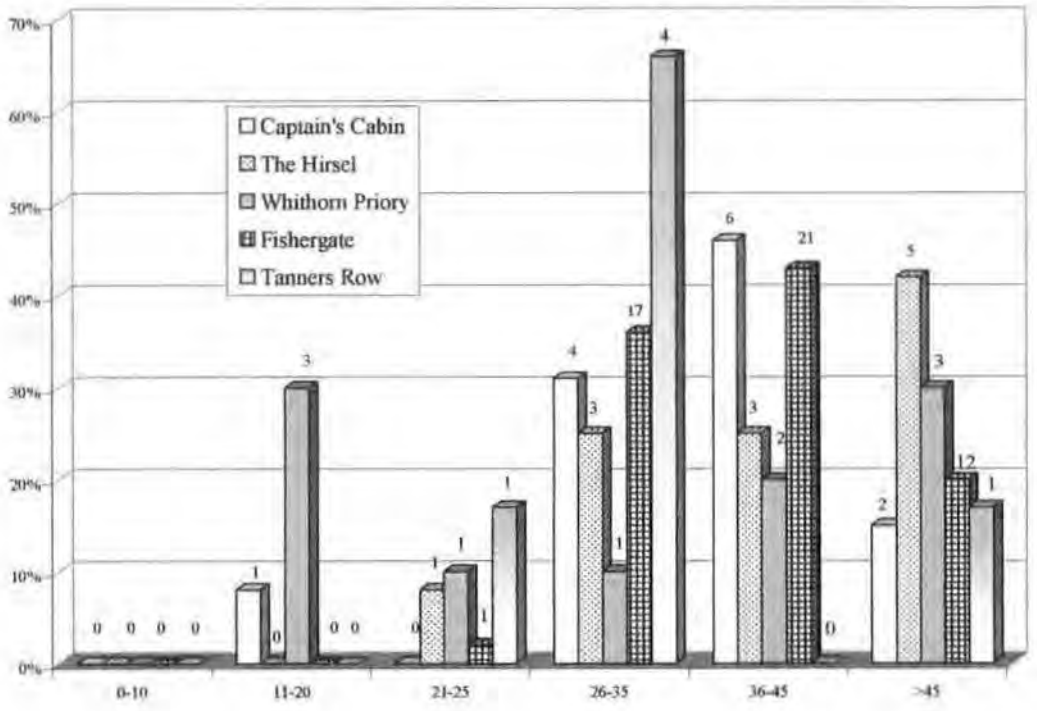

Figure 6.8 Numbers and percentages by age groups for all individuals found positive for Schmorl's nodes in the Captain's Cabin, Dunbar; the Hirsel, Coldstream; Whithorn Priory, Galloway, St. Andrew, Fishergate and the Tanners Row, Pontefract samples.

(ii) Eleven to twenty years of age

(a) Clinical data

Both female subadult individuals, of the 1994-5 Pinderfields Hospital sample, (Appendix 5, Table 6.18), who had Schmorl's nodes in the superior end plates of the 1st

and 2nd lumbar vertebra. The 1995 Pinderfields sample again comprised to female individuals whose incident rates and levels affected mirrored those of the 1994-5 Pinderfields Hospital sample (Appendix 5, Table. 6.23). Clinical rates for Schmorl's nodes for the subadults of the Royal Hospital for Sick Children sample were most common at the level of the 1st lumbar vertebra with the inferior end plate being affected at 50% (8), and the superior end plates at 38% (6) (Appendix 5, Fig. 6.29). The lumbar vertebrae showed a greater rate in both superior and inferior end plates, compared to the thoracic vertebrae in this clinical group.

(b) Archaeological data

The Hirsel, Coldstream, St. Andrew, Fishergate, and Tanners Row presented no evidence in this age group (Appendix 3, Table 6.9). Only one vertebral column (Sk 71) in the Captain's Cabin sample contained *rough*, central Schmorl's nodes at the levels of the 8th to 10th thoracic vertebrae (Appendix 6, Table 6.18 and Appendix 7, Table 6.26). The Whithorn Priory sample had a 30% (3) frequency of multiple Schmorl's nodes, with the greatest number at the level of the 12th thoracic vertebra, and both the superior and inferior end plates in all cases (Appendix 5, Fig. 6.36). All other skeletons in this group were negative for any other disorder or disease. End plate intrusions by Schmorl's nodes were much more evenly distributed between superior and inferior end plates within the clinical sample than that of the Whithorn Priory sample. The Whithorn sample for this age group displayed only inferior endplate intrusions of the thoracic spine except in the 12th thoracic vertebra where 100% (3) of the vertebrae had Schmorl's nodes in both superior and inferior end plates. Superior end plate lesions were predominant within the lumbar vertebrae, with the exception of the 3rd lumbar vertebra. The Royal Hospital for Sick Children sample had an almost even declining percentage of Schmorl's nodes within the inferior end plates of the lumbar vertebra:

- Lumbar 1: 50% (8)
- Lumbar 2: 38% (6)
- Lumbar 3: 32% (5)
- Lumbar 4: 32% (5)
- Lumbar 5: 6% (1)

with the highest rate at the level of the first lumbar vertebrae (Appendix 5, Fig. 6.29).

(iii) Twenty-one to twenty-five years old

(a) Clinical data

This age group produced wide variations in frequency between the samples. The 1994-5 Pinderfields Hospital sample (Appendix 5, Fig. 6.19) produced seven individuals positive for Schmorl's nodes five males and three females (Appendix 7, Tables 6.23a and 6.23b).Three of the five males affected by Schmorl's nodes also proved positive for scoliosis, and one male (CD142) also had osteoarthritis of the vertebral column. Another male affected by Schmorl's nodes suffered loss of intervertebral disc height, but no other diseases or disorders. One female (DC122) with Schmorl's nodes had both scoliosis and loss of intervertebral disc height, while the second female (ED268) had Schmorl's nodes without any other disorder or disease being observed. The 1995 Pinderfields Hospital sample (Appendix 6, Table 6.16) consisted of only two males; the first (ML 578) with Schmorl's nodes had no other disorders or diseases present. The second male (NK265) suffered a single Schmorl's node at the level of the 3rd lumbar vertebra with spondylolysis of the 4th lumbar vertebra and loss of intervertebral disc height at the levels of the 3rd and 4th lumbar vertebral segments. This sample showed an unusually low prevalence for Schmorl's nodes, with

the two 3rd lumbar vertebrae both being affected (Appendix 5, Fig. 6.24). Whether both clinical samples are treated as a single sample or two separate samples, the 1st lumbar vertebra remained the vertebra most affected by Schmorl's nodes in both endplates, while the 12th thoracic vertebra showed a clear shift to being affected by a single inferior end plate Schmorl's nodes in all vertebral columns.

(b) Archaeological data

In the archaeological samples for this age range there was a paucity of Schmorl's nodes with Captain's Cabin, Dunbar producing negative evidence and the other sites only produced a single individual, each with Schmorl's nodes. Whithorn Priory no longer produced a high rate for Schmorl's nodes. A single male (Sk 554) with multiple superior and inferior end plate Schmorl's nodes, commencing at the level of the inferior end plate of the 6th thoracic vertebra, and terminating at the inferior end plate of the 5th lumbar vertebra. Skeleton 554 suffered from osteoarthritis of the vertebral column and marginal osteophytes at the levels of the Schmorl's nodes. St. Andrew, Fishergate produced only one male (Sk 268) with a single inferior end plate intrusions at the levels of the 8th and 10th thoracic vertebrae; this skeleton was also positive for spina bifida occulta at the level of the 5th lumbar vertebra and all segments of the sacrum, no other disorder or disease was observed. A single female (Sk 4) from the Tanners Row sample had Schmorl's nodes in the superior end plates of the 1st and 2nd lumbar vertebrae and irregular superior end plates.

(iv) Twenty-six to thirty-five years old

(a) Clinical data

In the 1994-5 Pinderfields Hospital sample the 1st lumbar vertebra is now clearly the

level of the greatest number of inferior end plate Schmorl's node intrusions at 50% (7), closely followed by 42% (5) at the level of the inferior end plate of the 3rd lumbar vertebra. Inferior vertebral end plates from the 6th to 11th thoracic vertebra all have an 8% Schmorl's node rate, while the lumbar spine remains the area within the vertebral column with the greater Schmorl's nodes rates (Appendix 5, Fig. 6.20). The 1995 Pinderfields Hospital sample had a smaller number of Schmorl's nodes (Appendix 5, Fig. 6. 25) when compared to the previous age range of 21 to 26 years of age (Appendix 5, Fig. 6.24). The superior vertebral end plate of the 1st lumbar vertebra became the level of greatest frequency of Schmorl's nodes.

(b) Archaeological data

There was a definite upward trend of Schmorl's node frequency within this age group, with one exception; the Hirsel sample produced one individual (Sk 121) with a single inferior end plate intrusion of the 12th thoracic vertebra. The archaeological samples, with the exception of the Hirsel, began to show an upward trend in frequency within this age group. Individuals in the Captain's Cabin sample showed a frequency of between 20%(1) and 40% (2) from the level of the 7th thoracic to the 4th lumbar vertebra in both superior and inferior end plates (Appendix 5, Fig. 6.30). The 2nd lumbar vertebra stood alone with a 60% (3) rate, involving only the superior end plate. Whithorn Priory (Appendix 5, Fig 6.37) had a 100% (1) superior and inferior end plate Schmorl's node rate at the levels of the 11th and 12th thoracic vertebrae. One person (100%) had single inferior end plate Schmorl's nodes at the levels of the 9th and 10th thoracic vertebrae and the 2nd lumbar vertebra with the superior end plate of the 4th lumbar vertebra suffering an equal rate. Fishergate (Appendix 5, Fig. 6.40) had the highest rate of Schmorl's nodes of all the samples, commencing in the superior end plate of the 6th thoracic vertebra and terminating in the inferior end plate of the 5th lumbar vertebra. No vertebral end plate was exempt from Schmorl's nodes at any level from the 6th thoracic vertebra

to the 5th lumbar vertebra, with the higher rates at the levels of the 11th and 12th thoracic vertebrae. The twelfth thoracic vertebra had an equal rate for both its superior and inferior end plates (13% or 6), and the 11th thoracic vertebra was affected in 13% (6) of cases in the superior end plate, and 18% (7)in the inferior end plate. The superior end plate of the 1st lumbar vertebra of the Tanners Row sample (Appendix 5, Fig. 6.43) produced a 33% (2) prevalence. The only other vertebrae positive for Schmorl's nodes at (17% (1)) were the 12th thoracic vertebra, and the 3rd, 4th, and 5th lumbar vertebrae. The 4th and 5th lumbar vertebrae had inferior end plate Schmorl's nodes while the 3rd lumbar vertebra and 12th thoracic vertebrae had Schmorl's nodes of the superior end plate. Tanners Row and the Hirsel presented fewer Schmorl's nodes, commencing at a much lower level than the other samples for this age group.

(v) Thirty-six to forty-five years old

(a) Clinical data

From the 9th thoracic to the 5th lumbar vertebra of the clinical samples (Appendix 5, Fig. Fig. 6.21 and Fig. 6.26), Schmorl's nodes were present in similar numbers to those of the younger age groups, with the 1st lumbar vertebra remaining the most commonly affected by Schmorl's nodes within the superior and inferior end plates.

(b) Archaeological data

The Hirsel sample (Appendix 5. Fig. 6.34) had three males affected by Schmorl's nodes within this age group, but these were at higher levels than in the previous age group. Vertebrae had either superior or inferior end plate Schmorl's nodes, with a rate of 7% (1) overall. The only superior end plate Schmorl's nodes were observed in the 9th and 12th thoracic vertebrae, while the 8th and 11th thoracic vertebrae and the 2nd lumbar

vertebra had Schmorl's nodes in their inferior end plates. Schmorl's nodes in the Captain's Cabin sample (Appendix 5, Fig. 6.31) showed a shift in highest frequency from the 10th and 11th thoracic vertebrae in the previous age group to the 8th and 9th thoracic vertebrae in this age group. The same vertebrae were found to be positive for Schmorl's nodes with the exception of the 2nd lumbar vertebra which, in the previous age range, showed a 60% (3) rate, and in this age range a zero rate. A shift in highest frequency rates for Schmorl's nodes from superior to inferior end plate, and vice versa, was noted in the remaining vertebrae. The Hirsel (Appendix 5, Fig. 6.34) continued to produce a low rate for Schmorl's nodes, with only an 8% (1) superior endplate involvement in the 9th and 11th thoracic vertebrae, and inferior end plate involvement of 8% (1) in the 8th and 11th thoracic and second lumbar vertebrae. Whithorn Priory (Appendix 5, Fig. 6.38) produced a sudden increase in the number of vertebrae with Schmorl's nodes, from only six vertebrae in the previous age group, to every vertebra from the 6th thoracic to the 5th lumbar vertebra. 50% (2) superior end plate Schmorl's nodes were seen in the 5th lumbar vertebra and 25% (1) within the inferior end plate. A remarkably even 25% rate for Schmorl's nodes was observed in all superior and inferior end plates of the affected vertebrae. Fishergate (Appendix, Fig. 6.41) individuals in this age group had only one level of vertebra unaffected by Schmorl's nodes (the 1st thoracic). The 11th thoracic vertebra had a slightly higher rate than the 12th thoracic vertebra, with the superior vertebral end plate having a 6% (3) greater rate and the inferior vertebral end plate a 2% (1) reduced rate. Tanners Row had a zero rate due to a lack of preserved skeletons within this age group with complete vertebral columns.

(vi) Over forty-five years of age

(a) Clinical data

The clinical samples of the older individuals (Appendix 5, Fig. 6.22 and Fig. 6.27) were categorised to place them in the >45 years age group of the archaeological samples, to allow comparable data to be produced. There was a slight shift from the 1st to 2nd lumbar vertebra for the level affected by greatest number of Schmorl's nodes, while the 9th thoracic vertebra once again showed a zero rate.

(b) Archaeological data

In this age group, the Captain's Cabin sample produced only two individuals with vertebral columns showing Schmorl's nodes (Appendix 5, Fig. 6.32). The first (Sk 52), had inferior vertebral end plate lesions at the levels of the 7th and 8th thoracic vertebrae, and the second (Sk 44) had a single inferior vertebral end plate lesion at the level of 2nd lumbar vertebra, a reversal of the trend within the clinical sample of this age group of high levels of Schmorl's node. Again, the trend changes when comparing the younger age groups of the Hirsel with this age group (Appendix 5, Fig. 6.35); sudden increases in Schmorl's nodes within many more vertebrae affected were recorded. Levels of vertebral end plates affected by Schmorl's nodes were observed from the 5th thoracic to the 3rd lumbar vertebra, without exception. The highest rate of Schmorl's nodes was recorded in the inferior end plate of the 8th thoracic vertebra at 23% (3), closely followed by the 9th thoracic vertebra at 16% (2) inferior end plate rate, and an 8% (1) rate in the superior vertebral end plate. Apart from the 9th thoracic vertebra, all vertebrae from the 5th to 11th thoracic vertebrae displayed only inferior end plate Schmorl's nodes. The 12th thoracic to 2nd lumbar vertebrae were equally affected in the superior and inferior end plates at 8% (1). The 3rd lumbar vertebra again was observed as having an 8% (1) inferior end plate rate, as were the 5th to 7th thoracic vertebrae. Whithorn Priory had a much-reduced Schmorl's node rate compared to the 26 to 35 year and the 36 to 45 year age groups (Appendix 5, Fig. 6.39). The 2nd lumbar vertebra produced a 40% (2)

inferior vertebral end plate rate and a superior vertebral end plate rate of 20% (1). Only four vertebrae had evidence of Schmorl's nodes in either the superior and/or inferior vertebral end plates from the 12th thoracic to the 4th lumbar vertebra, with the exception of the 1st lumbar vertebra. Fishergate (Appendix 5, Fig. 6.42) again showed single end plate involvement with fewer vertebrae having Schmorl's nodes. The higher rates had shifted from the 11th to 12th thoracic vertebra when compared with the Captain's Cabin data and, apart from this 12th thoracic vertebra, only the 1st lumbar vertebra had both superior and inferior end plate involvement. Tanners Row (Appendix 5, Fig. 6.44) produced only two individuals with Schmorl's nodes, both with single vertebral end plate Schmorl's nodes. The first skeleton's vertebral column (Sk 26), a male, had a superior end plate Schmorl's node in the 6th thoracic vertebra and an inferior end plate Schmorl's node at the level of the 1st lumbar vertebra. Two inferior end plate Schmorl's nodes at the levels of the 10th and 11th thoracic vertebrae were recorded in the second skeleton (Sk 1), a female.

6.5 Altered dynamics of the vertebral column

Measuring minimal vertebral column shift, be it scoliotic, lordotic, or kyphotic is a much more straightforward measurement in clinical diagnosis where all soft tissues and organs are present, than it is where only the skeleton available.

6.5.1 Clinical data

Schmorl's nodes in the adult clinical populations are present in a significantly high number (25%) of individuals presenting with scoliotic and kyphotic vertebral columns. The subadult incident rate was higher still at 32% (7) of those with Schmorl's nodes.

(i) Pinderfields Hospital

One quarter (25%) of all Schmorl's nodes patients in this group had varying degrees of scoliosis reported. In the 1994-5 Pinderfields Hospital sample a 37% (13) rate was reported, and in the 1995 Pinderfields Hospital sample a 63% (12) rate was observed, giving a combined positive rate of 22% (25). The male to female prevalence was relatively close, with a 52% (13) female to 48% (12) male rate for scoliosis; a noticeable bias to the side of the concave curvature of the spine caused by eccentric intrusion of the nucleus pulposus through the end plates. Scoliosis to the left was associated with *rough* posterior Schmorl's nodes eccentrically positioned to the right of mid-line or sagittal plane, and scoliotic shift to the right where the affected end plates were to the left of mid-line. Kyphosis was accompanied by scoliosis where anterior Schmorl's nodes were present with irregular end plates; this sided bias was similar to that of the scoliotic patients. All patients without exception reported pain and, in two cases tenderness at the levels of the vertebrae found positive for Schmorl's nodes, were mentioned within the x-ray request data provided by the GP. In the female group, 26% (6) fell within the 41 to 55 year age range, placing these patients within the pre- and post-menopausal years. The three older patients within this age range (13%) were also having their phosphate levels checked and DEXA scanning undertaken. The remaining female patient (4%) attended with a specific tender spot at the level of the 1st and 2nd lumbar vertebrae following back injury incurred while helping with a patient transfer at her place of work; Schmorl's nodes were diagnosed at the levels of the vertebral column mentioned as pain specific on the x-ray request form. The Schmorl's nodes were accompanied by sclerotic end plates in several superior and inferior vertebrae adjacent to the vertebrae found positive for Schmorl's nodes, and scoliosis centred on the 2nd lumbar vertebra.

The male patients with Schmorl's nodes and scoliosis sat within a much narrower age range than the females of the Pinderfields clinical groups. Only three patients (25%) sat

outside the 30 to 50 year age range; they were all within the 21 to 25 age group, and they all had multiple, *rough*, posterior Schmorl's nodes in adjacent vertebrae with sclerotic end plates at the levels of insult and in several superior and inferior vertebral bodies. One patient aged fifty (8%) had a class II spondylolisthesis at the level of the 5th lumbar vertebra and the 1st sacral segment, and spondylolysis of the 5th lumbar vertebra. Active Schmorl's nodes from the 1st to the 4th lumbar vertebra in facing end plates with sclerosis were associated with this spondylolisthesis, and scoliosis convex to the right. Scoliosis with the same eccentric, *rough* and *smooth* posterior Schmorl's nodes were observed in the remaining 72% (9) of the positive male population.

(ii) Royal Hospital for Sick Children

Twenty-two paediatric patients (5%) of the sample were found positive for Schmorl's nodes and, of this group, only 36% or eight vertebral columns were reported as being scoliotic or kyphotic. Fusion defects of the vertebral column and a transitional vertebra at the level of 1st lumbar vertebra of one patient (122BA) were the main contributing factors causing Schmorl's nodes, scoliotic shift and rotation of the vertebral column; fronto-metaphyseal dysplasia and osteoporosis were present, contributing to reduced resistance of the end plates to pressure. Scheuermann's disease was diagnosed in one patient (170EF) where facing end plates from the 11th thoracic to the 4th lumbar vertebra had anterior Schmorl's nodes with accompanying wedging. The kyphosis was accompanied by slight scoliosis to the right where the wedging of the vertebral bodies appeared to be greater in the left antero-lateral margins. Scheuermann's disease with kyphosis and scoliosis was reported in patient 308PQ who had anterior Schmorl's nodes with an asymmetrical appearance when viewed in antero-posterior radiographic images. The scoliosis was convex to the left within the upper thoracic kyphosis. Patients 123AB and 101MN each had a transitional 5th lumbar vertebra with right sided sacralisation,

and smooth, slightly off-centre Schmorl's nodes to the left, supporting a convex scoliosis to the right. The remaining scoliotic patients had a scoliosis centred on the vertebra central to the multiple occurrences of Schmorl's nodes in facing vertebral end plates.

6.5.2 Archaeological data

Only one sample was found to have no Schmorl's nodes and scoliosis (Tanners Row, Pontefract). St Andrew, Fishergate was the only sample which reflected the adult clinical results in numbers affected, and in the almost even division between males and females.

(i) Captain's Cabin, Dunbar produced only a single vertebral column with Schmorl's nodes and associated scoliosis. A male (Sk 29) of 36 to 45 years of age with Schmorl's nodes in facing end plates from the 7^{th} to the 12^{th} thoracic vertebra had a scoliotic curve to the right with almost complete osteophytic fusion of the right antero-lateral borders of the 9^{th} and 10^{th} thoracic vertebrae. This individual male (Sk. 29) was also positive for osteoarthritis of the superior and inferior articular processes at the same levels (Appendix 7, Table 6.25).

(ii) In the Hirsel cemetery population, two vertebral columns had both scoliosis and Schmorl's nodes (Appendix 7m Table 6.26a and 6.26b); this sample was the only one where scoliosis was accompanied by a single deep Schmorl's node. The first individual, a male of >45 years of age (Sk 288) had a single large deep *rough* Schmorl's node in the superior end plate of the 12^{th} thoracic vertebra with scoliosis, convex to the right, and osteophytic growth on the antero-superior vertebral body border with marginally greater bone formation to the right. The second vertebral column (Sk. 85) was also from

a male, but of 36 to 45 years of age. The vertebral column comprised unusually narrow vertebrae in the horizontal plane and much greater in vertical height than would be observed in an average to robust vertebral body. The convex scoliotic curve was convex to the left, centred on a single deep, *rough*, posterior Schmorl's node in the superior end plate of the second lumbar vertebra. This same individual (Sk. 85) was also observed as having osteoarthritis, osteoporosis, and early osteophyte formation of the affected and immediately superior and inferior vertebrae.

(iii) Whithorn Priory produced a single female with a scoliotic vertebral column where Schmorl's nodes were present. This individual (Sk 539) had multiple end plate intrusions ranging from anterior to central and posterior, between the 7^{th} thoracic and the 5^{th} lumbar vertebra. There was slight wedging to the right antero-lateral border of several vertebrae, with those vertebrae beginning to look as though there was a change of status from deep *rough* Schmorl's nodes to collapse of vertebrae due to osteoporosis, or due to lytic lesions (Appendix 7, Table 6.27).

(iv) Fishergate produced a 20% (8) positive scoliotic group of Schmorl's nodes sufferers, of these 64% (5) were male and 36% (3) were female. Two age groups age covered the male scoliotic groups, with 60% (3) in the 36 to 45 year age group and 40% (2) in the over forty-five year age group. The scoliosis had a definite bias within this group of 100% convex to the right in the male population and 88%(7) of the positive group had multiple end plate insults by Schmorls nodes. Only one vertebral column suffered a single large, deep, Schmorl's node that caused end plate disruption anteriorly, medially, and posteriorly, and was positioned eccentrically to the right with osteophytic growth on the superior postero-lateral border. The females with Schmorl's nodes also fell into two age groups, the >45 age group consisting of 33% (1) and the 26

to 35 year age group making up the other 67% (2). One female (Sk. 145) of 25 to 35 years of age suffered acute posterior Schmorl's nodes in the lower thoracic spine and all of the lumbar vertebrae, with a scoliotic shift convex to the left.

6.6 Schmorl's nodes and their relationship to sex

6.6.1 Clinical data

Comparing the levels within the vertebral columns at which Schmorl's nodes were most prevalent, both male to female, and group-to-group, showed variations between those groups (Appendix 6, Tables 6.14a and 6.14b; 6.15; 6.16). Males and females within the 1994-5 Pinderfields Hospital sample and RHSC I sample were found to have the greatest number of Schmorl's nodes within the 1st lumbar vertebra, the males at 59% (23) having a 9% (2) greater rate of insult than the females. The 12th thoracic vertebra in both the males and females of this group had the highest rate (14% (6) reduction for the males and a 5% (2) reduction for the females when compared to the 1st lumbar vertebra). In the 1995 Pinderfields Hospital sample and RHSC II sample, the females produced their highest rate of Schmorl's nodes at 71% (22) within the 2nd lumbar vertebra, closely followed by the 1st lumbar vertebra at 68% (21). At the same level, the males of the group produced a 50% (10) rate within the 1st and 2nd lumbar vertebrae, and an equal incident rate of 35% (7) in the 12th thoracic vertebra, and the 3rd and 4th lumbar vertebrae. Female patients in the 1994-5 Pinderfields Hospital and RHSC I sample had their highest percentage of Schmorl's nodes within the 1st lumbar vertebra, whereas the Pinderfields 1995 and RHSC II group produced a caudad shift to the 2nd lumbar vertebra. When the male clinical groups were compared, the highest levels of Schmorl's nodes were found within the 1st lumbar vertebra for both groups. An equal incident rate of 50% is found at the level of the 2nd lumbar vertebra in the Pinderfields

1995 and RHSC II group, while the 1994-5 Pinderfields Hospital and RHSC I sample produced a 44% (17) rate at the level of the 12th thoracic vertebra. When the RHSC paediatric samples were removed from the two Pinderfields samples, the female groups showed no level change for the greatest number of Schmorl's nodes. The male clinical groups mirrored the female data.

The RHSC group could be accurately sexed as the x-ray request cards and the consultants' reports carried this piece of information, so the male to female results for the levels of Schmorl's node intrusions were recorded (Appendix 6, Table 6.16). These results were considered as an individual group finding, and also compared and contrasted with the Pinderfields results. The subadult males produced an equal rate of 18% (4) for the 12th thoracic vertebra, and the 1st and 2nd lumbar vertebrae. The subadult females produced a 32% (7) rate at the level of the 1st lumbar vertebra, closely followed by a 27% (6) rate at the level of the twelfth thoracic vertebra. Females in the subadult group had a 14% (3) greater incident rate at the level of the first lumbar vertebra when compared with the males of the group, and a 9% (2) greater incident rate at the level of the twelfth thoracic vertebra (Appendix 4, Fig. 6.12). The females of the 1994-5 Pinderfields Hospital sample (Appendix 4, Fig. 6.10) reflected the same levels of greatest Schmorl's node intrusion, but the 1995 Pinderfields Hospital sample (Appendix 4, Fig. 6.11) showed a greater rate in the 2nd lumbar vertebra. The male subadult sample showed a much more evenly distributed rate from the 11th thoracic to the 4th lumbar vertebra, with only a 4% variance across these vertebrae. This subadult Schmorl's node rate did not reflect that of the adult groups, with the 1994-5 Pinderfields Hospital sample having a 17% greater rate in the 1st lumbar vertebra, and the 1995 Pinderfields Hospital sample a 7% greater rate at the level of the second lumbar vertebra (Appendix 4, Fig. 6.11).

6.6.2 Archaeological samples

(i). Captain's Cabin, Dunbar

Schmorl's nodes were observed in the male vertebral columns between the 7th thoracic and the 5th lumbar vertebrae without exception, and the female vertebral columns covered the same range with the exception of the 1st and 3rd lumbar vertebra (Appendix 4, Fig. 6.13). The male vertebral columns had their highest rate in the 9th thoracic vertebra at 31% (4), which was 8% (1) more than in the 10th thoracic vertebra and the 1st and 3rd lumbar vertebrae. A 23% (3) rate for females was recorded in the 7th, 8th and 9th thoracic vertebrae, and a 15% (2) rate in the 10th and 12th thoracic vertebrae, and the 2nd lumbar vertebra. All other affected vertebrae produced an 8% (1) incident rate. Although number of males and females affected by Schmorl's nodes varied only slightly, the $\chi 2$ result (0.187) was not statistically significant at the 95% level of confidence that this was not just chance.

(ii). The Hirsel, Coldstream

Involvement of Schmorl's nodes in vertebral columns of males within the Hirsel sample included all vertebrae from the 5th thoracic to the 3rd lumbar vertebrae (Appendix 4, Fig. 6.14). A noticeable Schmorl's node peak of 50% (4) is seen in the 12th thoracic vertebra of the males, and in the females this 50% (2) rate was observed in the 9th and 12th thoracic vertebrae, and the 2nd and 3rd lumbar vertebrae. Female vertebral columns observed as positive for Schmorl's nodes include the 8th thoracic to the 2nd lumbar vertebra, with fewer vertebrae affected than in the male vertebral columns (Appendix 6, Tables 6.18a and 6.18b). Using the $\chi 2$ test (result 0.203) there was a likelihood of more than 5% that such a result could have occurred in a random sample of this size , even if the underlying populations characteristics

supported the null hypothesis (Schmorl's nodes in males and Schmorl's nodes I in females are equally likely), then the result is not statistically significant.

(iii). Whithorn Priory, Galloway

Two groups of skeletons have been included in the results of the Whithorn Priory results which could not be ascribed to either male or female, but which could help to show commonality of vertebral levels affected. The two groups were subadults, and those adult skeletons without the bony elements required to assign an accurate sex. Schmorl's nodes were observed at all levels from the 6th thoracic to the 5th lumbar vertebra in both male and female vertebral columns. The 6th, 8th, 10th, 11th and 12th thoracic vertebrae, and 4th lumbar vertebra all showed a 22% (2) rate in the males of this sample. All other vertebrae found positive for Schmorl's nodes within the male sample produced an 11% (1) rate. The female sample produced a 33% (3) rate at the level of the 4th lumbar vertebra, with a 22% (2) rate in the 3rd and 5th lumbar vertebrae, which is repeated at the level of the 12th thoracic vertebra (Appendix 4, Fig. 6.15). At the level of the 12th thoracic vertebra and the 2nd lumbar vertebra, the subadults and un-sexed vertebral columns showed a 22% (2) rate, mirroring that of both males and females at the level of the 12th thoracic vertebra (Appendix 6, Table 6.19) . Males and females were not proved to have an equal chance of being affected by Schmorl's nodes using the null hypothesis (Schmorl's nodes in males and Schmorl's nodes in females are equally likely), the result of $\chi 2=0.666$ being not statistically significant at the 95% level of confidence.

(iv). St. Andrew, Fishergate, York

Fishergate alone produced a clear predominance of male Schmorl's nodes at all levels of the spine (Appendix 6, Tables 6.20a; 6.20b; 6.20c; 6.20d and 6.20e). The 12th

thoracic vertebra produced a 33% (14) rate, closely followed by the 11th thoracic vertebra with a 31% (13) rate. An equal rate of 21% (9) was observed in the 9th thoracic and the 1st lumbar vertebra. Male vertebral columns were found positive for Schmorl's nodes from the 2nd thoracic to the 5th lumbar vertebrae, without exception. The females in this sample showed a much lower rate of Schmorl's nodes with the greatest rates at the levels of the 12th thoracic and the 1st lumbar vertebra. At 7% (3), a 26% lower rate than the male sample at the level of the 12th thoracic vertebra, and a 14% lower rate at the level of the 1st lumbar vertebra, the females of the Fishergate sample were well below the rates of all the other samples. If the unknown skeletons were female, they would only increase the Schmorl's node rate by 5% (2), leaving the females lagging behind the males by 22%. If they were assumed to be male, then the rate would exceed that of the females by 31% at the level of the 12th thoracic vertebra. Females were observed as having Schmorl's nodes from the 6th thoracic to the 3rd lumbar vertebrae with the exception of the 7th thoracic vertebra. The males showed the greatest rates at the 11th and 12th thoracic vertebrae, while the females showed their greatest rate at the levels of the 12th thoracic and 1st lumbar vertebra (Appendix 4, Fig. 6.16). Even though the characteristics of this sample were not expected to support the null hypothesis (Schmorl's nodes in males and Schmorl's nodes in females are equally likely), the result ($\chi 2 = 0.076$) was not statistically significant.

(v). Tanners Row, Pontefract

Females in this group produced a greater Schmorl's node rate than expected with a 43% (3) rate at the level of the 1st lumbar vertebra, followed by a 29% (2) rate in the 3rd lumbar vertebrae. All other female vertebrae from the 10th thoracic to the 5th lumbar vertebra had a rate of 14% (1). The males of the sample had involvement in only two vertebrae, the 6th thoracic and the 1st lumbar vertebrae with an incident rate of 14% (1)

(Appendix 4, Fig. 6.17). The $\chi 2$ result (0.700) was achieved using very low numbers of males and females, but again the result was not statistically significant at the 95% level of confidence.

6.7 The origins of Schmorl's nodes (clinical data)

The position of Schmorl's nodes did not conform to the expected profile of subadult centrally placed Schmorl's nodes and this profile continued throughout the adult samples both clinical and archaeological. Vertebral end plates, although involved, did not have a centrally weakened area through which the nucleus pulposus could infiltrate the vertebral body except where great pressures were experienced, or where congenital abnormalities had reduced bone mineral content.

6.7.1 Schmorl's nodes: subadults

In the RHSC paediatric sample where Schmorl's nodes were observed, 73% (16) of radiological reports recorded irregular endplates at the same levels (Appendix 7, Table 6.24); this was a higher rate than for any other disease or disorder in any sample studied. Viewing of the plain film radiographs, and the often-accompanying MRI images, produced a recurring pattern. The MRI contrast agent was seen to be running beneath the unfused vertebral body end plates, pooling in areas where the trabecular structure had been disrupted. Where sequestration of a small, often triangular, piece of bone on the antero-superior, or antero-inferior borders of the vertebral body was observed, the contrast agent was seen passing behind the sequestrated fragment, and again flowing under the end plates. The route taken by the contrast medium mimicked the route taken by the pulposus of the ruptured nucleus. Weak areas within the end plates were not observed in any vertebrae except, for example, where congenital spinal malformation, e.g. spinal dysraphism, was also found. Several congenital conditions, including

osteogenesis imperfecta and dysraphism (Appendix 8, Table 6.32), caused disruption of the trabeculae and thinning of the cortex. This would allow the end plates of the vertebrae to 'buckle', and to fracture under much lower compression forces than would be required were the vertebrae normal and healthy. Schmorl's nodes in the clinical and archaeological subadult populations were observed as having several different origins:

- When impact trauma takes place, the end plate of the vertebra remains intact and the Schmorl's node is formed by the dispersal of the pulposus of the nucleus beneath the end plate. The pulposus is moved in a wave like pattern around and beneath the vertebral end plate by repeated compression forces which lead to any weakened trabecular structures collapsing, enabling the pulposus to form a Schmorl's node.

- Schmorl's nodes occur where diseases and disorders have compromised bone mineral content, thus weakening the vertebral end plates and the sub-cortical bone of the vertebral bodies. Under such conditions much a lesser force is required for both the nucleus pulposus to rupture and the vertebral end plate to be infiltrated by the nuclear material to form a Schmorl's node.

- Schmorl's nodes have a greater impact on the vertebrae when the trabeculae immediately beneath the anterior borders of the end plates react like a sponge reducing the anterior vertebral height and causing flaring of the antero-superior and antero-inferior vertebral bodies. This type of Schmorl's node is often associated with Scheuermann's disease, and reported as a precursor to the onset of this condition.

6.7.2 Schmorl's nodes: adults

Several types of end plate disruption were observed in the archaeological samples, and these were radiographically imaged to try and understand whether there were different types of Schmorl's nodes, or various stages of other vertebral diseases and disorders which mimicked the appearance of Schmorl's nodes; many intrusions appeared atypical when compared to clinical, radiographic images. The following were observed:

- *Rough* deep Schmorl's nodes intruding into the trabeculae of the vertebrae with cross sectional measurements at their greatest width from 0.75 cm to approximately 2.00 cm, were the most frequently recorded type. In the upper thoracic vertebrae the Schmorl's node intrusions were the smallest in cross section and usually located in the posterior half of the vertebral body, but not always central to that area. The lower thoracic vertebrae and upper lumbar vertebrae contained increasingly large Schmorl's nodes placed almost centrally antero-posteriorly within the end plate; they were often of elongated appearance with the longest axis running through the coronal plane. The lower lumbar vertebrae contained the largest more centrally positioned Schmorl's nodes, with a tendency to extend into the anterior half of the vertebral end plate; these intrusions had the greatest cross sectional measurements.

- *Rough*, deep, narrow, fissure like structures, possibly Schmorl's nodes, were observed and recorded in each of the archaeological samples. These possible Schmorl's nodes cut through the posterior half, or third, of the vertebral body in the sagittal plane, completely dissecting the posterior cortical wall, or cutting through the superior border of the posterior wall to at least one third of its height.

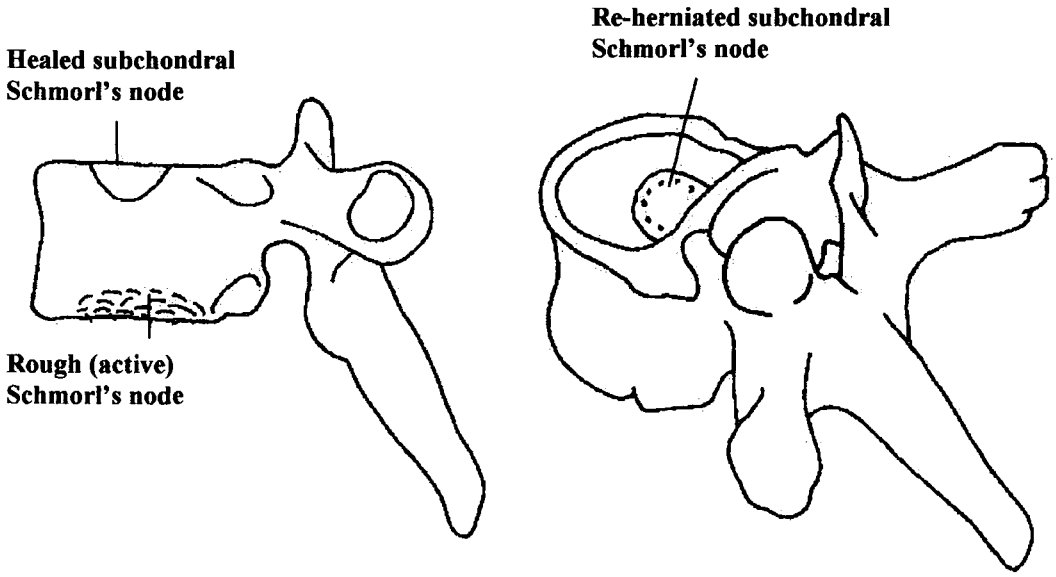

Figure 6.9 Diagram of thoracic vertebrae showing a healed subchondral Schmorl's node, a rough (active) Schmorl's node, and are-herniation of a healed, subadult, subchondral Schmorl's node (by R. B. McNaught, 2006)

- Small holes resembling pinpricks, marking out a horseshoe shape with the open ends of the horseshoe facing posteriorly, produced the clearest radiographic images of Schmorl's nodes within the archaeological samples. This space beneath the vertebral end plate had a cortical margin as if the healing process had tried to limit the destructive force of the nucleus pulposus.

- Smooth slightly shallower Schmorl's nodes placed in similar positions to the *rough* deep Schmorl's nodes were observed in 13% (10) of the positive osteoarchaeological sample, and 25% (33) in the positive clinical sample.

Smooth and rough Schmorl's nodes could be observed within different vertebrae of the same vertebral column found positive for Schmorl's nodes. Across the whole of the archaeological samples, 36% (28) of vertebral columns found positive for Schmorl's nodes had both *rough* and *smooth* intrusions within the same vertebral column; the

percentage was much smaller at 6% (5) within the complete clinical sample. No reliable evidence of a Schmorl's node forming a shape representative of bunches of grapes were found within the clinical or archaeological samples studied.

6.8 Schmorl's nodes and their association with irregularities of the pelvis and lower limbs (Clinical data)

The archaeological samples used in this research had very few complete sets of lower limb bones, and rarely all elements of the pelvis present, and therefore no archaeological data was gathered. Clinical data from radiographic requests and reports were gathered, making this section of the results a purely a clinically lead study. From the radiographic images viewed, and reports read, a definite pattern of associated scoliosis emerged. The scoliotic shift of vertebral columns affected curved away from the affected side of the associated disorder or disease. A left sided insult resulted in a right-sided curvature of the vertebral column. This was sometimes, but not always, accompanied by rotation of the individual vertebrae, as in the turning of a spiral staircase (Fig. 3.11) when viewed on a radiographic image. Scoliotic movement followed a consistent pattern of lateral curvature to the opposing side of the femoral and pelvic disruption, when studied using the Royal Hospital for Sick Children's radiographic images and reports. The number was small but was consistent with no contradictory results, making it worthy of further study (Appendix 3, Table 6.12)

Summary of the main findings

The hypotheses tested here were developed to try to gain answers to questions about the origins and aetiology of Schmorl's nodes. Using British populations, both clinical and archaeological, who in the present and past had lived in settlements not more than 150 miles apart from each other and, therefore who might not be expected to show much

diversity in living and working patterns through time. However, the main results of this study were:

1) The point of regression of the notochord is the weakest point within the end plate of the vertebra, making it the most likely point of herniation of the nucleus pulposus, and the formation of Schmorl's nodes. No clinical or archaeological evidence was produced in support of this hypothesis. However, separation of the end plate from the vertebral body at its' anterior border during acute trauma was observed. This allowed passage of the pulposus of the nucleus around and under the end plate to form a Schmorl's node when compression forced the pulposus to fracture the subchondral trabeculae in the subadult spine.

2) Schmorl's nodes are asymptomatic. The evidence for pain, often localised at the levels where Schmorl's nodes were reported was clearly evident in the clinical samples (see Appendix 8 for all of the information). Unusually there was little evidence for referred leg pain which is common to lateral or posterior intervertebral disc herniation. Archaeological evidence for pain is not possible even where the Schmorl's nodes mimic those of the clinical acute trauma model.

3) Almost all Schmorl's nodes occur within the first two decades of life. The archaeological samples produced negative evidence for Schmorl's nodes in the first decade of life and, only two samples provided evidence for Schmorl's nodes in the second decade of life. Positive evidence for Schmorl's nodes in the clinical samples was found, with all examples having suffered recent acute trauma with compression. However, the evidence did not support the hypotheses as clinically the 36 to 45 and >45 years age groups produced the greatest number of Schmorl's nodes and,

archaeologically the 26 to 35 and 36 to 45 years age ranges accounted for the greatest number of Schmorl's nodes

4) Schmorl's nodes when not centrally formed in the vertebral bodies, cause instability to the dynamics of the vertebral column. Schmorl's nodes were often present where scoliosis was observed, with Schmorl's nodes placed laterally in the end plates towards the concave curve of the scoliosis. However, it was not possible to prove whether the Schmorl's nodes preceded the scoliosis or, whether the scoliosis preceded the Schmorl's nodes. Scheuermann's disease or juvenile kyphosis may be linked to subadult Schmorl's nodes, where the end plate is separated from the vertebral body, allowing the pulposus of the nucleus to infiltrate beneath the end plate and causing the end plate to become irregular and drawn back from the anterior border of the vertebral body. This movement/retraction of the end plate allows nutrient infiltration to soften the exposed subchondral bone causing anterior wedging, followed by kyphotic curvature of the thoracic primary curve.

5) Different work patterns cause Schmorl's nodes at varying levels in the thoracic and lumbar vertebrae. Definite variations were observed in the data gathered from the clinical and archaeological samples studied, with the St. Andrew Priory data most closely matching the clinical data for levels of vertebrae affected by Schmorl's nodes. The Captain's Cabin data produced a profile for both males and females which was very similar in levels affected by Schmorl's nodes, but which did not fit the profile of any other sample. Only in the Hirsel sample did the data produce a greater number of vertebrae affected by Schmorl's nodes in the females of the sample.

6) The distribution of Schmorl's nodes remains constant through time for males and females of similar age at death in different archaeologically derived populations, and clinical groups of corresponding ages. This hypothesis was disproved by the results of the data gathered, with no two groups of matching age ranges showing similar levels affected by Schmorl's nodes. However, there were similar profiles of vertebrae affected by Schmorl's nodes in the age ranges within each sample, which all produced a dramatic drop in the oldest age range.

7) The different appearances of Schmorl's nodes have different origins and underlying causes. Schmorl's nodes are caused by impact of the vertebral column and repetitive compression with rotation and with or without extra loading. Subadult acute impact injury Schmorl's nodes are rough, often subchondral, without fractured end plates, but with irregular end plates. However, these do not all develop at the same rate, so sclerosis, irregular end plates, rough (active) Schmorl's nodes and smooth (remoulded with a cortical cover) Schmorl's nodes may all be visible at the same time, in the same spine. Secondary Schmorl's nodes in the adult spine appear as a horseshoe or crescent shape in the end plates. Adult Schmorl's nodes are also capable of healing by remodelling a cortical cover. Schmorl's nodes which are secondary to breast cancer, may be the earliest indicators of future destruction followed by collapse.

8) Underlying pathologies, deformities, and irregularities of the pelvis and alterations of leg-length, cause disruption to the dynamics of the vertebral column and Schmorl's nodes. Data was gathered from the clinical samples only, as the individuals of the archaeological samples were often lacking elements of the pelvis and lower limbs making accurate observations impossible. Spinal curvature was always away from the affected side and any Schmorl's nodes were positioned laterally on the vertebrae

towards the affected side. This was a small sample, which produced consistent results. However, caution must be taken in using these results until an in depth study has been carried out.

Chapter 7: Discussion

Past and present British populations were studied to test eight hypotheses relating to the origins and aetiology of Schmorl's nodes. The clinical samples chosen to test the hypotheses were Pinderfields Hospital, Wakefield, West Yorkshire, and the Royal Hospital for Sick Children (RHSC), Edinburgh, Midlothian, the archaeological samples were Captain's Cabin, Dunbar, The Hirsel, Coldstream, Whithorn Priory, Galloway, St. Andrew, Fishergate and Tanners Row, Pontefract; these archaeological samples cover the early to late medieval period, providing lifestyle differences and including rural and urban settlements, and monastic, military, farming and church contexts. The demographic profiles of the clinical and archaeological samples were compared and contrasted with each other to produce a profile of Schmorl's nodes in relation to age, sex and work patterns. In choosing samples with diverse lifestyles, any differences in Schmorl's nodes frequencies might be explained. The hypotheses were set out to explore questions relating to the historical understanding of the research of Schmorl (1930 and 1971), and to discover whether scientific advances and knowledge gained from recent research would challenge Schmorl's original findings. The questions contained in the eight hypotheses (Chapter 1: 70-74) were:

1) Did the vertebral end plate contain a weakened area caused by incomplete notochord regression which provided little resistance to infiltration of the ruptured nucleus pulposus and the formation of a Schmorl's node?

2) Were Schmorl's nodes symptomatic or asymptomatic?

3) Was there indisputable proof that the majority of Schmorl's nodes were formed

during the first two decades of life?

4) If Schmorl's nodes were not centrally placed within the vertebral end plates did they cause instability to the dynamics of the vertebral column?

5) Did differing work patterns produce Schmorl's nodes at different levels within the thoracic and lumbar spine?

6) When comparing males and females of similar age at death in different archaeologically derived populations and clinical groups of corresponding ages, did the distribution of Schmorl's nodes remain constant through time?

7) Did different appearances of Schmorls nodes have different origins and underlying causes?

8) Where underlying pathologies, deformities and irregularities of the pelvis and leg length cause disruption to the dynamics of the vertebral column, do they produce Schmorl's nodes?

7.1 Schmorl's nodes frequency

Schmorl's nodes are described as common occurrences in both medicine (Takahashi and Takata, 1994) and also archaeology (Anderson, 1994). Jurmain (1999: 163), states that "these lesions, frequently found on vertebral bodies, have attracted even less interest than enthesopathies from both clinicians and osteologists. Moreover, with few exceptions they have not generally been used by osteologists as a basis for reconstruction of activity behaviour", suggesting that further research might be a

positive step forward to a better understanding of Schmorl's nodes. Battié *et al* (2004: 2679)) make the following statement in relation to disc degeneration, "commonly evaluated degenerative findings are vertebral rim osteophytosis, disc bulging, herniations, and Schmorl's nodes", placing them all together as if related. Degenerative joint diseases is the grouping within which Schmorl's nodes are usually placed, yet these lesions are significantly less common than either osteoarthritis or osteophyte formation in all of the clinical and osteoarchaeological vertebral columns affected by Schmorl's nodes in this research (Appendix 7, Tables 6.22a to 6.29).

(i) Clinical samples

In the two Pinderfields Hospital samples, the prevalence for osteoarthritis varied between 36% (25) and 53% (21) of individuals with Schmorl's nodes, which was similar to the archaeological samples. The rates for osteophyte formation of 27% (19) and 18% (7) were much lower than in the archaeological samples; whether this was due to macroscopic analysis being able to detect more subtle changes, or radiographic imaging not recording the earliest stages of osteophyte formation is uncertain. Adams and Roughley (2006) discuss the possible methods of visualizing early osteoarthritic changes and early formation of osteophytes of the vertebral column from plain film radiography, but conclude that evaluation will always be susceptible to the viewer's interpretation of any scoring system, and that the quality of the radiographic images and patient habitus (body shape) will also affect the outcome. This difficulty in interpretation of arthritis and osteophyte formation by radiographic means is supported by Rogers *et al*,. (1990: 367-368), who says that "The discrepancy between visual and x-ray findings was striking. Severe osteophytosis and eburnation were often not visible in x-ray films even when these were examined with hindsight".

(ii) Archaeological samples

Schmorl's nodes in the archaeological samples at their most prolific are only found within 31% (13) of the Captain's Cabin Sample, compared to osteoarthritis of 50% (21), and osteophyte formation of 45% (19) in the same sample. All the vertebral columns affected by Schmorl's nodes produced higher rates of osteophytes and osteoarthritis compared to Schmorl's nodes. The individuals within the archaeological samples who did not have Schmorl's nodes showed much lower levels of both osteoarthritis and osteophyte formation. For example, the Captain's Cabin sample produced a prevalence for osteoarthritis of 23% (5) and for osteophyte formation of 18% (4), (see Appendix 3, Table 6.13a and 6.13b). Rogers *et al* (1997: 87) says, "osteophytes are strongly associated with osteoarthritis, probably forming in responses to abnormal stresses on the joint margins". The body of the text (*ibid*, 1997: 87-88) suggests that *bone formers* deal with mechanical stress by forming strong large osteophytes and bone remodelling, whereas people with normal and reduced osteoclastic and osteoblastic reaction to micro-trauma show very little alteration to the bone profile at the margins of the vertebral joints. However, the Schmorl's node was not discussed in this context, but it may be that these same bone formers re-profile the *rough* Schmorl's node with new cortical cover producing a *smooth* Schmorl's node. Ruff *et al.*, (2006) also discuss the adaptation of bone to the mechanical environment, by the strengthening and expansion of the bone matrix when placed under repeated stress, which may explain the variations in prevalence for osteoarthritis and osteophytes in the vertebral columns affected by Schmorl's nodes. The relationship between osteoarthritis, osteophyte formation and Schmorl's nodes may be altered by the number of individuals in any one sample with the ability to "form bone" in reaction to mechanical stress.

Without further research, disassociation of Schmorl's nodes from degenerative joint

disease cannot be completely justified, anymore than loss of intervertebral disc height can be directly associated to the formation of Schmorl's nodes, as the greater number of people experiencing lost disc height do not have the change within the motion segments where Schmorl's nodes are observed, rather they are distant to the end plate intrusions (Benneker, 2005). Sharing the same superior or inferior articular surfaces of a vertebra is the only absolute known in the relationships of Schmorl's nodes to degenerative joint diseases in the vertebral column.

Osteophyte size was not proportional to the size and depth of the Schmorl's node in either the same or opposing end plate of the vertebral body it shared. The position of the osteophyte appeared to be randomly placed around the vertebral rim, that is not diametrically opposed, or in lateral proximity to the Schmorl's node. Osteophytes were common on vertebral columns without Schmorl's nodes, showing only a slightly higher rate on vertebral columns affected by Schmorl's nodes (See Appendix 7, Table 6.25 to 6.29 for all of the information). Osteophytosis is recognised as a bony alteration used by the body as a stabilizing mechanism for the joints of the vertebral column (Kawaguchi *et al*, 2002), and is concomitant with destabilizing bony alterations such as in Paget's disease, bony metastases or myeloma, with ankylosis being the most extreme form. Andersson (1937: 2001) wrote in his search for the aetiology of ankylosing spondylitis "that there appears to be a link between disc degeneration, lack of vitamenes (recently discovered vitamins), and a more tenuous link with infection and inflammation"; his research describes eccentric Schmorl's nodes without naming them and the bracing of the vertebrae by osteophytes of varying size. Osteoarthritis is a degenerative disease which one would expect to observe as a normal bony alteration in relation to age, and wear and tear, and this was found in all samples, i.e. the number of individuals with vertebral osteophytosis increased proportionally with age (see appendix

Appendix 7).

Understanding workload distribution between the sexes and age groups in early populations may be biased by our own knowledge of modern work divisions of perceived household and manual tasks, which change with changing circumstances. By the Medieval period, documentary evidence for lifestyle was recorded in many formats: images from tapestries (Erlande-Brandenburg, 1989), woodcuts (Dürer, 1471-1528), stained glass (Anon 10, 1340), and paintings (Limbourgh, 1413). Jennings (2004), brings together many of the paintings of the workers, peasants, and serfs in her recent book on medieval gardens, where dirt, disease and poverty do not appear to affect the workers portrayed. These images may all have a bias to the idyllic setting. Medieval people are always depicted as wealthy and elegant, at rest or sporting in serene settings, clad in clean tidy clothes (Huxley, 1988). Divisions of work between males and females cannot be stated with absolute certainty for present (constantly moving) or past populations. Scott (1999) discusses the effects on *life's chances* by class, status, authority and sex, in so much as in having status and authority an individual has the choice of occupations, while lack of these essentials reduces an individual to the lower classes, and in so doing having most menial and self-demeaning types of work. This demarcation by class, status and sex is not a modern day invention, but one that has held societies together and at the same time kept them apart according to the needs of society (Anon. 9, 2006). Demographically, a picture of the inhabitants, the environment in which they lived, the work they would probably have carried out and their state of health at the moment of death have all been used to produce an image of life and living conditions for each sample studied here. Cox (2000) in his presentation of the population employment statistics by small finds analysis for the period from the 9th to 12th centuries at Dunbar, indicates employment rates of 26% for weaving and 3% for

food preparation assigned as female employment, and 13% for construction, 7% for metalworking and 6% for tools as male occupation. Ottaway (1996), presents the urbanisation of York from the 9th to 16th centuries as consisting of merchant houses (home and shop as one) and a large number of closely placed dwellings and workshops set in a great depth of rubbish and human waste, portraying a life of hard work and human deprivation. York at this period was also an area dense in churches and monastic sites, including the wealthy Gilbertine Priory of St, Andrew, Fishergate, from which one of the archaeological samples was excavated (Kemp and Graves, 1996). In assigning females to domestic and farm work, and males to industry, the church, the military and commerce portrays historical models (Napier, 2005).

The archaeological samples studied all contained immature remains from peri-natal to subadult, with the Gilbertine Priory burial ground of St. Andrew, Fishergate, producing the smallest number of subadults excavated of only 18% (28), and of those 82% (23) had complete subadult vertebral columns (Table 5.9). This low mortality rate occurred in an urban environment where close living, lack of fresh food stuffs and the greater risks of air-borne, water-borne and contact diseases, reflects the high status of the individuals within this cemetery (Kemp and Graves, 1996). The possible care and welfare of tenants and their children by the monks, is suggested by Hatcher (1986:26) who comments on the life and environment of the monks of Christ Church, Canterbury, that "the monks were exceedingly well fed, clothed and sheltered and that they benefited from levels of sanitation, hygiene and healthcare unavailable to the general population". The monks are known in some instances to have had families and dependants living within the monastic settlement (Clarke, 1984). Immature mortality rates within three of the other samples were similar; they were Captain's Cabin 40% (33), Whithorn Priory 32% (512), and Tanners Row 47% (98). Knowledge gained

through many Medieval cemetery excavations have found common burial areas for subadults along the external, and occasionally the internal foundations of the church walls. The main variation is the direction of the wall chosen, for example the north or south wall (Danielle, 1999); the overhanging eaves usually shelter these areas, allowing the burials protection from the elements. Infant burials close by internal and external church walls in clearly defined/segregated areas may be to allow them to lie close to God, as in "suffer the little children to come unto me" (Luke 18: verse 16); these are the author's own thoughts. The Hirsel, with a 31% (150) immature mortality rate, sat midway between the other groups, reflecting that of the RHSC in the late 19th century (Guthrie, 1960) and, unlike the other samples, the site of burial and settlement has not continued in use, perhaps indicating that the original settlement was not founded on land suitable to long term self-sufficiency in crops and animal husbandry. Even today, the Hirsel estate is self sufficient by means of utilising its house and outbuildings to provide tourist attractions, rather than by normal farming traditions (Coldstream, 2006).

The adult populations also varied, particularly in the proportions of males and females. Fishergate, which had the lowest subadult mortality, also produced the lowest female to male skeleton ratio 29% (89) female to 71% (220) male. The Fishergate percentages varied only slightly when the individuals with incomplete adult vertebral columns were removed from the sample to be studied, producing a 23% (38) female to 77% (124) male population (Table 5.9: 171). The Hirsel produced the most evenly divided population with regard to full vertebral column preservation with a 51% (88) female to 49% (85) male sample (Table 5.4: 163). The limitations of skeletal material studied did not produce significant demographic variations from the original data produced for the complete complement of recovered skeletons from each site.

The clinical groups showed clearly how they capture 'a moment in time', as does each archaeological assemblage. The two Pinderfields Hospital groups had only a four-month gap between them and yet the data on Schmorl's nodes showed considerable variations. There was a 43% (30) lower rate of Schmorl's nodes identified in 1995 group (Appendix 3, Table 6.1) compared to the 1994-5 group, with only 5% (87) fewer patients examined radiographically for spinal pain and debility. 30% more female patients were reported positive for Schmorl's nodes in the 1995 group compared to males, where the 1994-5 group produced 50% (35) more males compared to females. Subadult patients were a specialist group used to give the clinical groups a subadult compliment. These subadult patients were used as a comparative sample for the subadult burials found buried close to the walls of the churches of Whithorn Priory, St Andrew, Fishergate, and Tanners Row.

7.2 Vertebral end plate weakness and the formation of Schmorl's nodes: sub-adult

The assumption that a vertebral end plate weakness exists has been a belief around which many researchers have centred their search for a better understanding of the formation and aetiology of Schmorl's nodes. Chandraraj *et al* (1998: 171) are not alone in stating that, "weakness at these sites is attributed to the regression of the notochord", attributing this finding to Schmorl (1971: 158). Often, the previously stated belief is cited in the introduction to other research on Schmorls nodes. This citation is always attributed to Schmorl (1971), but cannot be found within the text. Often no reference is cited in the main body of the text, or in the bibliography, as in Silberstein *et al* (1999). The question: did they go back to the reference work or copy the citation from another modern work? Schmorl in Schmorl and Junghanns (1971: 3) does not make such a statement; he says:

"With the beginnings of ossification, the chorda dorsalis becomes encroached upon while in the area of the disc analage it becomes ballooned (intervertebral chorda swelling). Finally, within the vertebral border, the chorda disappears completely".

The notochord (chorda dorsalis) is cited as the first vestige of the vertebral column in the embryonic stage of development around which the somites evolve and unite to form the centra of the vertebral bodies in the foetus (Scheuer and Black, 2004, Sture, 2002). A central position within the vertebral end plates is assigned as the most likely area of weakness, due to the notochord having occupied that position during vertebral body formation. However, the writings of Schmorl and Junghanns (1971: 6) do not support this supposition; they write of the immature superior and inferior end plates of the vertebral bodies as:

"A zone of varying size having increased density and few perforations is seen on the border of each surface between the central and posterior thirds. The nucleus pulposus is located on this strengthened area which, thus, may be properly called a 'stress- bearing plate'."

In this research, each vertebral body was macroscopically examined on the superior and inferior surface to try to establish whether or not Schmorl and Junghanns were correct in their findings and, if so, whether later researchers (Hamanashi *et al*, 1994; Grive *et al*, 1999) are incorrect in believing the statements of Schmorl and Junghanns (1971). The focus was on the clinical and archaeological paediatric/subadult samples, so that possible weak areas of the end plate could be observed before Schmorl's node herniations had occurred, which would have destroyed the evidence. Adults in the clinical and archaeological samples were also studied, as the notochord regression might

have left a small lesion in the end plates which, might not have been affected by Schmorl's nodes.

7.2.1 Subadult end plate weakness: Clinical sample

Clinical evidence in the Pinderfields Hospital small subadult groups was studied and, was not convincing for centrally weakened end plates as three of the four patients had multiple contiguous Schmorl's nodes consistent with trauma, and not end plate weakness, which were all posteriorly positioned (Appendix 6, Table 6.14b and 6.15). The radiologist reported irregular end plates at several levels on superior and inferior surfaces, querying the possibility of early Scheuermann's disease for the fourth patient, but no Schmorl's nodes were reported. The RHSC sample again provided negative evidence for vertebral end plate weakness with the exception of three children. These three children all suffered from congenital conditions which had caused failures in the formation of the vertebral bodies and posterior neural arches, complicated by reduced cortical and cancellous bone formation (Appendix 8, Table 6.32).

7.2.2 Subadult end plate weakness: archaeological samples

Each subadult vertebral column within the archaeological samples only helped to confirm the non-existence of weak areas in normal healthy vertebrae of medieval British populations. Schmorl did not suggest or state that the subadult vertebral columns he examined for Schmorl's nodes were from vertebral columns with abnormal cortical or subchondral bone, and when he was recording vertebral anomalies, where congenital abnormalities or disease were present, he always recorded the abnormality observed. However, Fishergate had amongst its subadult population three vertebral columns containing possible end plate weakness. The first skeleton (Sk 268) suffered from spina bifida occulta, so might have had incomplete notochord regression, but the area of

Schmorl's node intrusion present was not a finely focussed central intrusion, so this individual was excluded from the possible group for end plate weakness . The second skeleton (Sk 435) had Schmorl's nodes in facing end plates from the first to fourth lumbar vertebrae, but osteoporosis or a congenital abnormality causing decreased mineral bone content may have accounted for these intrusions as the vertebrae were all very friable compared to the majority of skeletal remains within the collection. Skeleton 190 was rejected from the possibles, as the Schmorl's nodes were posteriorly placed on the vertebral end plates. The Tanners Row sample added little information to help test the hypothesis.

If the central area of the vertebral end plate is the weak link why were 73% (96) of all clinical Schmorl's nodes within vertebral columns posteriorly positioned, and only 14% (19) centrally positioned? The archaeological samples showed a similar but lower percentage of posteriorly positioned Schmorl's nodes at 53% (52) and slightly higher percentage of centrally positioned Schmorl's nodes at 18% (18); this evidence does not support a weakened central area in the vertebral end plate. Beneath the vertebral end plate may not be the most likely place to look for Schmorl's nodes, yet repeatedly it is described in the literature. Peng *et al.* (2003) suggest that Schmorl's nodes are the end product of ischaemic, necrosis beneath the end plate. Benneker *et al* (2005) report that integrity of the end plate is occasionally visible in the presence of Schmorl's node signalling in MRI studies. It was concluded that the data gathered from the clinical and archaeological samples did not support there being a weakened area retained within the central area of the vertebral end plates, except in the clinical samples where alterations to the vertebrae had taken place due to congenital, neoplastic or osteoporotic diseases.

7.2.3 Irregular vertebral end plates

First noticed by the author on MRI images taken as part of clinical investigations to discover why acute traumatic back pain was not quickly resolved in young adults, a pattern of sclerotic, irregular end plates and Schmorl's nodes were visualized, where previously only sclerotic end plates were viewed on plain film radiography . The significance of this disruption to the normally smooth, slightly concave vertebral end plates did not become apparent until the reports of all the subadult patients from the RHSC were read, and then a pattern began to emerge. All subadult patients admitted with traumatic impact injury to their vertebral columns were reported as having several different traumatic reactions within several vertebrae, in each of their vertebral columns. These were sclerosis, Schmorl's nodes and loss of lordosis, with or without scoliosis. One patient (NK265) in the Pinderfields Hospital group, and one patient (346XY) in the RHSC group had a series of vertebral radiographs taken over a twelve month period due to lack of resolution of acute back pain, which was now classed as chronic back pain. In both cases, Schmorl's nodes were visible in the sub-chondral bone of several vertebrae with other vertebrae displaying sclerosis. Second radiographic examinations were carried out several weeks later, providing evidence of irregular end plates where previously sclerosis alone was visible. On final examination, the original Schmorl's nodes were showing signs of healing and all the previously sclerotic end plates were now contained in Schmorl's nodes . This evidence could not be confirmed by the data in the subadult archaeological skeletal samples, as they lacked any macroscopic evidence for Schmorl's node herniations. Either the archaeological subadult Medieval children from northern England and southern Scotland had not suffered from acute trauma or repetitive compressive injury to the spine, or the evidence of Schmorl's nodes was either not clearly visible, or the end plate undulations were not easily readable. One subadult (Sk 358) of 11 to 14 years of age from the St. Andrew, Fishergate sample was observed as having vertebral end plates which appeared to be irregular and drawn back

from the edges of the vertebral body, replicating the most frequently reported disorder in the RHSC sample, of irregular end plates.

7.2.4 Beneath the end plates: immature clinical samples

Understanding the sequence of events taking place within vertebral bodies of the vertebral column before maturity is reached, may bring a clearer understanding the origins and aetiology of acute Schmorl's nodes in the immature vertebral column. The altering structure of the vertebral bodies and concomitant evolution of the end plates of the vertebral bodies, as well as their strengths and weaknesses, can be disrupted by a ruptured nucleus pulposus undermining the stability of the end plates when trauma occurs. Immature vertebrae need to grow in height and width to keep pace with growth of the axial and appendicular skeleton and, although they do not have diaphyseal and epiphyseal elements as with the long bones, they do have mechanisms to allow growth to take place. The end plates are avascular structures, acting as growth plates or boundaries between the vertebral bodies and the intervertebral discs of the immature spine (Urban *et al,* 2004). This dual role of the end plates has caused much confusion to researchers reading Schmorl in Schmorl and Junghanns (1971: 15), where he gives an account of two end plates:

"The cartilaginous end plate is fastened to the vertebral end plate by means of a calcium layer".

Modern authors such as Kakitsubata *et al.*, (2002), describe a cortical end plate with a cartilaginous component, and Taylor (2000), an anatomist, states that the cartilaginous end plate calcifies to become a cortical end plate. Such confusion of anatomical descriptions required new data to explain the alterations to the vertebral end plate on the

RHSC radiographic images, and the comments being made by the radiologists in the accompanying reports. The absence of end plate intrusions by Schmorl's nodes in the subadult vertebral columns also required further investigation. A fine sheet of hyaline cartilage covers the surface of the end plate facing and interacting with the nucleus pulposus and the annulus fibrosus. The surface of the end plate facing the vertebral body fuses with the vertebral body when all bony growth has ceased. Prior to end plate fusion the action, and reaction, of torsion and compression on the vertebral end plates, with or without added weight, causes movement to the loosely anchored vertebral end plates by the intervertebral discs; this alters the dynamics of the vertebral column. The anterior longitudinal ligament is attached to each superior and inferior end plate and intervening intervertebral disc, bringing its own restricting tensions to bear on the anterior edges of the immature vertebral end plates; the anterior longitudinal ligament fights to contain separation of the lumbar vertebrae in an attempt to retain the lumbar lordosis of the vertebral column (Panjabi *et al*, 1998).

Each and every one of these movements puts strain on the vertebral end plates in the immature spine, causing bending and fragmentation of the anterior vertebral end plates (Fig. 7.1). Baranto *et al*, (2005), discuss the vulnerability of the subadult vertebral end plate during injury as it is put under pressure by the anterior longitudinal ligament, causing it to sever its fibrous hold on the vertebral body, often leading to anterior vertebral body avulsion at the level of greatest torsion. Radiologists highlighted lifting of the vertebral end plates and subchondral herniation of the herniated nucleus pulposus, with sclerosis and avulsion of the end plates. However, they seemed unaware that they were observing the aetiology of acute traumatic Schmorl's nodes.

Part of a report (RHSC, Edinburgh, patient report 346XY, 1998) reads, "Irregular

defects involving the antero-inferior and antero-superior margins with sclerosis in the vertebral margins. The limbus vertebrae may be caused by anterior protrusion of the nucleus pulposus into the vertebral body between the end plate and the body. The significance is uncertain in relation to the patient's low back pain".

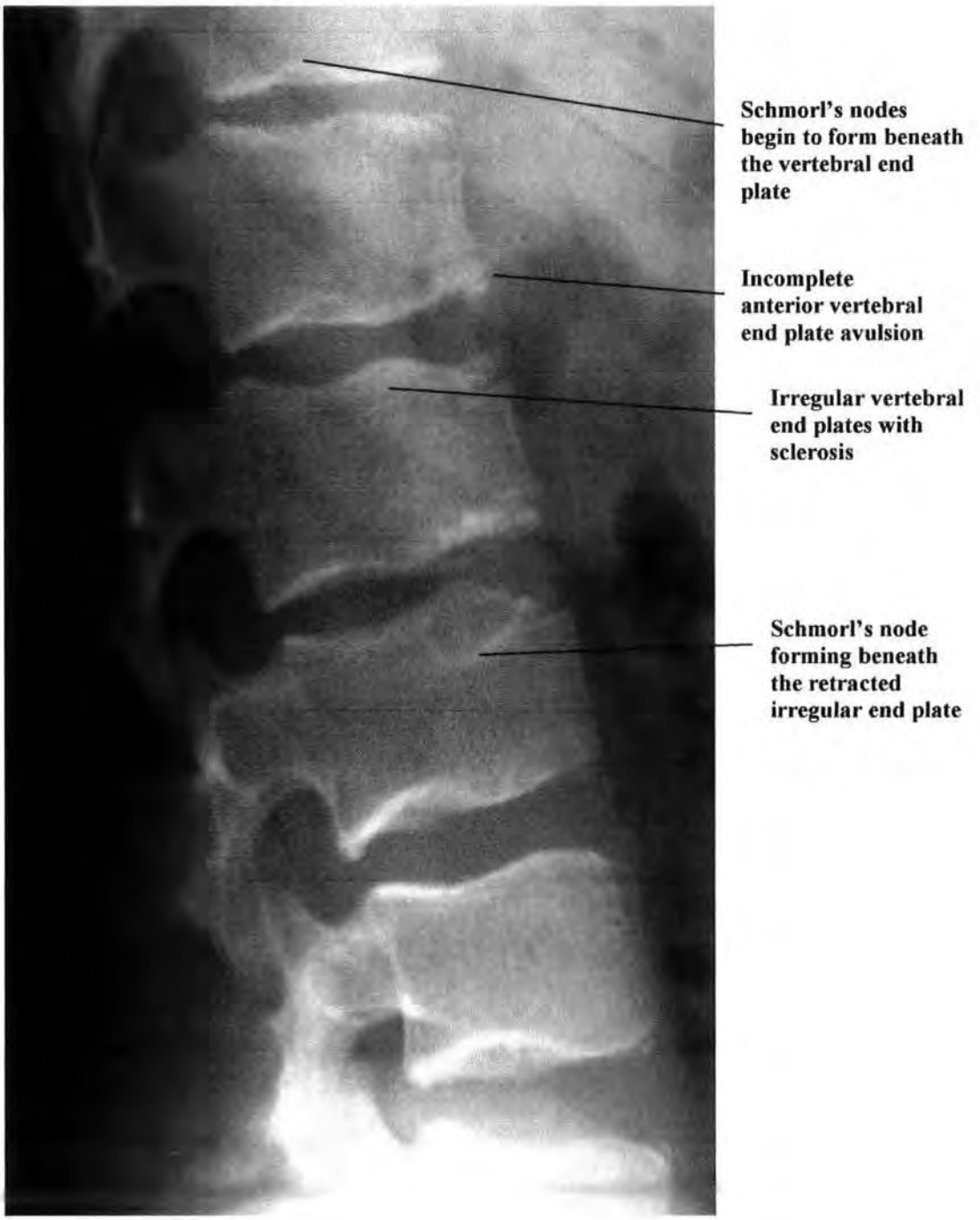

Figure 7.1 Immature lumbar spine showing vertebral end plate avulsions, separation, sclerosis, irregular end plates, and Schmorl's nodes forming and formed beneath the vertebral end plates (from the RHSC, Edinburgh teaching archive)

The description elucidated what had been seen on the radiographic images of the patients admitted to the RHSC with acute trauma to their vertebral columns; they had fallen or jumped from a height and landed upright or in the sitting position, causing traumatic compression to the intervertebral discs of the spinal column (Fig. 7.1). Another report (RHSC, Edinburgh patient report 170BC, 2000) reads, "the end plate appears to be raised where Schmorl's nodes are visible in the vertebrae beneath the end plates, I am not sure if this is significant or not".

Viewing MRI images of several of the subadult patients, where gadolinium had been introduced, the route it took outlined the perceived route of the pulposus of the nucleus, running around the anterior end plate where the anterior ligament had avulsed the anterior edge of the end plate. The avulsed portion of the anterior end plate left a gap between the anterior edge of the vertebral end plate and the subchondral bone of the vertebral body, where the pulposus (and the gadolinium) could infiltrate. The muscles, ligaments and tendons which form the vertebral column's myology, bring tensile strength and dynamic control to the vertebrae when put under strain during acute injury; they also determine the points of weakness within each vertebral segment. The tensile pressure in extension of the anterior longitudinal ligament, where it is meshed to the annulus fibrosus of the intervertebral disc, provides a surface with little resistance, along which the pulposus of the nucleus can 'flow'. The alternating tension and relaxation of the vertebral end plate as it interacts with the flexion and extension of the anterior longitudinal ligament causes it to undulate and separate from the vertebral body. Once the pulposus filtrates into the area beneath the vertebral end plate and comes to rest, the end plate displays a wave like pattern, quickly followed by a sclerotic reaction in defence of the cortical and subchondral bone. At the same time, the end plate tries to return to its natural shape, forcing the pulposus into the weakest trabecular areas, which

are further weakened, destroyed, and replaced, by the pulposus. MRI images of the vertebral columns of subadults affected by Schmorl's nodes showed Schmorl's nodes within the subchondral bone beneath an intact vertebral end plate. Peng *et al* (2003) describe areas of necrosis plus Schmorl's nodes beneath intact end plates, but they do not expand this knowledge further into discussing why this might be occurring.

It appears that subadult Schmorl's nodes are hidden from view beneath an intact vertebral end plate and, when healed, leave a cyst like space with or without a cortical lining and an unsupported area of that vertebral end plate. Therefore, the vertebral end plates strength has been compromised by the Schmorl's node hidden from view. Now that a weakened end plate has been formed, which will allow later herniations of the nucleus pulposus to easily infiltrate the vertebral end plate, the pulposus of the nucleus can enter the already prepared space. This end plate, when viewed after a second Schmorl's node infiltration, has a very noticeable pattern at the point of entry; this is a horseshoe shaped series of small holes, as if the nails of the horseshoe had been hammered home and then removed. An example of this horseshoe shape was observed in the eleventh and twelfth thoracic and third lumbar vertebrae of a male (Sk. 250) of >45 years of age from the St. Andrew, Fishergate sample. Whether the cortex of the vertebral body has been infiltrated by the pulposus of the nucleus through the many small infiltration points, or has caused the weakened end plate to fracture into the subchondral space, may be dependent on the force applied during any further trauma.

The vertebral end plate does not contain a weakened area through which the embryonic notochord passed. Instead, the nucleus pulposus, having taken advantage of the unfused vertebral end plate, infiltrated beneath that end plate during acute trauma, leaving an invisible fingerprint, and subsequently reduced the tensile strength of the adult vertebral

end plate. This sub-vertebral end plate intrusion observed macroscopically in the archaeological samples was clearly visible when radiographed. The irregular vertebral end plate caused by flow of the pulposus of the nucleus may also be in part to blame for the anterior wedging seen in the early stages of Scheuermann's disease; this is because the subchondral bone along the anterior border of the vertebra loses its protective cover as it is raised and drawn back. Taylor (2000: 275) presents a possible relationship between Schmorl's nodes and Scheuermann's disease but, like Schmorl (1971), he does not give any mechanical or structural information elucidating his hypothesis. However, he does state that "no end plate herniations were visible in the vertebral end plates of subadults of 0 to 12 years of age diagnosed with Scheuermann's disease", supporting the aetiology previously described.

7.3 Are Schmorl's nodes: symptomatic or asymptomatic?

Junghanns (1990) began research into the invisible space, now known as the intervertebral disc, prior to his work with Schmorl, and he continued his work until his death. Junghanns firmly believed that the answer to much of the patient's acute and chronic pain in Schmorl's nodes was rooted not in the vertebrae, but in the intervertebral disc and soft tissue structures interacting with the vertebral column. Takahashi and Takata (1994: 77) open their paper with the following words, "Schmorl's nodes are common spinal lesions generally believed to be asymptomatic"; this is a commonly held belief of many practicing general practitioners and orthopaedic surgeons. However, low back pain and upper back pain were recorded in 61% (43) of the 1994-5 Pinderfields Hospital sample but only 6% (4) of individuals had radiating leg pain. A slightly higher level of back pain was recorded in the 1995 Pinderfields Hospital sample of 73% (29) along with a similar rise in radiating leg pain of 15% (6). The most interesting findings here were the low percentages of leg pain compared to back pain.

Grive *et al.* (1999), discuss two cases of acute Schmorl's nodes and in both cases report acute localised back pain and no sciatica or referred pain. Wagner *et al.* (2000: 277) discusses the importance of recognition of acute Schmorl's nodes, saying that "Awareness that an acute Schmorl's node may be a cause of acute back pain could facilitate an accurate early diagnosis, even though therapeutic regimen may not change as long as no biomechanical instability is implied". The expectation of any neurologist charting pain pathways would be a clearly defined acute pain somewhere in the lower limbs, leading to a diagnosis of the level of intervertebral disc herniation. Acetabular hip pain, for example, accompanied by lateral femoral pain would indicate herniation of the second lumbar intervertebral disc. Examination of the back pain might pinpoint the levels of Schmorl's nodes within the vertebrae. One female (JH979) in the 1994-5 Pinderfields Hospital sample whose case history stated that "the pain begins at the level of the second lumbar vertebra", was found to have an inferior vertebral end plate Schmorl's node in the 1st lumbar vertebra when radiographic imaging was carried out (Appendix 8, Table 6.30b). The RHSC sample produced a 95% (21) rate for back pain with little emphasis on lower limb involvement, but the majority of these individuals were acute Accident and Emergency admissions, at which time the admitting doctor would be questioning for loss of feeling and function of all four limbs as an indication of spinal cord disruption. Damage to the components of the vertebral column by Schmorl's nodes would not be acknowledged as being of great relevance at the moment of admission, but they do indicate the continuing acute pain which becomes chronic until the Schmorl's nodes heal. In the case of a fifteen-year-old female (346XY) from the RHSC sample (Appendix 8, Table 6.32), her acute pain led to two further sets of radiographs being taken over a period of one year. These images provide an insight into the way in which sclerosis is a precursor to Schmorl's nodes which in turn are resolved or healed and how, only on resolution, does the localised back pain disappear.

If doctors believed that Schmorl's nodes were not just an incidental finding, they might ask appropriate questions to help to differentiate between patients with lateral or posterior extrusion of the nucleus pulposus (separate condition from Schmorl's nodes involving soft tissues i.e. spinal cord, nerve roots and the vertebral blood vessels), and patients with Schmorl's nodes; this patient information could then be recorded on the x-ray request form. Posterior extrusion will usually present with loss of feeling in the upper or lower limbs, with muscle weakness, depending on the level of compression, and lateral extrusion of the nucleus pulposus causes acute pain in the area served by the compressed nerve (Chapter 3; 2.8.1). Back pain in patients affected by Schmorl's nodes at the levels of the ruptured intervertebral discs, increases when finger tip pressure is applied during physical examination and rarely produces transferred pain to the legs or arms, there being no nerve root or spinal cord compression

The individuals in the archaeological samples cannot tell us of the pain caused by Schmorl's nodes, and to presume that it existed would be controversial. Comparison of the presentation of Schmorl's nodes in the archaeological samples with the clinical samples may give possible indications of back pain, specifically where the presentations of contiguous Schmorl's nodes in several vertebrae mirror those clinical patients with acute traumatic Schmorl's nodes (where acute pain is always noted in the patient history, and where previously there has been no pain). Where Schmorl's nodes form because of what appears to be minor trauma i.e. twisting and lifting a small weight, or sneezing while bending to tie up shoe laces, acute pain follows immediately.

Schmorl's nodes are symptomatic; acute, localised pain is present in very specific areas when flexion and extension tests are carried out, and there is no radiating pain to the limbs. Grive *et al.* (1999) provide evidence of two patients with localised pain and no

neurological symptoms who follow the pattern of events previously described. They had active Schmorl's nodes very late in the investigative process, when MRI was used. If, and when Schmorl's nodes heal, continuing localised pain will resolve. Schmorl's nodes may go undiagnosed if only sclerotic vertebral end plates are visible on immediate radiographic images. On later follow up films they may not be perceived as the possible pain source if the Schmorl's nodes no longer have sclerotic margins, or sclerotic vertebral end plates, unless medical practitioners are made aware of Schmorl's nodes as disorders of significance.

7.4 Schmorl's nodes and their relationship to age

Prescher (1998) summarises Schmorl's nodes as forming in their greatest numbers in the first and second decades of life, and this second decade of life is also suggested by Hamanishi *et al,* (1994). Roberts (2001) in the skeletal report for Captain's Cabin, Dunbar discusses the formation of Schmorl's nodes in older juveniles and young adults, as does Cardy (1997) in the Whithorn Priory skeletal report. These and many more research papers and reports dealing with Schmorl's nodes including Begg (1954) and Chandraraj *et al.*, (1998), do not appear to match with the radiographer's observations of Schmorl's nodes, or the radiologist's reports of vertebral columns radiographed due to either persistent back pain or acute trauma.

7.4.1 The first two decades

(i) Clinical subadults

Schmorl's nodes affected no subadults under the age of nine years, and only 5% (22) of subadults of 10 to 16 years of age were affected by Schmorl's nodes, according to the radiologists reports for all subadults in the RHSC sample. These rates for subadults

closely match the two adult Pinderfields Hospital samples, with the 1994-5 sample producing a 5% (70) rate, and the 1995 sample a 3% (40) rate. A much larger subadult Schmorl's node rate was expected; this low rate was mirrored in the archaeological samples.

(ii)Archaeological subadults

No cases of Schmorl's nodes were observed for subadults 0 to 10 years of age in the samples complete enough for this research. In the sub-adults of 11 to 20 years of age in the Hirsel, Coldstream, St. Andrew, Fishergate and Tanners Row, Pontefract sites again no Schmorl's nodes were seen. Only the military site of Captain's Cabin and the Whithorn Priory samples provided evidence for Schmorl's nodes of 8% (1) and 30% (3), respectively. If a weakness within the end plate existed, it resisted the pressures on the spine, both past and present. It has been established that the vertebral end plate does not have a weakened area except where congenital abnormality, or an underlying lytic lesion, or a bone compromising disease pre-exists (Kauffman, 2001). It has been proved that the vertebral end plate in the immature vertebral column can be compromised where acute impact trauma separates the vertebral end plate from the vertebral body, allowing the ruptured nucleus pulposus to pass under the plate and ultimately destroy subchondral bone. Those vertebral end plates of subadult vertebral columns which conceal Schmorl's nodes would in future decades allow less severe trauma to rupture the nucleus pulposus and enable it to infiltrate the end plate to form a secondary Schmorl's node. The first two decades of life are not the ages for the greatest prevalence of Schmorl's nodes to occur from the early to late Medieval period, or in the twentieth century, as was predicted.

(ii) <u>Individuals from 21 to 25 years of age</u>

This age group was added to the selected age ranges, because Scheuer and Black (2004), and Lusted and Keats (1972), give 20 to 25 years of age as the acceptable age range for final fusion of the end plates and the mamillary processes of the lumbar and sacral vertebrae. Late fusion might render the lumbar and sacral vertebrae vulnerable to the same end plate movements under extreme compression as individuals in their first two decades of life. Once again, the results did not follow the expected pattern.

(i) Clinical data

The 1994-5 Pinderfields Hospital sample (Appendix 5, Fig. 6.19) provided only a slight increase in rates for Schmorl's nodes for the 21 to 25 years age group when compared to the individuals from the RHSC (Appendix 5, Fig. 6.29) of 11 to 20 years of age; this was mirrored in the 1995 Pinderfields Hospital sample (Appendix 5. Fig. 6.23). The levels of intrusion of Schmorl's nodes from group to group showed definite variations, with the 1994-5 Pinderfields sample favouring the first and second lumbar vertebrae with almost equal superior and inferior end plate intrusions. The 1995 Pinderfields Hospital sample favoured the more caudal third lumbar vertebra, closely followed by the first lumbar vertebra, and no Schmorl's nodes were seen in the second lumbar vertebra. These two samples may be displaying different activities requiring differential vertebral column involvement. The 1994 sample could be showing Schmorl's nodes produced by weight lifting or repetitive work practices involving constant bending, whereas, the 1995 sample may reflect acute traumatic injury caused by sports such as mountain biking or motor biking where there is repeated compression low down in the spine in the seated position. Alternatively, similar vertebral column involvement in acute traumatic Schmorl's nodes at differing stages of evolution may be being observed, as these are all individuals with multiple contiguous vertebrae with single or double vertebral end plate Schmorl's nodes. No sudden increase in the number of individuals

with Schmorl's nodes was observed as might have been expected with young adults in their first places of employment, with many of them passing their leisure time in gymnasia or on the sports field.

(ii) Archaeological data

One sample had no Schmorl's nodes within this age group; this was the military site of Captain's Cabin, Dunbar. It would not be safe to assume that young military personnel did not undertake arduous work as even today's military forces work on a system where tasks are carried out by the lowest ranked individuals, without question, however back breaking and non-productive the task (Holmes, 2005). The other four samples produced a single individual each with Schmorl's nodes in this age group. One female from the Hirsel, Coldstream site, and one female from the Tanners Row, Pontefract, both had Schmorl's nodes at the levels of the first and second lumbar vertebrae with no other bony alterations diseases or disorders. These females would be of child bearing years and may have suffered Schmorl's nodes due to exaggeration of the lumbar lordosis by the anterior weight of the foetus, and its constant movement during the third trimester; this has not definitely been proved, but has been considered by several researchers including To and Wong (2003), and Ireland and Ott (2000). The remaining two individuals are both males. The first from St Andrew, Fishergate, has Schmorl's nodes in the first and second lumbar vertebrae which do not appear to be traumatic, and were associated with osteoarthritis and osteophytes at the same levels. The second male, who has multiple Schmorl's nodes in contiguous vertebrae, is from the Whithorn Priory sample. This male displays Schmorl's nodes which could be acute traumatic herniations produced by excessive compression of the intervertebral discs preceding rupture of the nucleus pulposus during a jump or fall from a height. However, this must remain speculation as the lower limbs were incomplete, precluding examination for trauma and,

even if there had been fracture evidence, the cause of the Schmorl's nodes would be conjecture at best.

7.4.3 Individuals from 26 to 35 years of age

(i) Clinical data

The frequency of Schmorl's nodes in this age range rose, with the superior and inferior end plates of the 1st lumbar vertebra remaining the most frequent location for Schmorl's nodes. In the 1994-5 Pinderfields Hospital sample the 2nd lumbar vertebra was the second most affected vertebra. This change is not reflected in the 1995 Pinderfields Hospital sample, which retains the 1st lumbar vertebra as the most affected, with the 12th thoracic and 2nd lumbar vertebrae as the next most affected by Schmorl's nodes. Whether this is mere chance, or due to different activities by males and females will be discussed in section 7.6.

(ii) Archaeological data

The archaeological samples reflect the increase observed in the clinical samples, but at a lower rate.

(a) Captain's Cabin, Dunbar

The Captain's Cabin sample in this age range produced only four individuals who were positive for Schmorl's nodes; all of these individuals had multiple contiguous *rough* Schmorl's nodes in keeping with trauma, except that these were at much higher levels than previously seen (the 7th thoracic vertebrae was the highest level of intrusion for two individuals, and the 8th thoracic vertebra in another). In the anterior thoracic curve, the Schmorl's nodes favoured the superior vertebral end plates, with superior and inferior

end plates being equally affected in the 1st lumbar vertebra at the point of alteration to lumbar lordosis, and then the inferior end plates being affected most in the 4th and 5th lumbar vertebrae. The lumbar vertebrae were the least affected by Schmorl's nodes (Appendix 5, Fig. 6.30). It may be that an activity was being carried out at the Dunbar site that caused compression with loading and rotational movement to produce Schmorl's nodes at these levels within the vertebral columns. We know that Captain's Cabin, Dunbar is part of a military site with an urban coastal settlement of military personnel; the population would have fished, farmed, and helped in the provisioning of the fort. Other than impact injury, one of the causes most often related to spinal disorders even in the early Medieval period was occupational induced injury (Dyer, 1989: 188-210). However, no contemporary report of occupational injury and disease has been located for this site. Five centuries later Ramazzini (1705) produced one of the earliest known statistical analyses of work related diseases, disorders and injuries of industrial workers, acknowledging the crippling vertebral column disorders suffered by men and women working in cramped and bent positions for many hours at a time.

If spines of the individuals of the Captain's Cabin sample were compressed due to load carrying, the description given by Cameron (1987/2005: 87) of the woman of the island of Lewis may shed light on one of the possible causes. "Women were responsible for household and domestic tasks and for the transportation of peats for fuel and wet seaweed for fertilizer using creels upon their backs". Deverenski (2000: 335) supports the belief that considerable weights were carried upon peoples' backs, saying, "Nonetheless, both men and women were physically stressed from an early age as the rocky and steep terrain did not permit the frequent use of horses and pony carts, and both agricultural carrying activities were done manually". These creels, kishie, or large woven baskets were supported at the curve of the sacrum by a padded strap similar to

the modern "bum bag" and with the main weight spread across the anterior chest/sternum and upper humeri just below the humeral heads".

Figure 7.2 A Shetland crofter from the Lerwick parish, knitting as she carries home her kishie full of peats. Note the posture of the woman as she walks (from the Shetland Museum Picture archive, photographer Wilson G. W. (1885)).

Keeping the load in place necessitated the carrier walking in a stooped position with their bottom pushed out to the rear (Fig. 7.2). Sudden compressive force with rotation of the intervertebral discs as the weight was lifted into place, followed by continuous weighted compression over a long period of time, and a sudden rotational decompression as the weight was lowered, may have caused rupture of the nucleus pulposus. Adams *et al.* (2000) experimented with loading of vertebral columns in flexion and extension over long periods, and then removing the compression to

assimilate work done. The nucleus pulposus eventually ruptured at several levels and the end plates at those levels were infiltrated by the pulposus of the nucleus producing Schmorl's nodes in the subchondral bone. Baskets or kishie were used for carrying fish, wood, vegetables and all manner of items, so may well have been used within, and without, the barracks of Dunbar's military fort. People using these creels are known to have carried up to 80 kilograms in weight for a single load (Murray, 1966). These creels had to be manoeuvred into place and, once transported, had to be removed and emptied, necessitating twisting and bending while lifting or removing the heavy load. Males and females of the 26 to 35 years age range may have been involved in the movement of different loads using similar methods, or in differing work practices which used exaggerated curvature of the upper thoracic and lower lumbar spine in their day to day activities. The environmental evidence from Captain's Cabin indicates a diet augmented by salt-water fish; fishing would apply similar tensile pressures of the vertebral column when trying to raise nets weighted with their catch.

(b) The Hirsel, Coldstream

The Hirsel, Coldstream, with only single vertebrae affected by Schmorl's nodes at the level of the 12th thoracic vertebra, produced a very different profile from that of Captain's Cabin with its multiple levels of Schmorl's nodes. An occupation where the primary thoracic curve is slightly exaggerated and lumbar lordosis reduced for long periods of time could produce these Schmorl's nodes. The more likely cause of these Schmorl's nodes at the thoraco-lumbar junction is reduced bone density and early signs of collapse, with the Schmorl's nodes taking up almost three quarters of the vertebral bodies' end plates. No archaeological contextual data for the Hirsel was available to help in understanding the causes of these Schmorl's nodes.

(c) Whithorn Priory, Galloway

Whithorn Priory, Galloway, home to St. Ninian and a place not only of pilgrimage, but a port, with all manner of goods being manufactured in the settlement, had only one individual (Sk. 509) of unknown sex affected by Schmorl's nodes. If the Schmorl's nodes of this individual are compared to those of the other males and females of this sample, it is more likely he/she falls into the male category. These Schmorl's nodes appear to conform to the RHSC acute trauma model, but could also be a product of compression due to heavy weights being carried on a regular basis. Buildings were being constructed and ships made ready to sail here (Higham, 1993: 111), all of which could have lead to a fall or jump from a height, but there is no evidence on which to base this theory.

(d) St. Andrew, Fishergate

In this age group from St. Andrew, Fishergate a sudden sharp increase of 35% (16) over the previous age range is seen, where only a single individual with Schmorl's nodes was observed. Only two individuals of this age range were females and the remaining fifteen were males. Their vertebrae were positive for Schmorl's nodes from the 5^{th} thoracic to the 5^{th} lumbar vertebrae, without exception, with superior and inferior vertebral end plates affected at each level. The 11^{th} and 12^{th} thoracic vertebrae were observed as having the greatest number of Schmorl's nodes in superior and inferior end plates, with a shift to the superior end plate of the first lumbar vertebra as the next most affected vertebra. This may be a case of chronic spinal contortion altering the primary and secondary spinal curves only slightly, the result of some activities when employed in any one of the many occupations carried out within the urban settlement of York. Cole *et al.* (2005) look at repetitive strain injury with back pain as one of the commonest areas affected, where management do not allow alteration to historic practices by the

work force, the outcome being reduced altered curvature and chronic pain. Rickett *et* al. (2006: 182) discuss the occupational hazard of manhandling bulky loads without the means of mechanical movement in nursing, saying that "The work is complex, varied and unpredictable, the human load is bulky, unstable, and often has to be lifted in a variety of awkward and unplanned situations"; the outcome is loss of natural lumbar lordosis and loss or exaggeration of the thoracic primary curve. Both of these work practices could help to explain the multiple levels of Schmorl's nodes at St. Andrew, Fishergate, which do not conform to the acute trauma model. Any of the occupations that they may have been employed in could have lead to Schmorl's nodes, including the manufacture of bone combs, die and weaving tablets (Kyriacou *et. al.*, 2004: 68 and 82), brooches and pins (*ibid*: 45-46 and 25) shoes and belts (*ibid*: 55), material and tablet weaving (Rogers, 1997: 1810-1829). Swanson (1988) and Rosser (1997) each write of a hierarchical society of guilds and craft societies with a workforce who may have been moonlighting in other trades, for example butchering by night and wool sorting and selling by day, woodwork by day and tallow candle dipping by night, or weaving by day and manufacture of component parts by night. Each of these occupations may have been undertaken during the length of working a day that we would not tolerate today, in a stooped/bent position with the thoracic curve increased and lumbar lordosis reduced. The St. Andrew, Fishergate excavation produced large amounts of residues of these activities as well as the completed articles.

(e) Tanners Row, Pontefract

This very early Medieval rural settlement with church and farming at its heart, produced only four individuals with Schmorl's nodes, their greatest level of intrusion involving the superior end plate of the first lumbar vertebra. This could be caused by ploughing and sowing, with the hours in between, spent in an almost upright position perhaps

herding cattle or droving sheep. No grave goods were found and no implements or tools to tell of a trade; no workshops hinted at commercial/industrial employment, leaving the cause of Schmorl's nodes unknown. These examples of possible work are based on the records made in the Domesday Book for the settlement then known as *Tateshalla*, where there were burgesses who owned arable land and kept animals, employing freemen to work the land (Hinde, 1997; 310-312), the assumption being that this settlement was a continuation and expansion of the Anglo-Saxon settlement.

7.4.4 Individuals from 36 to 45 years of age

(i) Clinical data

Both of the Pinderfields Clinical samples showed a sharp increase in the vertebral columns affected by Schmorl's nodes. This increase was reflected in females in both samples, which may indicate a different reason for the sudden increase rather than just work patterns causing chronic degeneration e.g. postmenopausal loss of progesterone and oestrogen, or secondary bone loss from breast cancer. Males do not suffer this sudden hormonal alteration, apart from exceptional cases (Carder *et al.*, 2005), which may be the reason that the male frequency hardly increases from the previous age range. If these were secondary Schmorl's nodes, or Schmorl's nodes which had herniated a previously weakened end plate, filling established subchondral Schmorl's node spaces, one would expect the male to female ratio to be almost 1:1 if the RHSC statistics are accepted as a model for modern subadult populations. One modern factor that could alter the male to female rate of Schmorl's nodes considerably is long-term extremes of dietary control (Derenne and Beresin, 2006) leading to loss of bone mineral density which, in its extreme form, produces osteoporosis.

(ii) Archaeological data

(a) Captain's Cabin, Dunbar

The Captain's Cabin sample continued to produce Schmorl's nodes in the upper thoracic and lower lumbar vertebrae observed in the previous age range, the only alteration being the shift, from the 11th and 12th thoracic vertebrae being the most affected to the 9th and 10th thoracic vertebrae. Osteoarthritis of zygapophysial joints, and osteophytic growth on the vertebral body margins (Appendix 7, Table 6.25) may have reduced the back's ability to bend, requiring the strain to be transferred higher up the chest and back. There was also a sudden rise in associated diseases, compared to the previous age range, with osteoarthritis, osteoporosis, osteophytes, mild osteochondritis, loss of lordosis and several instances of scoliosis of the vertebral column seen, which is not reflected in any other sample. This picture of ageing males and females required constantly to labour under great weights to keep the fort maintained and the troops fed, could account for excessive wear and tear upon the articular surfaces of the spine.

(b) The Hirsel, Coldstream

Hard work does not appear to have been carried out on this possible country estate with church. Only single vertebral end plates were observed to have Schmorl's nodes, at very few levels within this age group, reflecting a low overall rate for individuals. Little is known of the context of this site and its very existence was only discovered by chance, due to the number of grave markers ploughed out during cultivation. Was there an earlier Hirsel Manor, as yet undiscovered, with an estate church, or perhaps a church with an incumbent priest and lay people? So far, the historic records of Scotland have only produced documents mentioning the church and its removal from the chartulary at the beginning of the 16th century (Rogers, 1879: 80-83). The vertebral columns of the

individuals studied from the Hirsel cemetery do not show degenerative disease at the levels expected of a working population carrying out farming, building or heavy domestic work.

(c) Whithorn Priory, Galloway

Few people from the Whithorn Priory population who were dying at this age, were affected by Schmorl's nodes, and at least one of the two individuals affected by Schmorl's nodes may have come from a different level of society, or those peoples' lives did not involve much physical effort. The miracles of St. Ninian (McQueen, 1990: 88-101) of *Candida Casa* (the shrine of Whithorn Priory) brought holy men on pilgrimages of grace, seeking pardon, enlightenment and benediction (Brooke, 1994: 12-13). People from Ireland and Europe would have disembarked from the boats berthing in Whithorn's commercial port at the same time as imports were unloaded (Hill *et. al.*, 1997: 69). The individual may have been local, or may have been one of the many pilgrims seeking out 'Candida Casa', but instead of being granted an indulgence, or healed, they were laid to rest in the Whithorn Priory cemetery (Yeoman, 1999: 37-44). The second individual of unknown sex (Sk. 539) in this age range conforms to the multiple contiguous Schmorl's node group with Schmorl's nodes at every level from the 6^{th} thoracic to the 5^{th} lumbar vertebrae; this would place the individual into the male group of this sample. Skeleton 539 has Schmorl's nodes in multiple contiguous vertebrae; these are common to the males in all age ranges in the Whithorn Priory sample, whereas the females have only one or two single end plate Schmorl's nodes in all of the age ranges (Appendix 6, Table 6.19)

(d) St. Andrew Fishergate

In the St. Andrew, Fishergate sample, a continuing rising trend of vertebrae affected by

contiguous Schmorl's nodes was observed, with an increase in thoracic involvement. In the previous age range of 26 to 35 years the 6th thoracic vertebra was the highest level within the vertebral column that was affected by Schmorl's nodes, whereas the 2nd thoracic vertebra was the highest level affected in this age range. The main change was the increased number of thoracic vertebrae in the male sample affected by Schmorl's nodes, with the 11th thoracic vertebra the most affected; this reflects the level most affected by Schmorl's nodes in the men of Towton (Coughlan and Holst, 2000). Multiple contiguous Schmorl's nodes affect only the males in this age group; the females are affected in only one or two single end plates of individual vertebrae. This is an ageing population with chronic spinal conditions, and rising numbers of individuals with osteoarthritis, osteophytes, scoliosis and kyphosis; these, however, do not reach the levels seen previously in the Captain's Cabin, Dunbar for this age range.

(e) Tanners Row, Pontefract

Tanners Row, Pontefract produced no skeletal remains in this age range which were complete enough for analysis.

7.4.5 Individuals over 45 years of age

The clinical samples and the archaeological samples for the Hirsel, Coldstream and Whithorn priory show a continuing rising trend of Schmorl's nodes, whereas the Captain's Cabin, Dunbar and St. Andrew, Fishergate showed reducing rates in this age range.

(i) Clinical data

This age range showed a comparable number of individuals affected by Schmorl's nodes in both of the Pinderfields samples, with loss of intervertebral disc height scoring

more highly than osteoarthritis or osteophyte formation which was not unexpected in an ageing population for whom a sedentary lifestyle was no longer expected or accepted as in previous generations (Warburton *et. al.*, 2006). Reduced nutrient infiltration puts the intervertebral disc at risk of flaking and rupture, and reduces the tensile strength and cushioning effect with continuous wear and tear (Prescher, 1998). The 1994-5 Pinderfields group retains a slightly higher number of people with Schmorl's nodes, with more inferior vertebral end plates affected the level producing the greatest number of intrusions being the 1st lumbar vertebra compared to the 2nd lumbar vertebra in the 1995 Pinderfields hospital group perhaps this indicates a different work pattern. In the 1994-5 Pinderfields Hospital sample the individuals observed as positive for Schmorl's nodes and who were affected at the level of the first lumbar vertebra showed little variation between the male and female groups, with 50% (6) of males and 57% (8) of females affected. However, the individuals found positive for Schmorl's nodes in this age range in the 1995 Pinderfields Hospital sample showed considerable similarity between the males and females affected at the level of the second lumbar vertebra, with the males at 83% (5) and the females at 90% (9).

(ii) Archaeological data

(a) Captain's Cabin, Dunbar

The individuals from the Captain's Cabin, Dunbar sample suddenly showed vertebral columns with hardly any vertebral end plates affected by Schmorl's nodes, and these were only observed in three levels of inferior end plates which were the 7th and 8th thoracic and 2nd lumbar vertebrae (Appendix 5, Fig. 6.32). Only females were represented in this age range and those with Schmorl's nodes showing a different pattern to that observed in the two previous age ranges, with contiguous vertebral

involvement no longer present (Appendix 5, Fig. 6.30 and 6.31); this sudden differing pattern was unexpected and cannot be fully explained. Degenerative joint diseases of osteoarthritis, osteophytes and mild osteochondritis, and osteoporosis were all present, excepting the continuing contiguous vertebral involvement.

(b) The Hirsel, Coldstream

One female (Sk. 294) with contiguous vertebral end plate herniations caused a sudden increase in the number of individuals with Schmorl's nodes observed within this age group, and the 5th thoracic to the 3rd lumbar vertebrae were affected. Those Schmorl's nodes in the inferior end plate of the 10th thoracic vertebra, and superior end plates of the 1st and 2nd lumbar vertebrae were horseshoe in shape with only slight fissuring of the affected end plates, this was similar to the herniation described in section 6.7.2: 277, and may be sites of secondary herniation. When Schmorl's nodes have affected the vertebral end plates due to acute trauma in subadults, with the nucleus pulposus passing beneath the irregular end plates leaving them intact and without subchondral support, an adult Schmorl's node herniation of the end plates may have taken place after only minor trauma required.

(c) Whithorn Priory, Galloway

The point of greatest intrusion by Schmorl's nodes in the vertebral column has now moved from the 5th lumbar vertebra to the 2nd lumbar vertebra, with a much reduced number of vertebrae involved (Appendix 5, Fig. 6.39). Schmorl's nodes affected only three individuals, an individual, possibly male (Sk 537), with both the superior and inferior end plate of the 2nd lumbar vertebra affected, and a female (Sk. 519) with Schmorl's nodes of the superior end plates of the 12th thoracic and 4th lumbar vertebrae, and the inferior end plate of the 3rd lumbar vertebrae. Both of these individuals had

degenerative joint disease of the spine including osteoarthritis, and osteophyte formation, and osteoporosis, which were not exclusive to the levels affected by Schmorls nodes (Appendix 7, Table 6.27).

(d) St. Andrew, Fishergate

St. Andrew, Fishergate had a 23% (11) decline in the number of individuals affected by Schmorl's nodes and these were all single vertebral end plates apart from the 12th thoracic vertebra where both surfaces were affected (Appendix 5, Fig. 6.42). Six individuals of this group had early or advanced diffuse idiopathic skeletal hyperostosis which may reflect an indulgent life style, where plentiful high quality foodstuffs were freely available (Rogers and Waldron, 2001); a resulting type II diabetes may have ensued which, in its early stages, could have been controlled by a more moderate diet. Schmorl's nodes and DISH were only observed together in one male individual (Sk. 30). Perhaps we misjudge the monks' eating habits, when their life of prayer and meditation perhaps provided a too sedentary lifestyle to cause digestion to work efficiently and kidneys to filter quickly. It may be necessary for the width of grave cuts to be reported in future and judged against modern coffin sizes for overweight people to gain a clearer understanding of an individual's weight at death, and its relationship, if any, to DISH. In clinical medicine DISH in slim elderly patients is noted daily, and these patients when questioned gave a history of insulin controlled diabetes (*pers. comm.*, Patients attending for vertebral and pelvic radiography, Pinderfields Hospital, 2005-6). Two other males had suffered from tuberculosis with evidence of bony regeneration; this disease requires close contact with people already positive for tuberculosis (Khan, 1998), perhaps indicating contact with the poor e.g. handing out alms. There is a greater than average probability that these individuals were monks from the Gilbertine monastery of St. Andrew Fishergate and the two individuals

observed as positive for spinal tuberculosis were undertaking work in the hospital. Alternatively the two males with tuberculosis may have lived in squalid conditions with many other people.

(e) Tanners Row, Pontefract

Schmorl's nodes in this age range, with only single vertebral end plate intrusions (Appendix 5, Fig. 6.44), affected only two individuals. These Schmorl's nodes in single vertebral body surfaces did not suggest an obvious cause. Both individuals also suffered degenerative joint disease of the spine, as would be expected in people who carried out manual labour (Sofaer, 2006: 162-3). In addition, one of the two individuals had osteophytes which increased proportionally in size the more caudadly they were placed on the vertebral body margins. These osteophytes appeared to be stabilizing the segmental joints by reducing slippage of the vertebral bodies where the intervertebral discs were worn. Osteochondritis of the vertebral bodies, a disease associated with friability of the intervertebral discs caused by loss of nutrient infiltration (Setton and Chen, 2006), was observed at the levels of the Schmorl's nodes and osteophytes.

7.5 Altered dynamics of the vertebral column

Proving that Schmorl's nodes, when not centrally placed within the end plates of the vertebral body, are responsible for scoliosis or kyphosis, was fraught with difficulty as muscle dynamics can alter due to asymmetric loading over prolonged periods (Edenbichler et. al,. 2001). Muscle spasm may also produce scoliotic shift which is temporary and quick to resolve itself. Macroscopic observations of the anterior vertebral body height were made in the archaeological samples, and the vertebral column reconstructed to assess whether there was a definite increase in thoracic curvature, or

lateral shift in the sagittal plane of the thoracic or lumbar vertebral column. Clinical radiographs were used to assess scoliosis and kyphosis in the clinical samples

7.5.1 Clinical data

(i) Pinderfields Hospital samples

Scoliosis and/or kyphosis was present in 25% of the Pinderfields Hospital samples; those with scoliosis showed a scoliotic bias, curving away from the side of insult, so that a Schmorl's node situated to the left lateral margin of the vertebral body produced a convex curve to the right of the vertebral column's sagittal plane. In the male groups within these samples, 75% of the patients were in the 21 to 25 year age range and all of those presented as acute trauma. This meant that there was a greater than even chance that, as the Schmorl's node moved through the stages of the RHSC acute trauma model, the scoliosis would resolve and the normal curve would return. However in cases of acute trauma where Schmorl's nodes were present, and no other significant bony injury was observed, muscle strains and ligament tears can place asymmetrical strains upon the vertebral column, producing alterations to the natural curves. The females of the clinical samples affected were spread over several age ranges and produced a much more varied case history than that of the males. The older females with Schmorl's nodes and scoliosis were all having investigative tests for osteoporosis or carcinoma. In making a reasoned judgement into the impact of these particular eccentric Schmorl's nodes, the question must be asked: "do these Schmorl's nodes present prior to vertebral collapse or are we misdiagnosing early stage myeloma and osteoporotic collapse?" There is a lateral concave curvature (scoliosis) on the side of the Schmorl's node and convex curvature to the side opposite to the Schmorl's nodes repeated throughout this group. In the younger age groups, a minor lumbar scoliosis, beginning at the 1st lumbar vertebra

and ending at the 4th lumbar vertebra, was not always accompanied by eccentric (not centrally placed) Schmorls nodes, but was accompanied by acute pain which became chronic over time. Resolution was rarely observed on radiographic images taken at a later date, suggesting another complicating factor, combining with the Schmorl's nodes causing this deviation from the mid-line. On looking at previous requests for radiographic imaging of the lumbar spines of several of these patients a single piece of evidence united them: they had each had a full term pregnancy during which time they had first suffered low back pain, which had never resolved. This minimal lumbar scoliosis in patients with Schmorl's nodes, who had no history of injury, may be the result of supporting a gravid uterus with its continually moving contents (a baby) of approximately 3 to 3.5 kilograms. Without further research, this can only be suggested as a cause and outcome.

(ii) Royal Hospital for Sick Children

Kyphosis in this sample was shown to be directly related to the anterior wedging of the vertebral bodies where the formation of Schmorl's nodes had caused the vertebral end plates to lift and retract from the anterior edge of the vertebral body, allowing compression and lipping (outward curvature) of the subchondral structures. Scoliosis and kyphosis was also observed where, in the antero-posterior radiographic images, narrowing of vertebral body height laterally was consistent with laterally positioned Schmorls nodes, and anterior wedging with irregular end plates. It would appear that the juvenile vertebral column is much more susceptible to columnar deviation than that of the adult, and Schmorl's nodes that are formed by the passing of the nucleus pulposus beneath the end plate making it lift and occasionally to retract. As in the Pinderfields Hospital samples, the convex curve was opposite to the side containing the eccentric Schmorl's nodes.

7.5.2 Archaeological data

Tanners Row, Pontefract produced negative evidence for altered vertebral column dynamics. Captain's Cabin, Dunbar produced only one individual with a thoracic scoliosis to the right, with large osteophytes on the antero-lateral borders of the vertebral bodies opposite to the eccentric Schmorl's nodes which were placed to the left. The vertebral osteophytes were almost at the point of ankylosing on the side opposite to the vertebral height reduction, as if trying to contain any further development of the scoliosis. Advanced osteoarthritic changes of eburnation, pitting and osteophytes were observed in the apophyseal joints at the same levels. This male of 36 to 45 years of age displayed vertebral columnar changes possibly consistent with a life where asymmetric movements over many years produced Schmorl's nodes in response to repeated pressures on the vertebrae, probably with rotation and bending to the left. Ageing of the components of the vertebral column would reduce the cushioning effects of the intervertebral discs as discussed by Prescher (1998) and Jacenko *et al.* (1994). They would lose there elasticity, and nutrient filtration would be reduced, associated with the reduced ability of the osteoclasts and osteoblasts to remodel damaged bone which, in turn, allowed distortion to occur. Schmorl's nodes may have been the catalyst in these altered dynamics, but if respite from this sided pattern of movement, or altered work patterns had been introduced, then scoliosis might not have been the outcome.

Two vertebral columns from the Hirsel cemetery population were observed as having Schmorl's nodes and scoliosis. Neither of these individuals mirrored the Captain's Cabin individual. A single large, deep, *rough*, posteriorly placed Schmorl's node was observed in the 2nd lumbar vertebra of the first vertebral column (Sk. 85). Osteophytes were observed on the right antero-lateral vertebral margins of the 10th thoracic to the 4th lumbar vertebrae and appeared to contain the scoliosis from further exaggeration of its

convex curve. The second individual was observed as having vertebral bodies of an unusual shape and height, along with osteoarthritis and osteoporosis; again only a single posteriorly placed Schmorl's node slightly to the right of centre was seen, and this time the scoliosis was to the left. Could the scoliosis be a sided alteration, where the musculature of the vertebral column was affected by the dominance of right over left side, or vice versa? Whithorn Priory produced the first female scoliotic individual, whose Schmorl's nodes were *rough* and deep, and wedging to the same lateral margin was evident. The scoliosis was again on the opposing side to the wedged vertebrae. These Schmorl's nodes may well have been transitional, bordering on collapse from underlying osteoporosis or lytic lesions. Pursuing these possibilities was not possible within the confines of this research.

Intriguingly, all the males and one female of the Fishergate population who had Schmorl's nodes and scoliosis, produced a convex arc to the right with multiple contiguous Schmorl's nodes, reflecting the same findings in the individuals from the Captain's Cabin sample. Again, osteoarthritis and osteophytes were observed in the majority of individuals affected by Schmorls nodes and scoliosis. Work related Schmorl's nodes with long-term working conditions using asymmetrical movements of the upper limbs and vertebral column are the most likely cause of such a shift of the vertebrae from the mid-line. Whether the movements were replicated in the same type of employment is impossible to say, but the outcome was the same.

7.6 Schmorl's nodes and their relationship to sex.

Originally the Pinderfields Hospital samples were only divided into male and female groups, but to produce comparisons between subadults, adult males and adult females in the archaeological samples, they were redefined and the sub-adults placed into separate

groups. The RHSC sample was split into the known male and female groups to produce evidence which could be compared with each of the other samples to discover whether the pattern mirrored that of the adults whose sex was known.

(i) Clinical data

The 1994-5 Pinderfields Hospital sample produced a male to female ratio of 1:1 with two of the female group being subadult (Appendix 4, Fig. 6.10), while the 1995 Pinderfields Hospital sample produced a male to female ratio of almost 1:2 with two of the females falling into the subadult group (Appendix 4, Fig. 6.11). The RHSC clinical sample also produced a male to female ratio of 1:1. The push for equal opportunity for males and females at work and in sport might be expected to produce a rise in adult females suffering from Schmorl's nodes, but equality in the subadults of the RHSC clinical sample was unexpected. The subadult Schmorl's nodes were confined to a much smaller number of vertebrae, with the 1st and 2nd vertebrae producing the greatest incidence in both groups, and the 12th thoracic vertebrae in the 1995 Pinderfields Hospital group being the same; this was not replicated in the 1994-5 Pinderfields Hospital subadults (Appendix 4, Fig. 6.11 and Fig. 6.10). Adult Schmorl's nodes were at there most numerous in the first lumbar vertebra for both males and females in the 1994-5 Pinderfields Hospital sample, and most numerous in the 2nd lumbar vertebra in the 1995 Pinderfields Hospital sample. In both samples, there was a sharp increase in the number of Schmorl's nodes at the level of the 12th thoracic vertebra, steadily increasing to the lumbar vertebra, with the males in the 1994-5 Pinderfields sample showing a higher rate of incidence than females, while in the 1994 Pinderfields Hospital sample the trend was reversed.

There was no significant variation in the male to female rates in each age range for

Schmorl's nodes of the samples studied. However there was a significant variation in the male to female levels of osteoarthritis of the spine observed in the two samples. The males of the 1994-5 Pinderfields Hospital sample produced a 46% (16) rate compared to the female rate of 29% (10), and the males of the 1995 Pinderfields Hospital sample produced a 29%(4) rate compared to the female rate of 65% (17) (Appendix 3, Table 6.13a). This may be indicative of differing work patterns, which could not be proven as no data on employment was available.

A very different profile for the vertebral levels affected by Schmorl's nodes was produced when the subadults of the RHSC sample were viewed (Appendix 4, Fig. 6.12), compared to the adult males and females of the Pinderfields Hospital samples. Apart from two female peaks at the twelfth thoracic and first lumbar vertebrae, an even rate was observed from the thoraco-lumbar junction to the fourth lumbar vertebra. Comparing the RHSC Sample with the subadults of the Pinderfields samples did not produce a Schmorl's node rate similar in levels or numbers, for the two samples. Only three individuals from the RHSC sample were not acute trauma patients, whereas the Pinderfields samples were for the main part patients presenting with back pain and no history of a recent traumatic incident, so that the causes of Schmorl's nodes in each sample differed.

(ii) Archaeological data

(a) Captain's Cabin, Dunbar

The females of the Captain's Cabin sample produced a 50% (6) rate for Schmorl's nodes with the males at a slightly lower rate of 42% (5), with a sub-adult rate of 8% (1). Schmorl's nodes within the Captain's Cabin sample compares to that of Towton at 40%

(Coughlan and Holst, 2000). This sample has a different profile from all the other clinical and archaeological samples, with the females of the sample showing step like increments of Schmorl's nodes (Appendix 4, Fig. 6.13). The 7th, 8th and 9th thoracic vertebrae show the greatest number of Schmorl's nodes, followed by the 10th and 12th thoracic and 2nd lumbar vertebrae; a downward progression is followed by the 4th and 5th lumbar vertebrae. Exceptions are the 1st and 3rd lumbar vertebrae which provided no evidence for Schmorl's nodes. The males of the sample were most affected by Schmorl's nodes at the levels of the 9th and 10th thoracic, and 1st and 3rd lumbar vertebrae, produced perhaps by a slightly different type of loading to the vertebral column compared to the females. The crew of the Mary Rose (Stirland and Waldron, 1997) produced the greatest number of Schmorl's nodes at the levels of the 9th and 10th thoracic vertebrae, and the 1st and 2nd lumbar vertebrae produced a similar but not exact replication of the Captain's Cabin sample. Stirland and Waldron (1997) suggested a similar picture to that of the Captain's Cabin sample, with crew members employed at a young age in all the occupations onshore and aboard ship including heavy physical work. Stirland and Waldron (1997) then go on to describe the methods of heaving and hauling the guns which weighed up to two tons, by teams of six men per gun, a work practice which would also have been common to the military site of Captain's Cabin. This vertebral column loading suggests an initial dead weight lift and then a transferring of weight to move an object to its final resting place, as would be required in the movement of cannon balls and the many other items of heavy military equipment. Reasoned thought does not equal fact, and only by studying Schmorl's nodes in archaeological samples from known military contexts can a clear picture of any recurring work induced Schmorl's nodes be properly observed and analysed. The females, as discussed earlier in this chapter, may also belong to a unique group of coastal and island people who used the creel or kishie as their main method of carrying

large weights, requiring their own in depth study to produce sufficient workable data.

(b) The Hirsel, Coldstream

The Hirsel sample produced the expected profile of a higher male rate for Schmorl's nodes compared to that of the females of the sample. This male incident rate of 64% (7) compared to the female 36% (4) fits the historical profile of other Medieval sites, e.g. Logies Lane St. Andrews (Cardy, 1993), and the Blackfriars, Ipswich (Mays, 1991), but the small numbers studied can only allow a tentative comparison to be made. There is little known about the composition of the inhabitants of this site, so the unusually high number of male individuals with spina bifida occulta, spondylolysis and spondylolisthesis are not easily understood, anymore than the very low number of individuals found with Schmorl's nodes (Appendix 3, Table 6.13a). Schmorl's nodes were absent from all of the complete vertebral columns where spina bifida occulta was observed. Only 13% (11) of the population with complete vertebral columns were observed as having Schmorls nodes, with the female group having no level preferentially affected, and only the eighth thoracic to the second lumbar vertebrae being involved. Males showed a peak involvement at the level of the twelfth thoracic vertebra, with Schmorl's nodes from the fifth thoracic to the third lumbar vertebrae (Appendix 4, Fig. 6.14). This pattern does not fit the profile of any other sample, but the males of the Hirsel do show parity with the males of the St. Andrew Fishergate, sample with their peak rate at the twelfth thoracic vertebra.

After the deconsecration of the Hirsel church, the building was subdivided into several dwelling places, but before this point there was no indication of a village or settlement in close proximity to the church (Cramp, 1983 and 1984). Perhaps this is indicative of seasonal settlement where animals are grazed on the low pastures in summer and

removed to more sheltered areas in winter, or did a previous 'Hirsel Hall' or House stand where the more modern building is now placed? The latter seems the more probable, but does not explain the low Schmorl's node rate, or the high rate of spondylolisthesis and spondylolysis, both of which are believed to be caused by asymmetric stresses upon the pars interarticularis of the lower lumbar vertebrae (Merbs, 1996b). The Hirsel showed a higher than average number of individuals affected by spina bifida occulta, which in a group where spondylolisthesis and spondylolysis were also unusually high, raises the question of close family ties or perhaps even familial intermarriage (Padmanabhan, 2006 and Shaer *et al.*, 2006).

(c) Whithorn Priory, Galloway

Whithorn Priory produced a Schmorl's node rate where the female to male ratio was 2:1, with the males producing even fewer examples than the subadults (Appendix 3, Table. 6.13b). This could perhaps be accounted for if the majority of males studied were monks, merchants or traders, who had laymen, serfs or slaves to carry out all of the manual work required (Pelterest, 2002 and Jones, 2000), or if they were pilgrims visiting the shrine of St. Ninian at 'Candida Acasa' (McQueen, 1990: 25-28). The males with Schmorl's nodes suffered multiple contiguous Schmorl's nodes of the RHSC acute trauma model, while the females all presented with only single levels of Schmorl's nodes, suggesting different origins. This sample did not fit the expected Medieval profile of a higher percentage of Schmorl's node sufferers; instead it showed a similar female profile to that of the 1995 Pinderfields Hospital sample. The subadults showed a lower number of Schmorl's nodes over a much narrower group of vertebrae compared to the adults; this presentation of Schmorl's nodes was very similar in profile to the subadults of the 1995 Pinderfields Hospital sample. The males showed peaks from the sixth to the eleventh thoracic vertebra, while the females produced peaks from the third

to fifth lumbar vertebra. The males of Whithorn Priory appear to have been subject to greater physical activity than the females (Cardy, 1997: 552), unless the female Schmorl's nodes were the product of hormonal changes and underlying osteoporosis. Again, no grave goods were found which could possibly indicate a specific type of employment status (Batey *et al.*, 1994a and b: 42-45 and 148-163) although many artefacts relating to employment were excavated on site (Hill and Nicholson, 1997: 400-433). Lead vessels and working debris, iron tools including scythes and draw knives, stone moulds for dishes and spoons, carved stones and masons debris, spindle whorls and wool combs are a few of the many finds relating to work carried out on this monastic site, but not in a context showing a relationship between an individual and their employment.

(d) St. Andrew, Fishergate

In this large well-preserved cemetery population, the males were dominant, as they were when observing the numbers of vertebral columns affected by Schmorl's nodes. Schmorl's nodes were observed in 78% (32) of the male population. This prevalence of Schmorl's nodes was found to be much greater than any of the other archaeological samples studied, as were the numbers of male individuals with diffuse idiopathic skeletal hyperostosis. As discussed in 7.4 this may be an indicator of monastic lifestyle and diet. The most interesting result was the absence of Schmorl's nodes in the subadults, who lived in an urban environment and would have been expected to commence their working lives at an early age, undertaking menial repetitive tasks. This lack of Schmorl's nodes or any other disease or disorder of the vertebral columns of the subadults is perhaps indicative of a higher social status where food was plentiful and where physical labour was not required (Stroud and Kemp, 1993: 252-253). It might also account for burial within a monastic cemetery rather than the poor town cemetery

of St. Helens on the Walls, in York, where injury and disease were prevalent amongst the majority of subadults (Dawes and Magilton, 1980). In this age group only 17% (1) of females were affected by Schmorl's nodes compared to 83% (5) of males (Appendix 4, Fig. 6.16); this is reflective of St. Brides, London where 75% of males and 20% of females were affected by Schmorl's nodes (Saluja, *et al*, 1986). Only the over forties show any real signs of degenerative joint disease, with females positive for Schmorl's nodes, and for those who were not, producing almost equal numbers affected by osteoarthritis, osteoporosis, osteophytes, and mild osteochondritis. Genetic factors may account for this sudden change in health, if these were the females of the more affluent in local society who were buried in the cemetery of this Gilbertine Priory of St. Andrew, Fishergate. However this site provides data which is always going to be male dominant due to the number of males compared to females interred in the cemetery.

(e) Tanners Row, Pontefract

One male and one female in this age range were affected by Schmorl's nodes on inferior vertebral end plates; the male was affected at the level of the 1st lumbar vertebra and the female at the levels of the 9th and 10th thoracic vertebrae. Both of these individuals were also affected by osteoarthritis and osteophytes of the spine. Females appeared to be the dominant sex in Schmorl's node involvement, in this sample, but this was only because the sample was too fragmentary (Appendix 4, Fig. 6.17) to allow sufficient information to be gathered to provide meaningful data.

7.7 The origins of Schmorl's nodes

The origins of Schmorl's nodes are closely linked to the evidence discussed in 7.2. Here the vertebral end plate was found not to have a central weakened area, but an anterior weakness where acute trauma produced a series of events where, under extremes of

compression and relaxation of the anterior longitudinal ligament caused avulsion and end plate distortion in immature individuals, predisposing them to late Schmorl's nodes.

7.7.1 End plate disruption by Schmorl's nodes

Vertebral end plate involvement in Schmorl's nodes is not in doubt; all researchers discuss and describe the disruption to the end plates of the vertebrae caused by the intrusion of the pulposus of the nucleus of the intervertebral discs. The number of superior and inferior end plates affected by Schmorl's nodes are regularly calculated and recorded, always indicating the inferior vertebral end plate as the most affected (Jakob, 2005: 41). Hilton *et* al. (1976: 127), state that, "Schmorl's nodes occur most frequently in the lower end plate", as does Anderson (2001:353-354) when discussing the prevalence of Schmorl's nodes in the population of St. Gregory's Priory, Northgate, Canterbury. What is not considered is the relationship between adjacent vertebrae and the intervening intervertebral disc of each motor segment of a complete vertebral column.

7.7.2 Superior and inferior end plate incidences for Schmorl's nodes

When viewing radiographic images of thoracic and lumbar vertebrae, a noticeable repeat pattern was observed when multiple Schmorl's nodes were present; the inferior end plate of the superior vertebral body appeared to mirror the disruption to the superior end plate of the inferior vertebral body. This pattern was found in all of the clinical groups, and was found again within the archaeological samples, with only two exceptions (Fig. 6.3). Both of these groups fell outside the observed regular pattern. First the Hirsel (Appendix 6, Tables 6.18a and 6.18b), where only three skeletons presented multiple Schmorl's nodes, two of which did fit the usual pattern, and secondly Tanners Row (Appendix 6, Table 6.21) where no vertebral columns were observed as

having multiple Schmorl's nodes. If this group of contiguous vertebral end plates containing Schmorl's nodes were treated as a new dataset, they would provide evidence for traumatic Schmorl's nodes. The inferior end plate intrusions continued to have a slightly higher prevalence than the superior end plate intrusions, but this prevalence was reduced. Previous reporting of end plate intrusions may not have included data for contiguous end plates, as they would not naturally occur if each vertebra was observed and data recorded without regard for the inter-relationship within the motion segments. Contiguous Schmorl's nodes in several vertebrae in the clinical samples were always related through clinical patient histories to acute or recent impact injury; this may be applied to archaeological samples where the same pattern was seen to occur, allowing a possible indication of how the Schmorl's nodes were caused. If lower limb injuries are also present, they may add weight to the possibility of impact injury where falling or jumping from a height has taken place and the individual lands on their feet or knees. Males and females from the clinical samples produced almost equal numbers of multiple level contiguous Schmorl's nodes. However, the archaeological samples produced an almost exclusively male predominance in the young adult through to 36 to 45 year age groups, with one or two unsexed individuals who, if they followed the observed trend, would also belong to the males of the sample.

Four possible variants of Schmorl's nodes were reported from the radiologists' reports of the Pinderfields Hospital samples, only three of which were observed in the clinical and archaeological samples by macroscopic archaeological observation, clinical radiographic imaging or archaeological radiographic imaging. The one variant, which was not observed, was the 'bunch of grapes'; this may not be a Schmorl's node, but early indications of intraosseous degenerative bone-cysts due to osteoarthritic changes (Quigley *et al.*, 2006). Cortical bone within osteoarthritic joints is reduced in strength

and thickness where the joints have lost their cartilage covering, allowing bone-to-bone contact (Halanski *et al.*, 2004). Porosity of the weakened vertebral cortex allows infiltration of the nucleus of the pulposus to filter into the trabecular spaces beneath the vertebral end plate, forming pools in the cystic voids. These are filled with granulated nucleus pulposus where osteoclasts have begun to destroy the vertical and horizontal trabecular structures, mimicking subchondral bone-cysts.

(i) Tunnelling Schmorl's nodes

No instances of tunnelling Schmorl's nodes were observed in the clinical samples and only five possible cases were observed in the archaeological samples, those samples being Captain's Cabin, Dunbar and St. Andrew, Fishergate. The first of the Captain's Cabin individuals (Sk. 36) was a male of 26 to 35 years of age with thoracic kyphosis, osteoarthritis and osteophyte formation; the vertebrae were radiographed, but no visual evidence of tunnelling Schmorl's nodes, cystic lesions or collapse was shown. A female (Sk. 44) of >45 years of age from the same sample with severe osteoarthritis, where eburnation, osteophyte formation and altered contours of the apophyseal joints were observed, was also radiographed, but no tunnelling Schmorl's nodes were visualized. The profile of the end plates of this individual appeared to be very concave and may have been exhibiting the early stages of collapse. St. Andrew, Fishergate provided three possible instances of tunnelling Schmorl's nodes, non of which provided definite positive evidence when all the data had been collated. One female of 21 to 30 years of age (Sk. 328) had multiple Schmorl's nodes in contiguous end plates with one much deeper rough Schmorl's node; whether this was directly attributable to impaction of the intervertebral discs, causing greater infiltration at this level because of another undiagnosed disease causing reduced vertebral body resistance, is uncertain. Bone metastases in the spine, when diagnosed in breast cancer patients, may in their earlier

stages present as acute Schmorl's nodes, and progress through the sclerotic vertebral end plate stage to be quickly followed by *rough*, large, deep Schmorl's nodes; however, they do not lose the lucent look of reactive sclerosis. In their final stage lytic lesions are clearly visible; at this stage a procedure known as "liquid cement injection" (Duedeney, 2002) is used to stabilize the cortical shell of the vertebra, reducing pain and slowing down vertebral collapse which would ultimately lead to death (Simmons and Zheng, 2006). Spinal collapse, where surgical intervention is not a possibility, causes compression of the spinal cord and nerve roots, producing motor nerve compression with acute pain, and autonomic nerve compression leading to vital organ dysfunction, or even cease to function. Patients often complain of sudden onset of pain between the shoulder blades, this being a warning signal to oncologists of possible bony involvement. A plain film radiograph is taken, frequently as a follow up to a bone scan (which shows "hot spots" or areas absorbing noticeably high levels of radium) (Sadik *et al.*, 2006). Schmorl's nodes and sclerotic vertebral end plates are usually described in the radiologists' initial report. Oncologists may be unaware that Schmorl's nodes may be a precursor to subchondral bone loss, and thinning of the vertebral end plates in the early stages of bony metastases (*pers. com.*, several breast cancer patients, April 2005 – May 2006). It may be that only when all surviving elements of the skeleton are examined, when large, deep, *rough* Schmorls nodes are present that it may be proved whether an indicator of bone metastases is being observed in archaeological samples. Being a soft tissue carcinoma, breast cancer as a primary lesion may only be observed if the ribs immediately posterior to the breast show signs of lytic lesions (Kono, 2005).

(ii) *Rough* Schmorl's nodes

Rough Schmorl's nodes were the type of Schmorl's node observed in greatest numbers

in both the clinical and archaeological samples studied. The clinical samples produced a 74% (98) rate and the archaeological samples an 80% (74) rate. Where multiple *rough* Schmorl's nodes were observed and no metastatic lesions or centres of myeloma were observed or reported, then it is possible to say in clinical circumstances, that this is due to impact injury when patient data indicates a recent fall from a height, landing with the vertebral column in an upright position. One case of possible acute Schmorl's nodes in an archaeological sample, where very recent trauma may have occurred, was seen in a male (Sk. 38) of 26 to 35 years of age from the Captain's Cabin site; he had *rough* superior end plate Schmorl's nodes from the 9th thoracic to 3rd lumbar vertebra, with the exception of the 10th thoracic vertebra. *Rough* Schmorl's nodes were also observed in the inferior vertebral end plates from the 10th to 12th thoracic vertebrae. It cannot be categorically stated that this individual jumped or fell from a height, landing in an upright position, but with the knowledge gained from the clinical samples it becomes a definite possibility. Now knowing that Schmorl's nodes due to acute injury do not all form, progress and heal at the same rate, it may be that this individual, if he had lived longer, may well have developed contiguous Schmorl's nodes in all of the affected vertebrae, from the 9th thoracic vertebra to the 3rd lumbar vertebra. Another male (Sk. 21) of 36 to 45 years of age from the Captain's Cabin, Dunbar sample, was observed to have a similar pattern of Schmorl's nodes. These contiguous Schmorl's nodes of possible traumatic origin are a male only occurrence in the archaeological samples, with the exception of the St. Andrew, Fishergate sample. Here ten males, covering the age ranges from 21 to >45 years, were observed with multiple contiguous *rough* Schmorl's nodes, as well as three young females of 21 to 35 years of age. This group of females may have been carrying out work where they were continually stooped over, as they had Schmorl's nodes and slight widening of the anterior vertebral margins, with wedging and loss of lumbar lordosis, and thoracic kyphosis. It can only be assumed, without

specific evidence, that they may have carried large loads on their backs or worked in a continually stooped position (Thackrah, 1831). The frequency of Schmorl's nodes in the males of St. Andrew, Fishergate, with their posterior position, and the number of vertebrae involved, mirror much more closely the acute trauma model drawn from the clinical samples. *Rough* Schmorl's are the active and reactive stages of Schmorl's nodes, which when observed in clinical patients over a period, will eventually heal (Appendix 8, Table 6.32: 346XY).

(iii) Smooth Schmorl's nodes

The profile of an end plate affected by a Schmorl's node does not return to its original smooth, slightly concave surface when healing occurs; instead, it retains the impression of the Schmorl's node, but with a smooth covering of regenerated cortical bone, or a cortical shell in the case of a Schmorl's node beneath an intact end plate. In the clinical samples, 24% (32) of vertebral columns were recorded as having smooth Schmorl's nodes, and in the archaeological samples, 10% (9) of vertebral columns. Those vertebral columns which mirrored the acute trauma model with smooth and rough Schmorl's nodes in their various stages of herniation, sclerosis and healing represent 8% (11) of the clinical samples, and 6% (6) of the archaeological samples affected by Schmorl's nodes. Regeneration of cortical end plate does occur over time when no bone destroying disease e.g. carcinoma or osteoporosis is also present. Healed Schmorl's nodes should be recognised as such and treated as any other bony fracture which, when healed, would not be referred to as a "fracture", but as a healed Schmorl's node, or old Schmorl's node injury.

7.8 Schmorl's nodes and their association with irregularities of the pelvis and lower limbs

Asymmetry of the lower limbs must have been an extremely difficult condition to live with in the past as it affected gait, pelvic tilt and the alignment of the vertebral column. In the living, development dysplasia of the hip should be diagnosed relatively early, when paediatricians and/or nurses carry out limb assessment during the neo-natal period (Sharpe *et al.*, 2006). Occasionally developmental dysplasia of the hip is not diagnosed until early adulthood when patterns of asymmetric gait have begun to affect the knee and hip joint on the unaffected side (Wenger *et al.*, 2006) and rotational scoliosis has become well established (Al-Eisa *et al.*, 2006). Asymmetric leg length, developmental dysplasia, Perthes disease and slipped femoral epiphysis on the affected side are believed to cause early onset of osteoarthritis (Cloisy *et al.*, 2006). Due to the incompleteness of many of the individuals studied, it was impossible to gain meaningful data from the archaeological samples. Nevertheless, the clinical data provided interesting results which were unexpected.

7.8.1 Clinical irregularities of the pelvis and lower limbs

Schmorl's nodes were present in all of the subadults suffering from a lower limb or pelvic disruption causing alteration to the normal symmetrical anatomical position of the hip joints. Perthes disease, slipped femoral epiphysis, and developmental dysplasia of the hip, once diagnosed, are easily treated, but do not always result in a return to the expected and predicted growth pattern, or acetabular profile of the hip. Infantile septic arthritis is the most aggressive, rapid and painful joint disease affecting the hip, noted for the extreme heat it produces as it attacks the femoral head; it causes necrosis of the epiphysis and, within twenty four hours of onset, can completely destroy it if untreated (Fig. 7.3), (McCarthy *et al.*, 2004). This disease does not kill, but brings about permanent disruption to the pelvis and affected lower limb, changing the sufferer's gait.

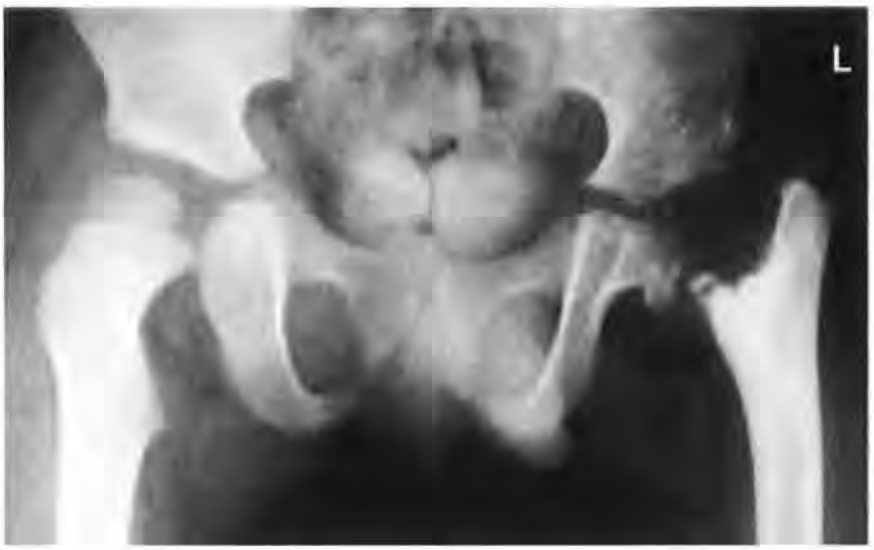

Figure 7. 3 Late stage septic arthritis with complete destruction of the left femoral epiphysis (McCarthy *et al*, 2004).

Eight subadults suffered from Schmorls nodes where asymmetry of leg length was diagnosed and scoliosis was present. The question was: were the Schmorl's nodes the cause of the scoliosis or were they the outcome of disruption to the vertebral column. Each of the Schmorl's nodes was drawn (Appendix 2, fig. 5.21 and 5.22) to give positional information in relation to the convex and concave curves of the scoliosis and the shortened leg of each of the sub-adults. In each instance, the scoliosis formed a convex arc away from the side of the insult, with the exception of one case. The scoliotic alteration to the spine appeared to be attempting to reduce the unequal pressure placed upon the paired spinal muscles and, at the same time, maintain vertical alignment of the vertebral column. The Schmorl's nodes were rough and deep at the point of greatest arc, and placed on the concave edge of the vertebra, moving more centrally and becoming shallower as the arc lessened towards its furthest limit. Constant asymmetric loading of the vertebral column, with added pressure from walking, sitting and twisting, appears to have conspired to compress the intervertebral disc, initiating rupture of the nucleus pulposus, which has then passed beneath the immature vertebral end plates

where separation has occurred. This manifestation of Schmorl's nodes is similar to the Schmorl's nodes viewed when Scheuermann's disease was diagnosed, so they may follow a similar line of least resistance. Instead of the immature vertebral end plate being drawn back from the anterior vertebral body margin as a Schmorl's node forms beneath the end plate in acute traumatic conditions, could the musculature on the extended side of the arc of the scoliosis separate the end plate far enough to allow the ruptured nucleus pulposus to pass underneath the end plate until it was stopped by the compressed area of the concave arc? This possibility does not rule out Schmorl's nodes as exacerbating the scoliotic curve, but it would help to place them as secondary formations in the progression of scoliosis. This small group of clinical patients was not sufficient to use as a model of spinal scoliosis and Schmorl's node position in relation to the side of limb shortening, but it was sufficient to raise questions of a possible model of vertebral column movement and Schmorl's node positioning in asymmetry of leg length.

7.9 Summary of the results

The following summarises the results:

- No weak area was found in vertebrae either in the clinical or the archaeological samples studied.

- Definite proof of symptomatic Schmorl's nodes was found in the clinical samples, from the case histories provided on the x-ray request card; this localised acute pain was not accompanied by referred pain in the lower limbs.

- Subadult individuals were not most affected by Schmorl's nodes.

- Schmorl's nodes did alter the dynamics of the vertebral column when they were not centrally positioned within the vertebral body.

- Work patterns do alter the levels and types of Schmorl's nodes for different populations past and present, and those work patterns produce Schmorl's nodes at different levels within vertebral columns for males and females within the same sample.

- The distribution of Schmorl's nodes did not remain constant through time for males and females of similar age at death in either the clinical or the archaeological samples. Schmorl's nodes of differing appearances can be at varying stages of development from acute to healed, or they can have underlying diseases producing a lesion which, in the early stages mimic Schmorl's nodes.

- Underlying pathologies, deformities and irregularities, of the pelvis and leg length do cause Schmorl's nodes by disrupting the vertebral columns natural primary and secondary curves.

This research has altered the understandings of several of the original results of Schmorl's research. It has also shown the need for further research into other areas of dynamic alteration to the vertebral column.

Chapter 8: Conclusions

8.1 The hypotheses and main findings

1) The point of regression of the notochord is the weakest point within the end plate of the vertebra, making it the most likely point of herniation of the nucleus pulposus, and the formation of Schmorl's nodes.

No weakened area exists in the end plate; the anterior longitudinal ligament in acute trauma can compromise the end plate at its anterior border with the vertebral body in immaturity. This traumatic episode can cause avulsion of the anterior edge of the superior and/or inferior end plate, which allows the ruptured nucleus pulposus to infiltrate beneath the end plate causing it to rise and retract (irregular end plate).

2) Schmorl's nodes: symptomatic or asymptomatic?

Clear evidence for localised pain at the levels of the vertebrae and intervertebral discs affected by Schmorl's nodes was found in the clinical samples and no referred leg pain was found. This hypothesis could not be proved in the archaeological samples as pain in past populations is at best speculative where no written evidence exists, but many instances of multiple contiguous Schmorl's node herniations were observed which matched the clinical acute trauma model.

3) Almost all Schmorl's nodes occur within the first two decades of life.

No evidence was found to support this hypothesis; the data produced compelling evidence to place the 3rd and 4th decades in both clinical and archaeological samples as

the decades in which individuals were most affected by Schmorl's nodes.

4) Schmorl's nodes, when not centrally formed within the vertebral bodies, cause instability to the dynamics of the vertebral column.

This hypothesis could not be proved or disproved; that Schmorl's nodes affected the end plates eccentrically (laterally) to the concave curve in scoliosis was proved. However, whether the Schmorl's nodes caused the scoliosis or, the constant alteration to the primary and/or secondary curve caused the Schmorl's nodes, could not be proved with any degree of certainty. In kyphosis the infiltration of ruptured nucleus pulposus beneath the end plate causing it to rise and retract (irregular end plate), would appear to be instrumental in the softening and wedging of the unprotected subchondral bone causing Scheuermann's disease or juvenile kyphosis.

5) Different work patterns cause Schmorl's nodes at varying levels in the thoracic and lumbar spine.

The different archaeological populations provided data suggesting that different work practices in different communities, e.g. military, monastic and farming settlements caused different presentations of Schmorl's nodes. This study requires further better documented skeletal samples. Clinically it was almost as difficult to produce finite evidence, as the Pinderfields and RHSC samples consisted of very mobile populations made even scatter graphs imprecise as evidence.

6) The distribution of Schmorl's nodes remains constant through time for males and females of similar age at death, in different archaeologically derived populations, and

clinical groups of corresponding ages.

Differences in the vertebral levels affected by Schmorl's nodes between males and females in the same sample were observed and, no two samples produced the same profile for males or females. This hypothesis was disproved.

7) The different appearances of Schmorl's nodes have different origins and underlying causes.

Sclerosis and rough Schmorl's nodes are the acute stages of the herniation of the pulposus of the nucleus and the formation of Schmorl's nodes. Smooth rounded subchondral Schmorl's nodes with a cortical cover are the product of a subadult traumatic episode causing avulsion of the anterior edge of the superior and/or inferior end plate, which allowed the ruptured nucleus pulposus to infiltrate beneath the end plate causing it to rise and retract (irregular end plate). A horseshoe shaped lesion affecting the end plate has by radiographic means, been proved to be a secondary Schmorl's node caused by infiltration of the pulposus of the nucleus caused by a lesser trauma. Schmorl's nodes or early stages of metastasis secondary to breast cancer present as rough Schmorl's nodes, often going undiagnosed until vertebral collapse occurs.

8) The underlying pathologies, deformities, and irregularities of the pelvis and alterations of the leg length cause disruption to the dynamics of the vertebral column and Schmorl's nodes.

This hypothesis was proved using only clinical evidence. The continuous unequal

pressure placed upon the vertebral column was proved to cause scoliosis and Schmorl's nodes. The scoliosis always curved away from the side of the effected limb or inominate bone in the sample studied and, the Schmorl's nodes were always placed laterally to the concave arc of the scoliosis, occasionally with reduced vertebral height to the side containing the Schmorl's node.

8.1.1 Comparison of pooled clinical data and pooled archaeological data

Comparing the pooled data of the clinical samples which represent a modern mobile community with the pooled data of the archaeological samples, each of which represent very different life styles and work patterns, might have altered the results of several of the hypotheses researched in this thesis. Pooling the archaeological samples produced a larger positive group of viable thoracic and lumbar vertebral columns, but this sample still fell far short of the combined clinical sample.

The pooled clinical sample consisted of 3,277 individuals of whom 132 (4%) were affected by Schmorl's nodes, whereas the pooled archaeological samples consisted of 277 viable vertebra columns of which 78 (28%) proved positive form Schmorl's nodes. This method of comparing clinical and archaeological prevalence of Schmorl's nodes provided a greatly increased disparity between clinical and archaeological materials with the pooled archaeological sample showing a 24% greater incident rate.

8.1.1.1 Vertebral end plates affected by Schmorl's nodes

- Using the pooled data for clinical and archaeological samples produced much closer data sets when comparing superior, inferior and contiguous vertebral end plates affected by Schmorl's nodes :

a) clinical superior end plates affected by Schmorl's nodes 13% (55)

archaeological superior end plates affected by Schmorl's nodes 21% (66)

b) clinical inferior end plates affected by Schmorl's nodes 25% (108)

archaeological inferior end plates affected by Schmorl's nodes 35% (111)

c) clinical contiguous end plates affected by Schmorl's nodes 62% (268)

archaeological contiguous end plates affected by Schmorl's nodes 44% (144)

These results give added weight to the significance of contiguous end plates affected by Schmorl's nodes where impact injury may have occurred.

8.1.1.2 Almost all Schmorl's nodes occur within the first two decades of life

Using the pooled data did not alter the outcome of this hypothesis. Clinically the first two decades of life produced 19% (26) individuals affected by Schmorl's nodes, compared to 32% (42) individuals in the >45 age range. The 36 to 45 years age range of the archaeological sample was found to be the most affected by Schmorl's nodes at 36% (32) and the first two decades the least affected with only 4% (4) of individuals found positive for Schmorl's nodes.

8.1.1.3 The distribution of Schmorl's nodes remains constant through time for males and females of similar age at death, in different archaeologically derived populations and clinical groups of corresponding ages

This hypothesis was disproved when comparing the pooled clinical and archaeological samples, with the males of the clinical sample affected by Schmorl's nodes showing a 57% (28) irate of insult at the level of the 1st lumbar vertebra and, the males of the

archaeological sample affected by Schmorl's nodes showing a 47% (22) rate of insult at the level of the 12th thoracic vertebra. The levels of the vertebrae most affected by Schmorl's nodes were repeated in the females of both the clinical and archaeological samples, with the clinical sample producing a 51% (31) rate of insult at the 1st lumbar vertebra and, the archaeological sample producing a 34% (10) rate of insult at the level of the 12th thoracic vertebra.

Although the males and females of each pooled sample were now proved to have a common level of highest incidence of vertebrae affected Schmorl's nodes, it could not be proved that there was an equal chance of both males and females being affected by Schmorl's nodes using the null hypothesis (Schmorl's nodes in males and Schmorl's nodes in females are equally likely), the result of $\chi 2 = 0.194$ not being statistically significant at the 95% level of confidence. It was not possible to consider the same null hypothesis using the pooled clinical sample as the composition of male to female in the sample was not recorded.

"Discovery consists of seeing what everybody has seen and thinking what nobody has thought"

(Albert von Szent-Györgyi, 2005: 697)

8.2 Limitations to the research

Albert von Szent-Györgyi sums up the feelings of the author when searching for a better understanding of the aetiology of Schmorl's nodes. Certain macroscopic changes in the vertebral end plates were being observed and recorded, but only when clinical reports

were carefully studied and the changes reviewed, did they begin to make sense. Returning to Schmorl's (1971) own research results showed where misinterpretations of the text had taken place and consequently been used as a basis for modern research. However, in several instances modern radiographic images and radiologists reports, have brought a clearer understanding of the origins and aetiology of Schmorl's nodes which without the range of archaeological samples, and several clinical samples, might have remained elusive. Advances in understanding what is seen when looking at human vertebral columns have been made, but this was not without its constraints brought about by the samples chosen and, because of clinical restrictions brought in by the Data Protection Act, and by the places of curation of the archaeological samples. Careful consideration was given to the materials and methods chosen for use in this research so the problems that were encountered in both the clinical and archaeological areas were surmountable, but this often caused delays in the study and collection of data.

Using radiography to study clinical Schmorl's nodes did not allow the vertebrae to be viewed three dimensionally, except where MRI or CT had been used as a further method of ascertaining the reason for the patient's pain. Restricted permissions did not give access to patients' notes to retrieve any further useful information, so the x-ray card (Appendix 2, Fig. 4.5) and the radiologists' reports were the only source of patient background information. Although some personal information such as sex and age could be used, no identifying markers could be retained for further research to be carried out; this was to comply with the present Data Protection Act. In gathering such large amounts of information, it was necessary to use computerised information systems, which put constraints upon the possibility of using a 10 or even 5 year age gap for samples as the systems had only been put in place eighteen months prior to data collection. This was still an invaluable method of data collection as the models used for

reporting within the hospital systems were consistent in their delivery, and an onsite archive of recent patient radiographic images reduced the search time that might have been required.

Adaptation of the methods used to gather clinical information was minimal, allowing the clinical and archaeological observations to be compared and contrasted with the diagrammatic drawings replacing the radiographic images. The samples were chosen to try to look at groups of people covering the whole of the Medieval Period, who were exposed to differing living conditions and patterns of work in urban, rural and coastal settlements, to see if the patterns, levels and types of Schmorl's nodes, and associated disorders and diseases, varied widely or not at all. The final choices of the five samples studied in this work should have provided well-preserved materials producing a wealth of data to use in this study, but things were not as straightforward as expected. Materials were held in very varied conditions, some easily accessible and others curated in unsupervised, distant places of storage. The condition of several of the skeleton collections did not match the initial skeletal report available. Sex estimation of the individual skeletons was sometimes made difficult by other researchers having been granted permission to remove single elements of a sample e.g. skulls and mandibles. Radiography was chosen as a method of imaging possible, probable and definite Schmorl's nodes from each sample; this was not always possible due to curators' fears for the security of the skeletal remains if removed from the place of curation. Those vertebrae that were radiographed provided vital information into the origins of Schmorl's nodes, and those bony lesions which were perceived as Schmorl's nodes, and those which were Schmorl's nodes. The need for a complete complement of thoracic and lumbar vertebrae greatly reduced the numbers of skeletons available from each of the chosen samples, with the exception of the St. Andrew, Fishergate sample.

Photography in often badly lit workspaces with little suitable space was not conducive to the quality of images required for publication. Two of the sites from which the archaeological samples were chosen did not have published reports, and neither site had any other source of published information on the history, topography, demography or archaeology of the site. This reduced the knowledge available to interpretation of the data in context.

8.3 The advantages of a clinical and archaeological study

Not only the differences, but also the similarities of the injuries, disorders and diseases, and ageing processes could be studied to give continuity through time from 6th to 20th century. Archaeological research can solve clinical puzzles and place a disease or disorder in a time line of global disease distribution, relating it to the interaction of peoples in relation to expansion by exploration, and subsequent historical events. Occasionally the source of a cure, or control for a disease can be found by tracing that disease to its place of origin to find how an indigenous population has contained or eradicated a disease over the centuries, using their own acquired antibodies, or by the use of herbal remedies. Clinical research using modern methods provided a non-destructive view of the minutiae hidden beneath the shell or cortex of human bone. Using clinical samples where consultant expertise has laid down a paper trail of information leading to the diagnosis of a disease can, by the very wording, lead researchers to new knowledge and known but not recognised knowledge in the aetiology of diseases and disorders. Crossing the boundaries laid down by separate modalities helps to bring about many resolutions to the questions posed by the body's ability to self-destruct and self-heal by adaptation and remodelling where death does not intervene. However, for this research, the benefits of being able to compare macroscopic visualisation of Schmorl's nodes and, all of the other observed spinal

conditions with the radiographic images, and reports, cannot be emphasised enough. Sharing in research by discussion with experts in both clinical and archaeological settings has allowed the author to understand how others interpret the radiographs and vertebral alterations when making a diagnosis. This knowledge was used when deciding which vertebrae should be radiographed to allow confident inclusion or, exclusion of end plate conditions that might be interpreted as Schmorl's nodes in the vertebral columns studied. Using radiographic imaging of vertebrae from the archaeological samples and comparing those to clinical radiographs helped to determine, which vertebral end plate alterations were secondary Schmorl's node herniations and, which were early stages of vertebral collapse when viewed macroscopically. Interdisciplinary research in the study of Schmorl's nodes and associated conditions has helped to refine diagnosis of Schmorl's nodes in their various stages of formation and healing when viewed in skeletal vertebrae.

8.4 Possible directions for future vertebral column research

While studying the archaeological samples many other questions were raised and set aside to be pursued at a later date. Firstly, a repeating feature was observed of the angulation of the spinal processes in the upper thoracic spine to either right or left within the horizontal axis. Could this be a signature of handedness or side preference in work and/or sport? Next, the alteration of the lateral pedicles to point backwards and upwards, perhaps indicates a different use of the thoracic myology, dependent upon the possible work patterns of individuals within settlement groups. The most interesting anatomical variant was the spinal cord space (vertebral canal) formed from the posterior vertebral body wall, the lateral pedicles and lamellae, where the space did not conform to the expected anatomical shape, either being reduced (stenosis) or increased in its diameter. Occasionally the apophyseal joints were so overgrown by osteophytic

remodelling that the intervertebral notch was reduced and may have caused nerve root compression. Finally, differentiation between Schmorl's nodes and other types of vertebral end plate fracturing need to be more clearly defined, so that researchers can produce comparable data when researching the human vertebral column, its disorders and diseases.

Schmorl's nodes, now more clearly defined, require further studies to be carried out using skeletal samples with large populations known to contain males, females and subadults, all with well preserved vertebral columns to test the findings of this research. If these populations have documentary evidence of occupations and family status, it may help in interpreting any class or social divide, which might predispose a section of that population to Schmorl's nodes; alternatively, groups of people employed in a known occupation might prove more susceptible to Schmorl's nodes than those of another occupational group. Comparing textual evidence from archaeological populations with clinical evidence for individuals affected by Schmorl's nodes may help to either, retain Schmorl's nodes as a degenerative joint disease of the spine or, to place it firmly in its own diagnostic category of the spine.

On a cautionary note, do not use skeletal reports alone as an indicator of the completeness of the skeletal remains without ascertaining that time, storage, and handling have not significantly altered the quality of conservation. This research has been limited by the condition of several of the samples, which had deteriorated in curation; not by handling, but as an after effect of the acidity of the shale content of the red sandstone infill of the graves. Depending on the methods chosen to carry out the research, permissions for the removal of skeletal remains may be refused or, limited depending upon the method of transportation and storage during study, as happened

during this study. Once the research samples have been chosen, early access requests including a clear description of the chosen methods to be used should be sent to curators, as often non-destructive methods may not be clearly understood and require further definition before permission is obtained. This problem was met during this research as not all radiographic techniques are non-destructive. Distance between the place of curation and the workplace of the curators can take time and effort to resolve, as supervision will always be a requirement of access to human remains. Often several months elapsed between requested access and access being granted, and as the author discovered this research could not take precedence over the curator's own work schedule.

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APPENDICES

Appendix 1: Permissions given to allow clinical research and data collection

The Mid Yorkshire Hospitals NHS
NHS Trust

Dept of Clinical Psychology & Neuropsychology
Ward One
Pinderfields General Hospital
Aberford Road
Wakefield
WF1 4DG

Tel: 01924 212736 / 212573 / 212571
Fax: 01924 213915

12 July 2005
IGB PMW

TO WHOM IT MAY CONCERN

Re: Janet McNaught- Senior Radiographer, Pinderfields General Hospital, Wakefield

Research Title : Clinical and Archaeological Study of Schmorl's Nodes

This letter is to confirm that in 1996 Mrs McNaught came to see me in my capacity as a member of the District Research Ethics Committee. She explained the outline of her project which included a blind and anonymised study of x-ray records and other clinical details on patients.

In my opinion, as there was no alteration of patients' treatment and no way the patients could be identified, the research came under the heading of 'Audit' rather than 'Clinical Research'. As such, it did not need to be taken in front of the Research Ethics Committee.

Mrs McNaught has recently come back to see me to confirm my view in writing and I am happy to do so.

Yours sincerely

Dr I G Burnside
Consultant Clinical Psychologist

Written permission confirming earlier verbal permission to carry out research in the diagnostic x-ray department of Pinderfields Hospital

Janet McNaught

From: "Siddall Jonathan" <jonathan.siddall@midyorks.nhs.uk>
To: <janet@mcnaught.freeserve.co.uk>; "McNaught Janet" <Janet.McNaught@midyorks.nhs.uk>
Sent: 01 July 2005 12:55
Attach: ATT00015.htm
Subject: Permission to research for thesis

Dear Janet,

I confirm that I have given you permission to research your thesis using statistics from the Radiology Information System and the use of copy X-Rays, providing that all data and images presented are anonymised.

Best regards

Jonathan Siddall

Radiology Services Manager (during the period when the research was undertaken)

Pinderfields General Hospital

Wakefield

02/07/2005

Retrospective permission given by Jonathan Siddall to allow the clinical research to be carried out at Pinderfields Hospital

The Mid Yorkshire Hospitals NHS
NHS Trust

Trust Headquarters
Rowan House
Aberford Road
Wakefield
West Yorkshire
WF1 4EE

Ext. 3821
Direct Line: 01924 213821
Fax: 01924 814929
E-mail: jane.shewan@midyorks.nhs.uk

Our Ref: JS/sa

18 July 2005

Janet McNaught
36 Northfield Drive
Pontefract
WF8 2DJ

Dear Janet

A Clinical & Archaeological study of Schmorl's Nodes
R&D Ref: 04/416

Thank you for meeting with me on 12 July to discuss your PhD study.

Our meeting confirmed that you began this work a number of years ago, and that advice you obtained at that time led you to believe that you did not need to apply for Research Governance approval from this Trust.

I noted that you would have had access to patient data in the normal course of your work, that there has been no effect on patient management, that you have anonymised and kept confidential your data, that you acted in good faith, and there has been neither risk nor benefit to patients from your study.

I am therefore pleased to confirm that you have Research Governance approval from this Trust to complete your study, and that this approval also applies retrospectively to this study from its commencement.

Kind regards.

Yours sincerely

Jane Shewan
HEAD OF RESEARCH & EFFECTIVENESS

DIRECTORATE OF NURSING AND PRACTICE DEVELOPMENT
Ms T L McErlain-Burns
Chief Nurse/Director of Patient Experience

Written permission from the new NHS Research Practice Manager of the Mid Yorkshire NHS Trust

Queen Margaret University College

Ms Janet McNaught
36, Northfield Drive
Pontefract
West Yorkshire
WF8 2DJ

Alison Scott
Lecturer
Department of Radiography
Queen Margaret University College
Leith Campus
Duke St, Edinburgh
EH6 8HF
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Email: ascott@qmuc.ac.uk

8th June 2005

Dear Ms McNaught,

Further to our telephone conversation today, I am happy to confirm that, in September 2000, you were facilitated in your research by the Radiology Department of the Royal Hospital for Sick Children in Edinburgh.

This enabled your access to patient clinical and demographic information after agreement that the data would be presented in statistical form only with no associated patient identifiers being published. The only condition for access at that time was verbal approval from the Lead Radiologist and myself.

I hope this confirmation helps the progress of your thesis and I wish you luck with your work.

Yours sincerely,

Alison Scott
Lecturer

Retrospective permission given confirming verbal permission given prior toresearch being carried out in the Diagnostic X-Ray Department of the RHSC

Appendix 2: Data sheets for clinical and archaeological recording

The Mid Yorkshire Hospitals NHS Trust

Radiology Examination Request

Surname: McNaught
Forename: Janet
Address & Post Code: 36 Northfield Drive, Pontefract
Phone:

PAS No/Unit No:
DOB: 29/11/47
affix patient label in this box

Source - Ward/Dept: GP
Date: 21/12/2000

NHS ☐
Private ☐
Cat II ☐

Dept. required
Pontefract ☐
Pinderfields ☐
Clayton ☐
WGH ☐
IDH ☐

Walk ☐ Chair ☐ O_2 ☐
Trolley ☐ Bed ☐ Drip ☐
Mobile ☐ *N.B. Mobile X-Rays pose a greater radiation risk and may be questioned*

Ambulance Required? Yes ☐ No ☐

Urgency
Emergency ☐
Urgent ☐
Routine ☐

Consultant: Deacon
Sex M♂ ☐ F♀ ☐ X

Clinical Information *(include details of relevant surgery and occupational exposure)*
Has the patient ever been a miner? Yes ☐ No ☐

Low back pain in the upper lumbar region with exquisite pain on application of pressure over L2.

Examination Requested *(please state exam type below by writing "x-ray", "ultrasound" or "CT")*

Lumbar spine and thoraco-lumbar junction

Clinician – please answer these general and radiation safety questions
Previous examinations?
Year........ Hospital.........................
Patient has known allergy to contrast medium? Yes ☐ No ☐
Known diabetic? Yes ☐ No ☐
Patient's LMP date ....
Possibility of patient being pregnant? Yes ☐ No ☐

Doctors name *(Block Letters)*
Doctor's signatur *A Fitchett*
Bleep No./Phone (mandatory) 928

Radiology use only → | Date & time received | Appt. details | Colour code | Radiographer name | Radiographer's comments | Hardcode

CF 2826a PCH

The x-ray request card used to gather patient data for all clinical patients Used in this research

SKELETAL RECORD

Skeletal Sample: ______________

Location: ____________________

unique No	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	L1	L2	L3	L4	L5	L6	S1

The data collection sheet used for the recording of all clinical and archaeological skeletal data

DISORDERS AND DISEASES

Skeletal Sample: _______________

Location: ______________________

Skele. No	Age	Sex	PNAD	Osteoarthritis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrololisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's Node	Anterior	Central	Posterior

The data collection sheet used for the recording of all disorders and diseases for the clinical and archaeological samples

OTHER RELEVANT INFORMATION

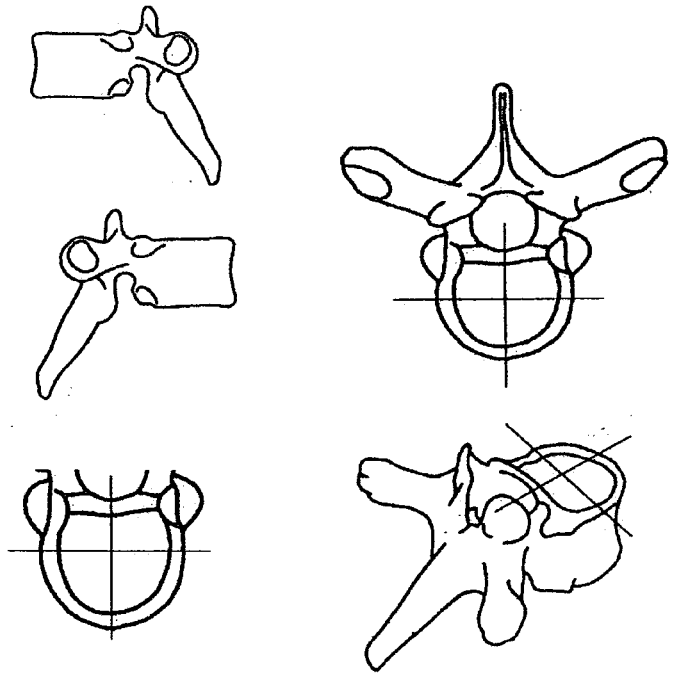
Skeletal Sample: ______________

Location: ____________________

Skele No	data

The data collection sheet for all other information which might be of relevance when analysing the results from each of the clinical and archaeological samples

Collection: SKELETAL No: TV NO:

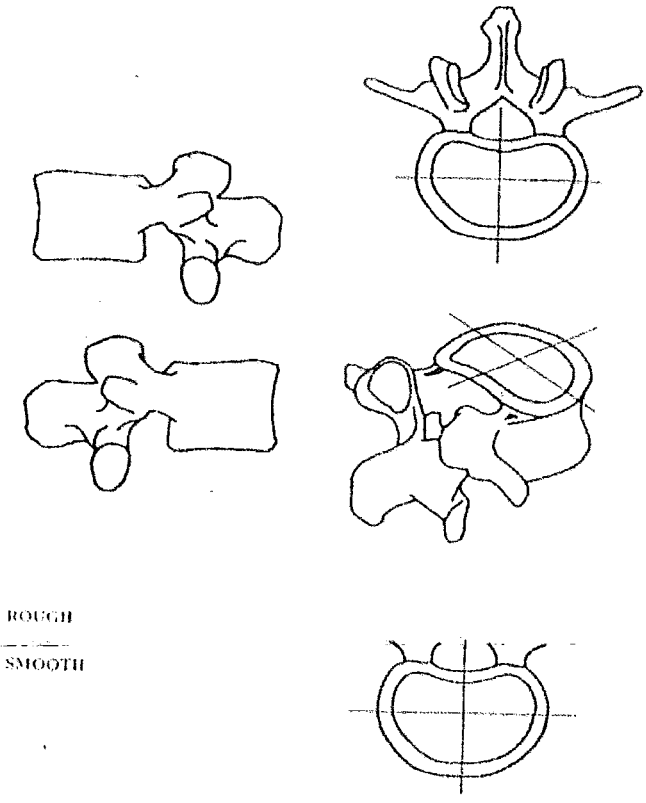


ROUGH

SMOOTH

Figure 5.21 Diagrammatic recording sheet for macroscopic data (thoracic)

Collection: SKELETAL No: LV No:



ROUGH

SMOOTH

Figure 5.22 Diagrammatic recording sheet for macroscopic data (lumbar)

APPENDIX 3: Tables showing percentages and numbers of individuals within clinical and archaeological samples

Sample	%Affected	Number (*n*)	Total (*N*)
Pinderfields Hospital 1994-5	5%	70	1461
Pinderfields Hospital 1995	3%	40	1374
Royal hospital for Sick Children	5%	22	442

Table 6.1 The number of vertebral columns studied in each clinical sample, and the number and percentages found positive for Schmorl's nodes in each clinical sample

Site	% of complete vertebral columns	Vertebral columns preserved (*N*)	Number positive for Schmorl's nodes (*n*)
Captain's Cabin, Dunbar	57%	23	12
The Hirsel, Coldstream	25%	57	11
Whithorn Priory	62%	21	9
St. Andrew, Fishergate	28%	165	41
Tanners Row, Pontefract	64%	11	7

Table 6. 2 The numbers and percentages for Schmorl's nodes using the complete vertebral columns within each archaeological sample as the complete sample

	Superior	Number (*n*)	Inferior	Number (*n*)	Contiguous	Number (*n*)
Pinderfields 1994-5	18%	33	30%	58	52%	100
Pinderfields 1995	9%	14	25%	30	66%	104
RHSC	9%	8	22%	20	69%	64
Captain's Cabin	28%	13	34%	16	38%	18
The Hirsel	22%	7	66%	21	12%	4
Whithorn Priory	15%	13	25%	22	60%	52
Fishergate	18%	24	28%	37	54%	70
Tanners Row	37%	9	63%	15	0%	0

Table 6.3 The frequency of vertebral end plate intrusions associated with Schmorl's nodes for superior, inferior and contiguous end plates

Archaeological sample	**Age at death**					
	pre/neo	0-5	6-10	11-15	16-20	Total
Captain's Cabin	1	1	2	2	1	7
The Hirsel	2	5	9	1	0	17
Whithorn Priory	0	0	2	4	3	9
Fishergate	0	6	8	6	3	23
Tanners Row	0	1	1	0	0	2
Total	3	13	22	13	7	58

Clinical sample	**Age when radiographed**					
	pre/neo (in-utero)	0-5	6-10	11-15	16-20	Total
PGH 1994-5	0	0	0	1	1	2
PGH 1995	0	0	0	1	1	2
RHSC	0	0	6	14	2	22
Totals	0	0	6	16	4	26

Table 6.4 The number of complete vertebral columns in each age group examined for possible notochord weakness (weakened area within the vertebral end plates)

Site	Subadult individuals	complete vertebral columns	Incomplete vertebral columns	Percentage of complete vertebral columns
Captain's Cabin	18	7	11	23%
The Hirsel	31	17	14	55%
Whithorn Priory	20	9	11	45%
Fishergate	28	23	5	82%
Tanners Row	16	2	14	13%

Table 6.5 The viability of the sub-adult archaeological materials studied for possible vertebral end plate weakness caused by incomplete notochord regression

Site	Individuals with centrally placed Schmorl's nodes	Percentages total observed
Captain's Cabin	1	14%
The Hirsel	0	0%
Whithorn Priory	1	11%
Fishergate	3	13%
Tanners Row	0	0%

Table 6.6 Numbers and percentages of subadults found to have centrally placed Schmorl's nodes which may be indicative of vertebral end plate weakness caused by incomplete notochord regression

Age								
Sex	0-5	6-10	11-15	16-20	21-25	26-35	36-45	>45
Males	0	2	4	0	5	10	8	12
Females	0	0	6	1	2	4	13	14
Totals	0	2	10	1	7	14	21	26
Percentages	0%	2%	12%	1%	9%	17%	27%	32%

Table 6.7 Numbers and percentages of individuals with Schmorl's nodes by age for the 1994-5 Pinderfields Hospital sample and the Royal Hospital for Sick Children 1 sample

Age								
Sex	0-5	6-10	11-15	16-20	21-25	26-35	36-45	>45
Males	0	3	3	0	2	3	3	6
Females	0	2	1	4	0	3	11	10
Totals	0	5	4	4	2	6	14	16
	0%	10%	8%	8%	4%	12%	27%	31%

Table 6.8 Numbers and percentages of individuals with Schmorl's nodes by age for the Pinderfields Hospital 1995 sample and the Royal Hospital for Sick Children 2 samples

	Ages at death											
Site	0-10		11-20		21-25		26-35		36-45		>45	
Captain's Cabin	0	0%	1	8%	0	0%	4	31%	6	46%	2	15%
The Hirsel	0	0%	0	0%	1	8%	3	25%	3	25%	5	42%
Whithorn Priory	0	0%	3	30%	1	10%	1	10%	2	20%	3	30%
Fishergate	0	0%	0	0%	1	2%	17	36%	21	43%	10	20%
Tanners Row	0	0%	0	0%	1	14%	4	57%	0	0%	2	29%

Table 6.9 Numbers and percentages for individuals with Schmorl's nodes at death for all the archaeological samples

Clinical samples	% with osteoarthritis	No. with osteoarthritis	% with osteophyte	No. with osteophytes	% with osteochondritis	No. with osteochondritis	No. of vertebral columns
Pinderfields Hospital 1994-5	36%	25	27%	19	3%	2	70
Pinderfields Hospital 1995	53%	21	18%	7	10%	4	40
Royal Hospital for Sick Children	5%	1	0%	0	0%	0	22

Table 6.10 Number and percentages of the three most prevalent disorders found in each of the clinical samples where Schmorl's nodes were observed

	% with osteoarthritis	No. with osteoarthritis	% with osteophytes	No. with osteophytes	% with osteochondritis	No. with osteochondritis	% Whole vertebral columns without Schmorl's nodes	sample studied without Schmorl's nodes	Sample numbers
Captain's Cabin	23%	5	18%	4	18%	4	45%	10	22
The Hirsel	32%	21	24%	16	5%	3	83%	55	66
Whithorn Priory	33%	5	20%	3	0%	0	62%	15	24
Fishergate	35%	38	39%	42	19%	20	72%	108	149
Tanners Row	50%	2	25%	1	25%	1	36%	4	11

Table 6.11 Numbers and percentages of the three most prevalent disorders found in each of the archaeological samples where no Schmorl's nodes were observed

Royal Hospital for Sick Children				
Patient No.	Schmorl's nodes	Disorders and diseases	Side of insult	Scoliotic shift
123AB	yes	loss of lordosis	right hip relocation	left
170EF	yes	sclerotic and irregular end plates	right leg shorter	left
303ZA	yes	loss of lordosis and irregular end plates	right leg shorter	left
123DE	yes	none	right femoral neck shorter	left
101MN	yes	none	left leg shorter	right
353ST	yes	none	left hip subluxation	right
122BA	yes	osteoporosis	right femoral head, new bony destruction	none

Table 6.12 Scoliotic shift in relationship to the affected lower limb in subadults with Schmorl's nodes and other associated disorders and diseases (RHSC)

	Males, Pinderfields Hospital 1994-5	Females, Pinderfields Hospital 1994-5	Males, Pinderfields Hospital 1995	Females, Pinderfields Hospital 1995	Males, Royal Hospital for Sick Children	Females, Royal Hospital for Sick Children	Males, Captain's Cabin	Females, Captain's Cabin	Subadults, Captain's Cabin	Males, the Hirsel	Females, the Hirsel	Subadults, the Hirsel
% Posterior neural arch defect	6%	9%	0%	4%	9%	0%	0%	0%	0%	43%	0%	
Posterior neural arch defect	2	3	0	1	1	0	0	0	0	3	0	
% Osteoarthritis	46%	29%	29%	65%	9%	0%	100%	83%	0%	86%	25%	
Osteoarthritis	16	10	4	17	1	0	5	5	0	6	1	
% Osteopenia Osteoporosis	17%	23%	29%	12%	9%	9%	40%	50%	0%	43%	25%	
Osteopenia Osteoporosis	6	8	4	3	1	1	2	3	0	3	1	
% Osteophyte formation	29%	26%	7%	23%	0%	0%	100%	83%	100%	71%	25%	
Osteophyte formation	10	9	1	6	0	0	5	5	1	5	1	
% Mild osteochondritis	3%	3%	7%	15%	0%	0%	40%	50%	100%	14%	0%	
Mild osteochondritis	1	1	1	4	0	0	2	3	1	1	0	
% Juvenile osteochondritis	3%	6%	7%	12%	0%	0%						
Juvenile osteochondritis	1	2	1	3	0	0						
% Loss of lordosis	11%	6%	0%	12%	18%	18%	40%	33%	0%	0%	25%	
Loss of lordosis	4	2	0	3	2	2	2	2	0	0	1	
%Scoliosis	20%	17%	36%	27%	55%	9%	20%	0%	0%	29%	0%	
Scoliosis	7	6	5	7	6	1	1	0	0	2	0	
% Sclerotic end plates	0%	3%	0%	8%	18%	27%	0%	0%	0%	0%	0%	
Sclerotic end plates	0	1	0	2	2	3	0	0	0	0	0	
% Irregular end plates	11%	11%	0%	12%	55%	91%	20%	0%	0%	0%	0%	
Irregular end plates	4	4	0	3	6	10	1	0	0	0	0	
% Loss of disc height	43%	40%	43%	69%	0%	0%						
Loss of disc height	15	14	6	18	0	0						
% Retrololisthesis	0%	3%	7%	0%	9%	0%	20%	17%	0%	0%	0%	
Retrololisthesis	0	1	1	0	1	0	1	1	0	0	0	
% Spondylolisthesis	0%	3%	0%	0%	18%	0%	0%	17%	0%	14%	0%	
Spondylolisthesis	0	1	0	0	2	0	0	1	0	1	0	
% Spondylolysis	6%	0%	14%	0%	18%	0%	0%	0%	0%	14%	25%	
Spondylolysis	2	0	2	0	2	0	0	0	0	1	1	
Number of individuals	35	35	14	26	11	11	5	6	1	7	4	0

Table 6.13a Male, female and sub-adult numbers and percentages of disorders and diseases for individuals found positive for Schmorl's nodes in the 1994-5 Pinderfields Hospital sample, the 1995 Pinderfields Hospital Sample, the Royal Hospital for Sick Children sample, the Captain's Cabin, Dunbar sample and the Hirsel, Coldstream sample. Blank = no evidence of disorder in that population group or, no subadults present affected by Schmorl's nodes

	Males, Whithorn Priory	Females, Whithorn Priory	Subadults, Whithorn Priory	Males, Fishergate	Females, Fishergate	Subadults, Fishergate	Males, Tanners Row	Females, Tanners Row	Subadults, Tanners Row
% Posterior neural arch defect	50%	50%	0%	3%	0%		0%	0%	
Posterior neural arch defect	1	2	0	1	0		0	0	
% Osteoarthritis	100%	50%	0%	41%	33%		100%	50%	
Osteoarthritis	2	2	0	13	3		1	3	
% Osteopenia Osteoporosis	50%	0%	0%	13%	44%		0%	33%	
Osteopenia Osteoporosis	1	0	0	4	4		0	2	
% Osteophyte formation	100%	75%	0%	63%	67%		100%	33%	
Osteophyte formation	2	3	0	20	6		1	2	
% Mild osteochondritis	0%	25%	0%	25%	22%		100%	50%	
Mild osteochondritis	0	1	0	8	2		1	3	
% Juvenile osteochondritis									
Juvenile osteochondritis									
% Loss of lordosis	0%	50%	0%	25%	11%		100%	17%	
Loss of lordosis	0	2	0	8	1		1	1	
%Scoliosis	0%	25%	0%	16%	33%		0%	0%	
Scoliosis	0	1	0	5	3		0	0	
% Sclerotic end plates	0%	0%	0%	0%	0%		0%	0%	
Sclerotic end plates	0	0	0	0	0		0	0	
% Irregular end plates	0%	50%	0%	6%	11%		0%	33%	
Irregular end plates	0	2	0	2	1		0	2	
% Loss of disc height									
Loss of disc height									
% Retrololisthesis	0%	25%	0%	0%	0%		0%	0%	
Retrololisthesis	0	1	0	0	0		0	0	
% Spondylolisthesis	0%	0%	0%	0%	11%		0%	0%	
Spondylolisthesis	0	0	0	0	1		0	0	
% Spondylolysis	0%	25%	0%	3%	11%		0%	0%	
Spondylolysis	0	1	0	1	1		0	0	
Number of individuals	2	4	3	32	9	0	1	6	0

Table 6.13b Male, female and sub-adult numbers and percentages of disorders and diseases for individuals found positive for Schmorl's nodes in the Whithorn Priory sample, the St. Andrew, Fishergate sample and the Tanners Row sample. Blank = no evidence of disorder in that population group or, no subadults present affected by Schmorl's nodes

APPENDIX 4: Figures showing the male, female, subadult and unsexed distributions of Schmorl's nodes

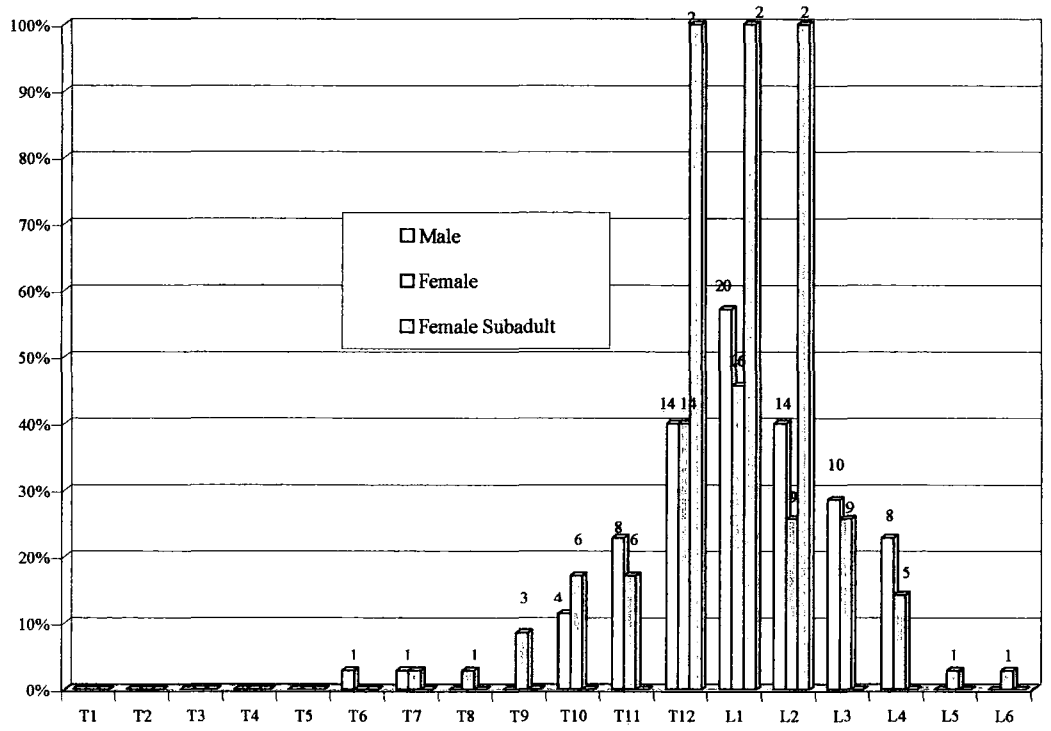


Figure 6.10 Numbers, percentages and levels of Schmorl's nodes for males, females and subadults in the 1994-5 Pinderfields Hospital sample

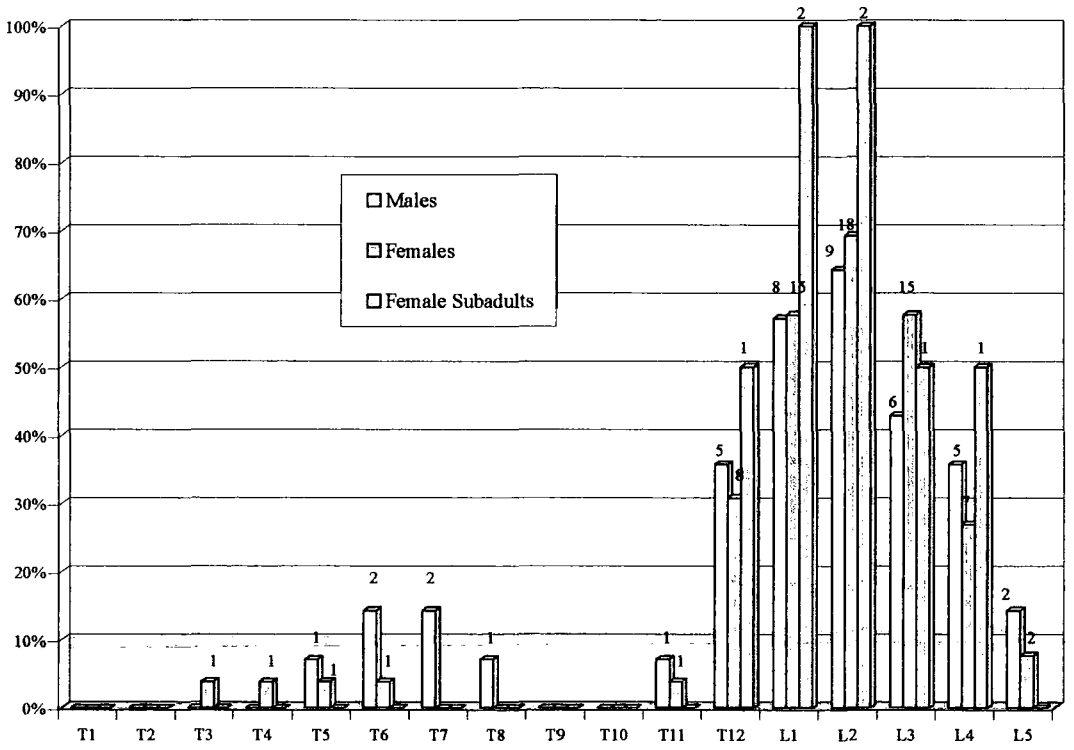


Figure 6.11 Numbers, percentages and levels of Schmorl's nodes for males, females and subadults in the 1995 Pinderfields Hospital sample

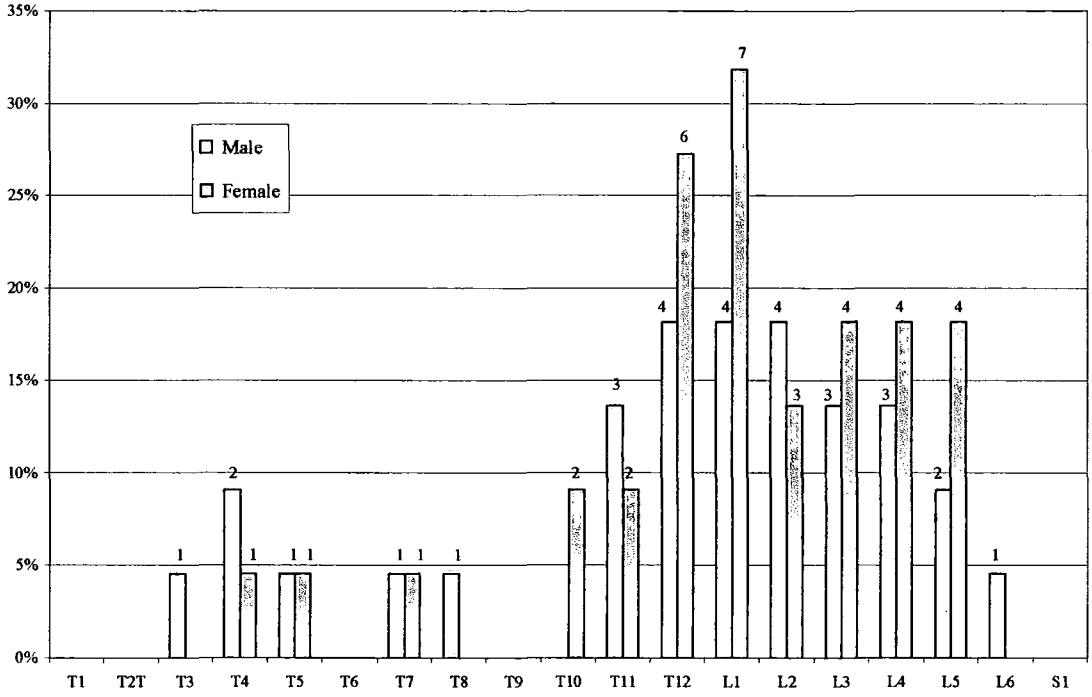


Figure 6.12 Numbers, percentages and levels for subadult males and females affected by Schmorl's nodes in the Royal Hospital for Sick Children sample

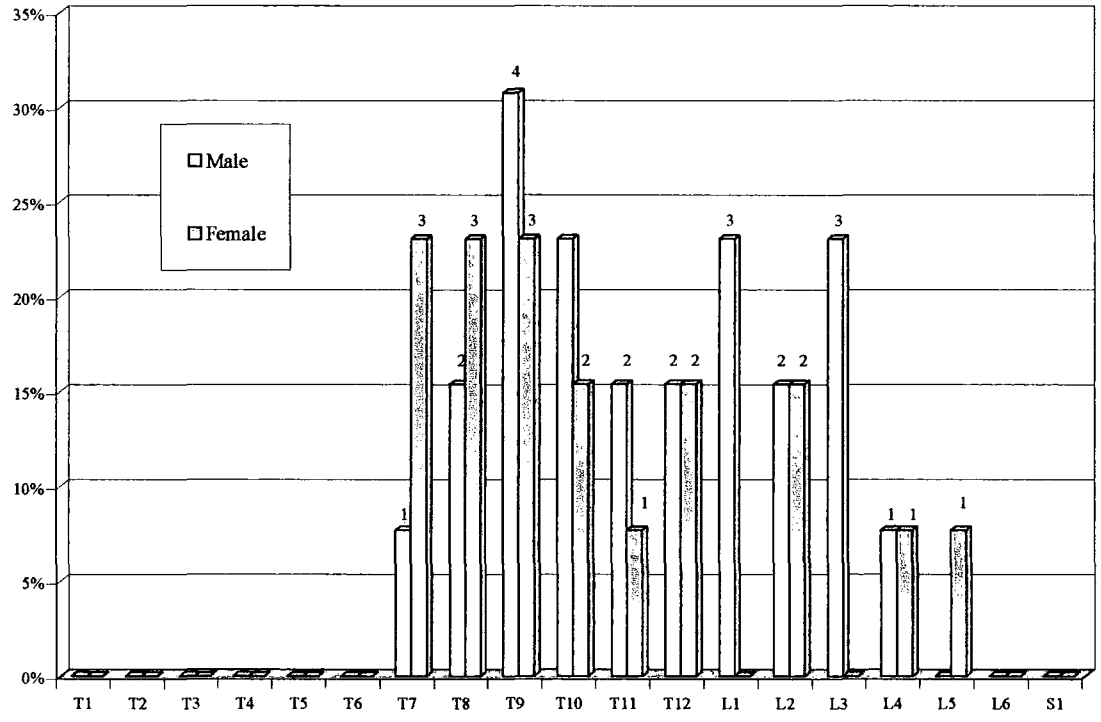


Figure 6.13 Numbers, percentages and levels of Schmorl's nodes for males and females in the Captain's Cabin, Dunbar sample

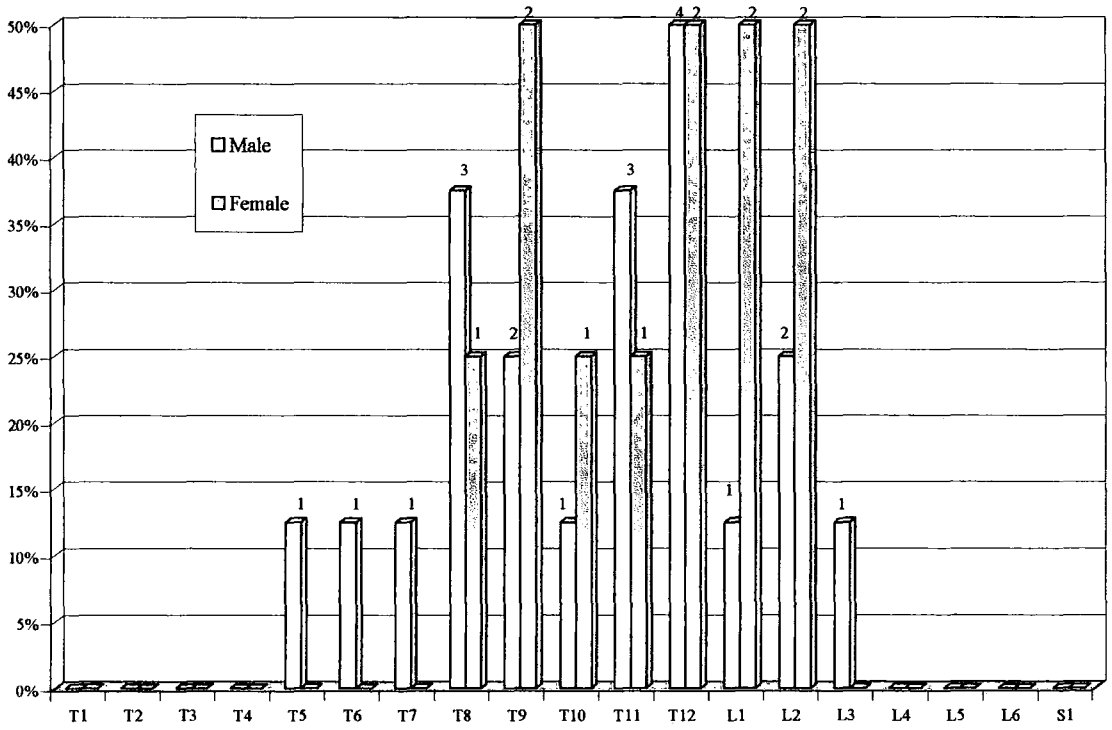


Figure 6.14 Numbers, percentages and levels of Schmorl's nodes for males and females in the Hirsel, Coldstream sample

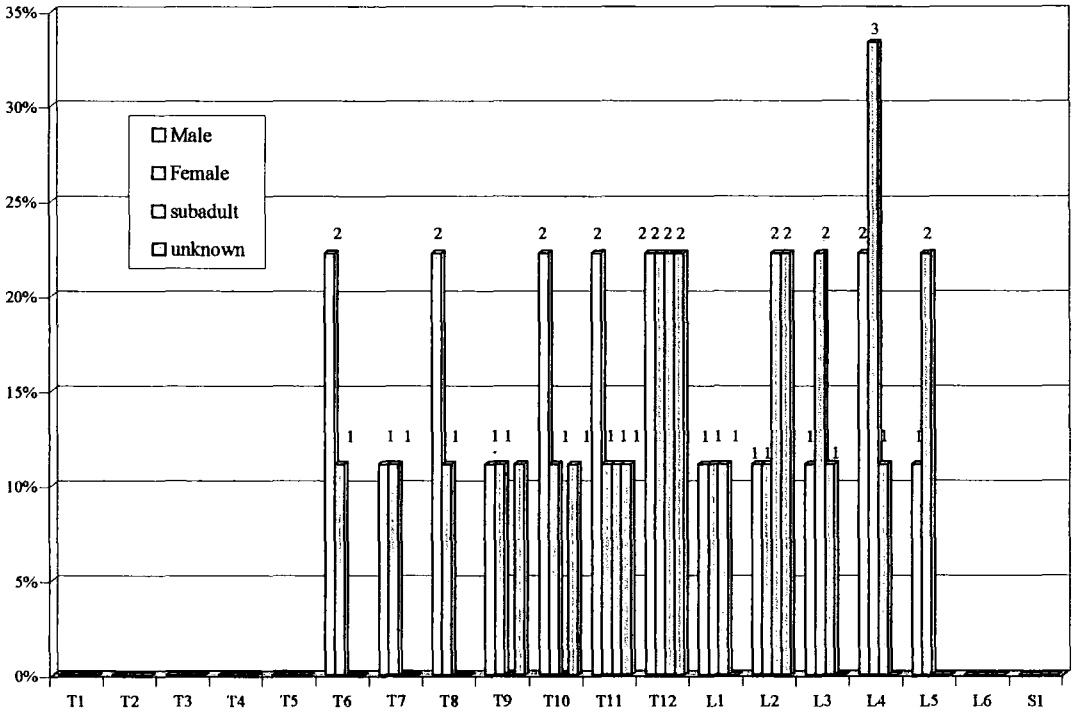


Figure 6.15 Numbers, percentages and levels of Schmorl's nodes for males, females, subadults and unsexed adults in the Whithorn Priory, Galloway sample

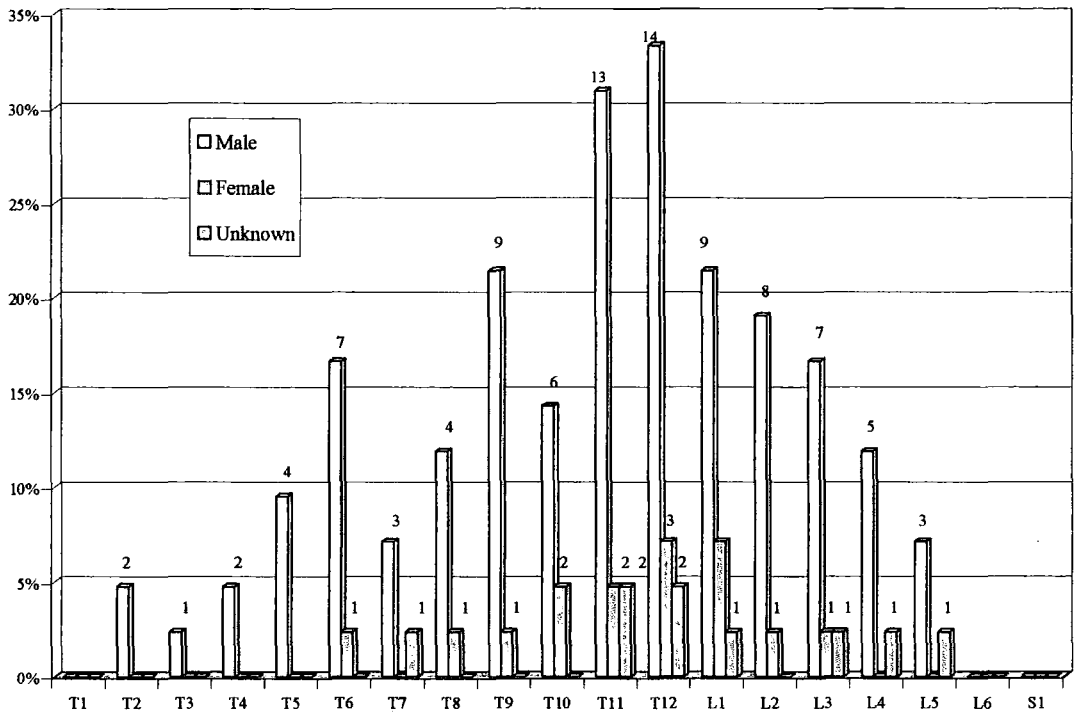


Figure 6.16 Numbers, percentages and levels of Schmorl's nodes for males and females in the St. Andrew, Fishergate sample

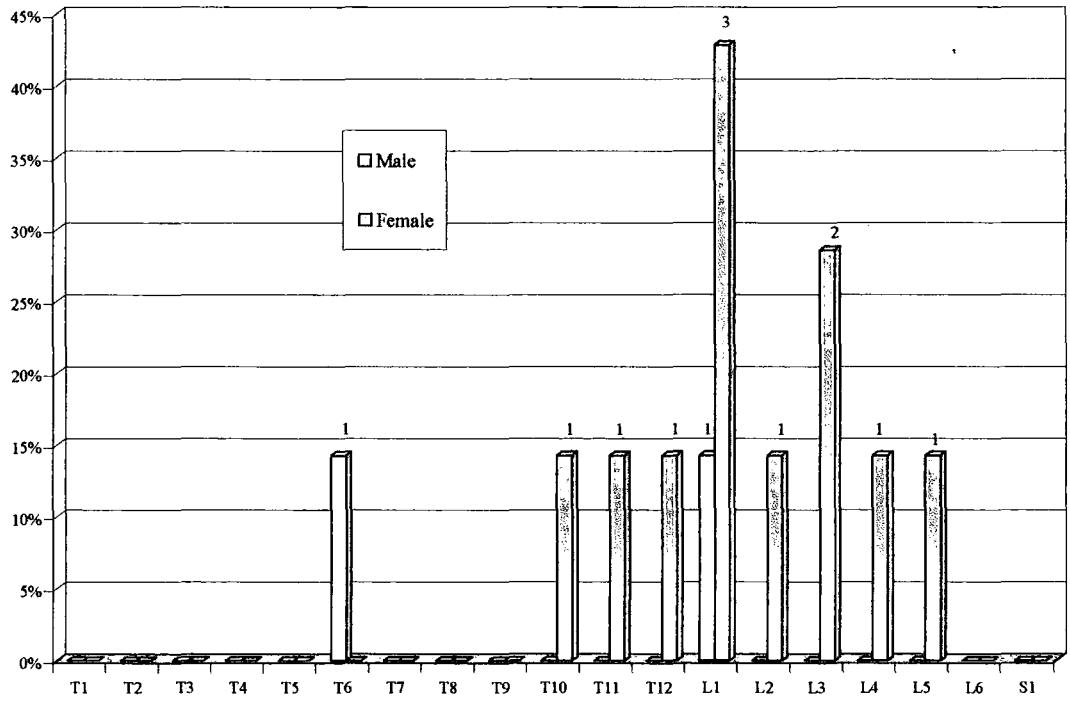


Figure 6.17 Numbers, percentages and levels of Schmorl's nodes for males and females in the Tanners Row, Pontefract sample

Appendix 5: Superior and inferior Schmorl's nodes in clinical and archaeological samples of different age groups

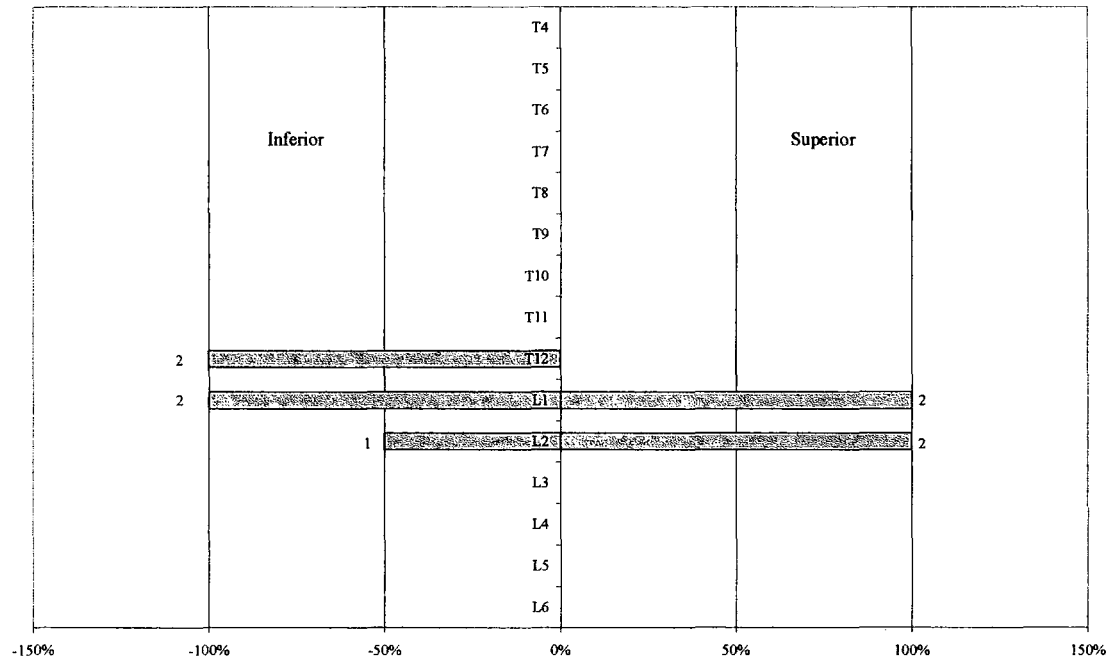


Figure 6. 18 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1994-5 Pinderfields Hospital sample aged 11 to 20

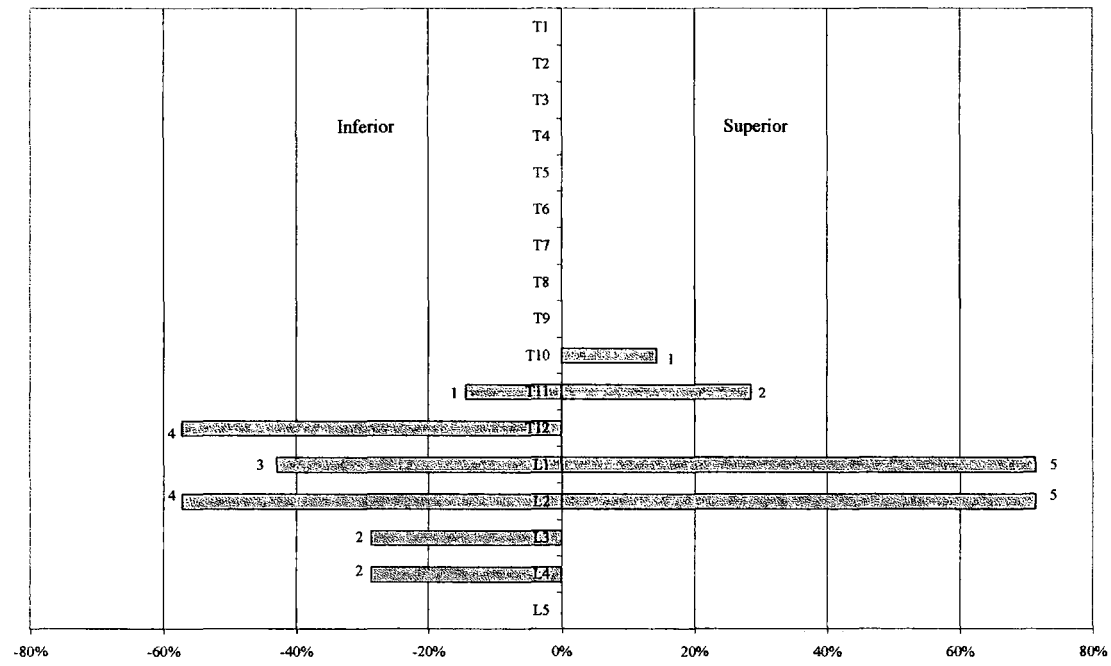


Figure 6.19 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1994-5 Pinderfields Hospital sample aged 21 to 25

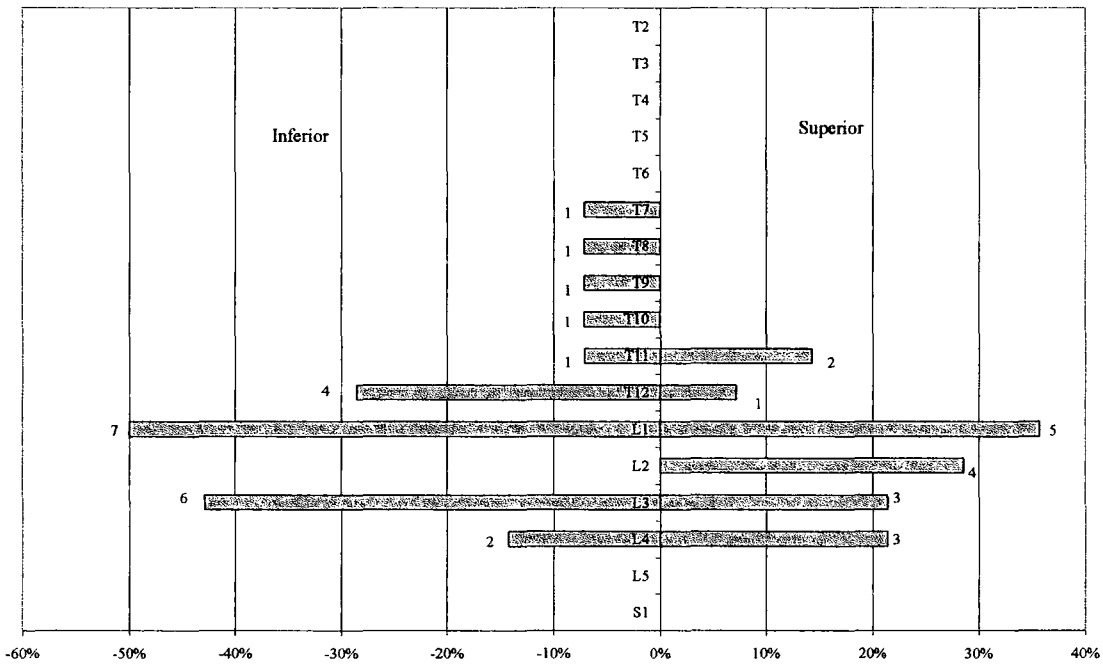


Figure 6.20 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1994-5 Pinderfields Hospital sample aged 26 to 35

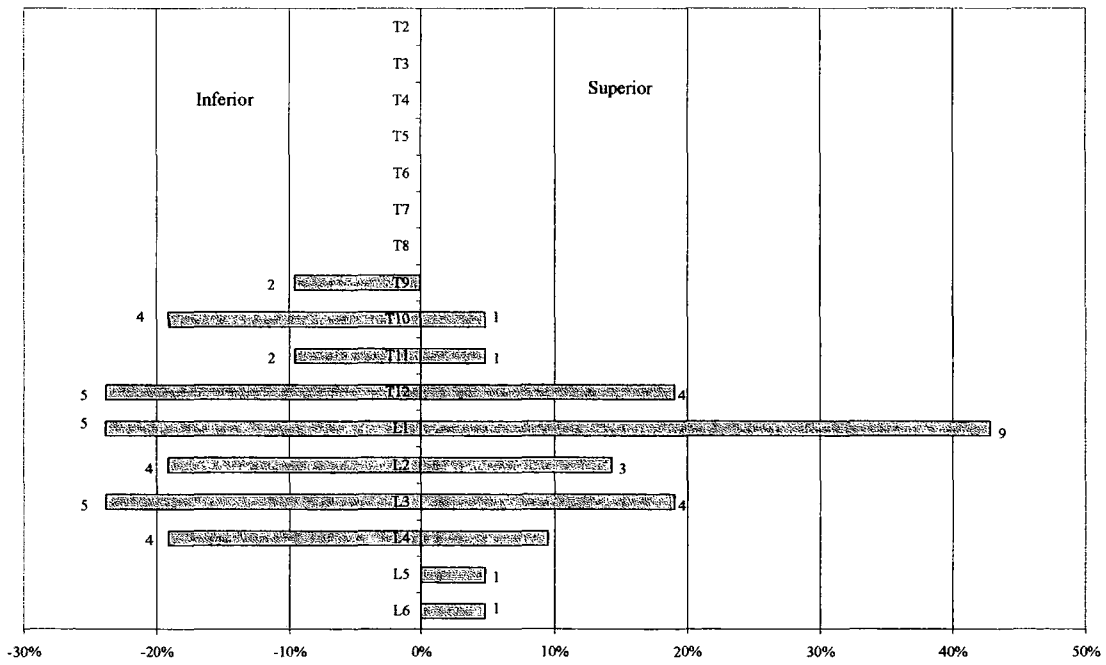


Figure 6.21 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1994-5 Pinderfields Hospital sample aged 36 to 45

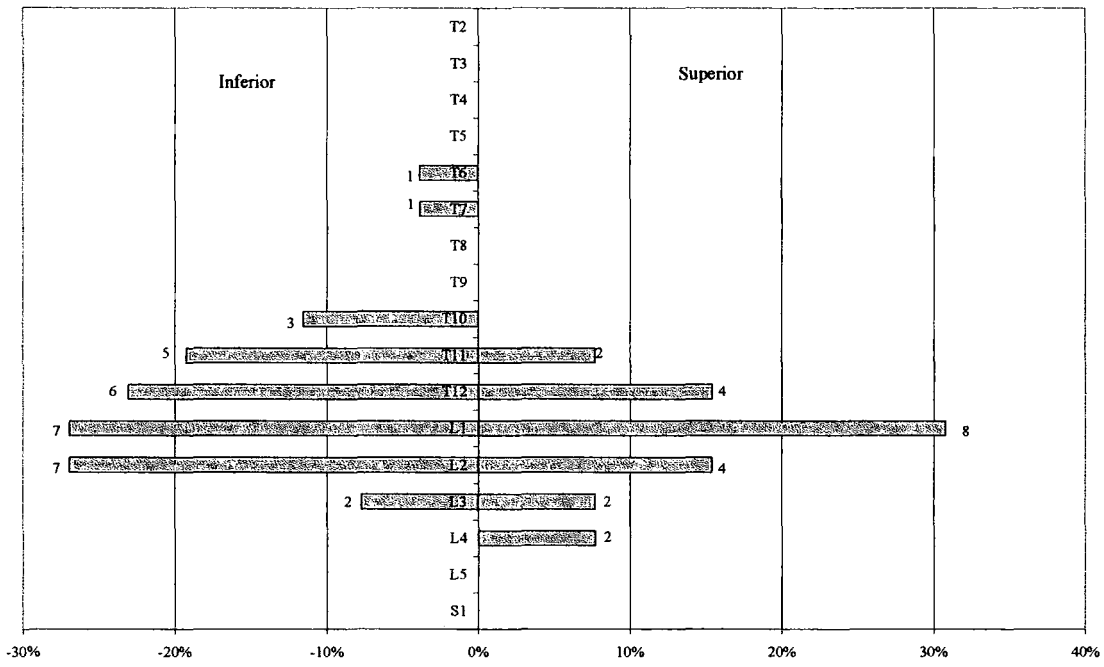


Figure 6.22 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1994-5 Pinderfields Hospital sample aged >45

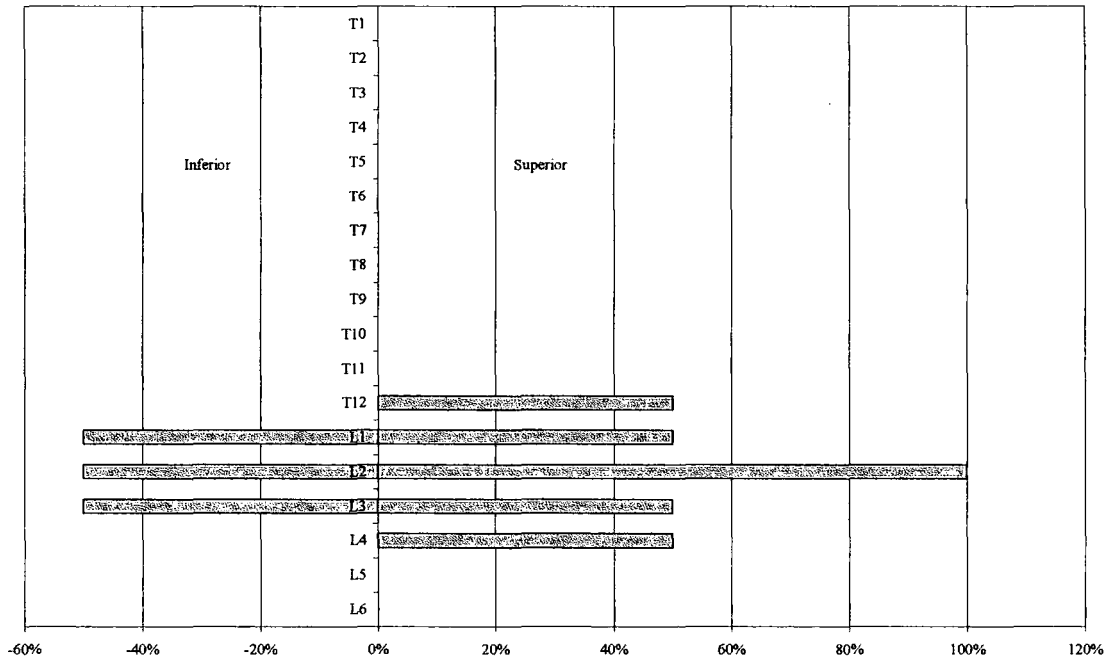


Figure 6. 23 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1995 Pinderfields Hospital sample aged 11 to 20

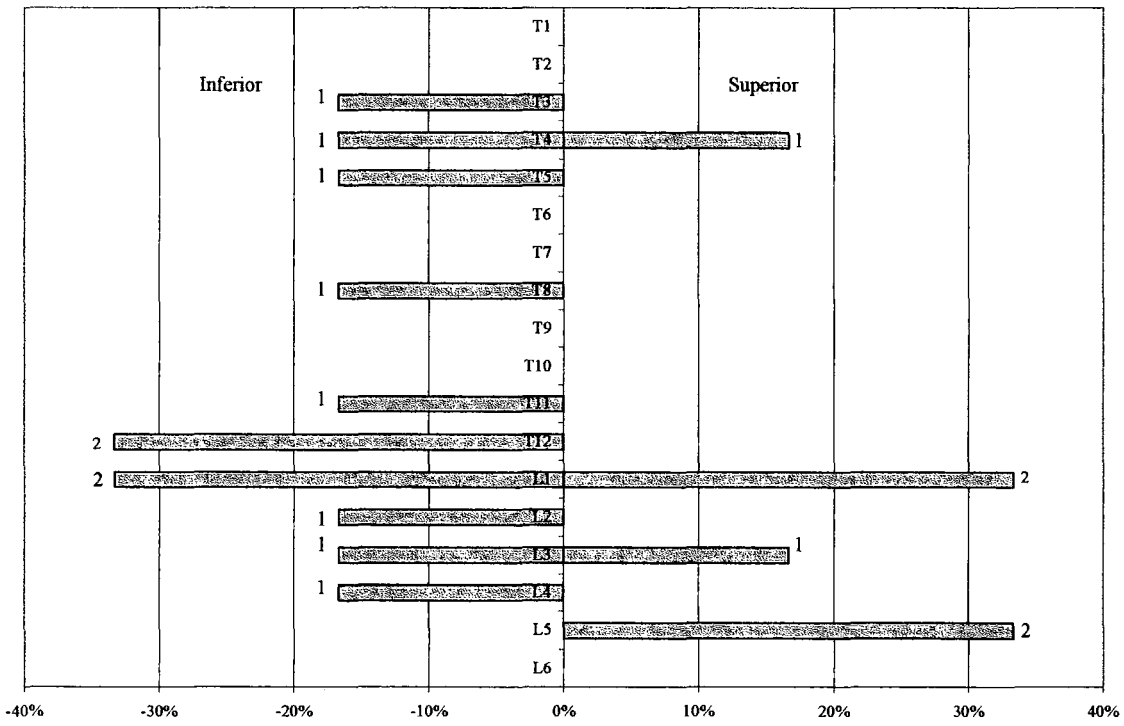


Figure 6.24 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1995 Pinderfields Hospital sample aged 21 to 25

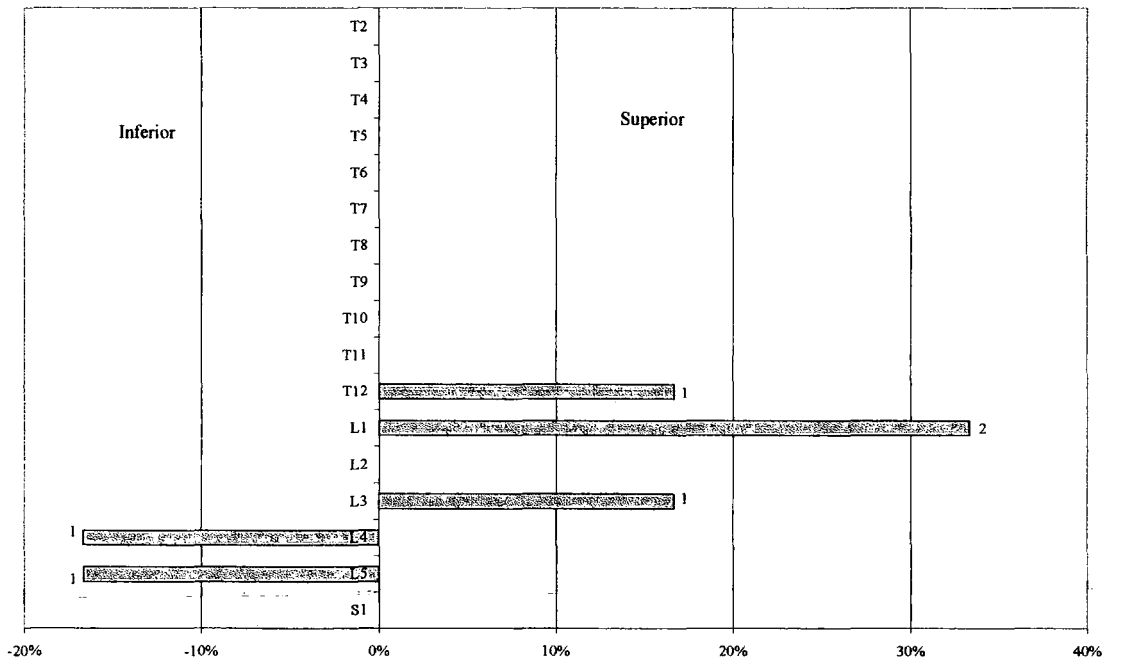


Figure 6.25 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1995 Pinderfields Hospital sample aged 26 to 35

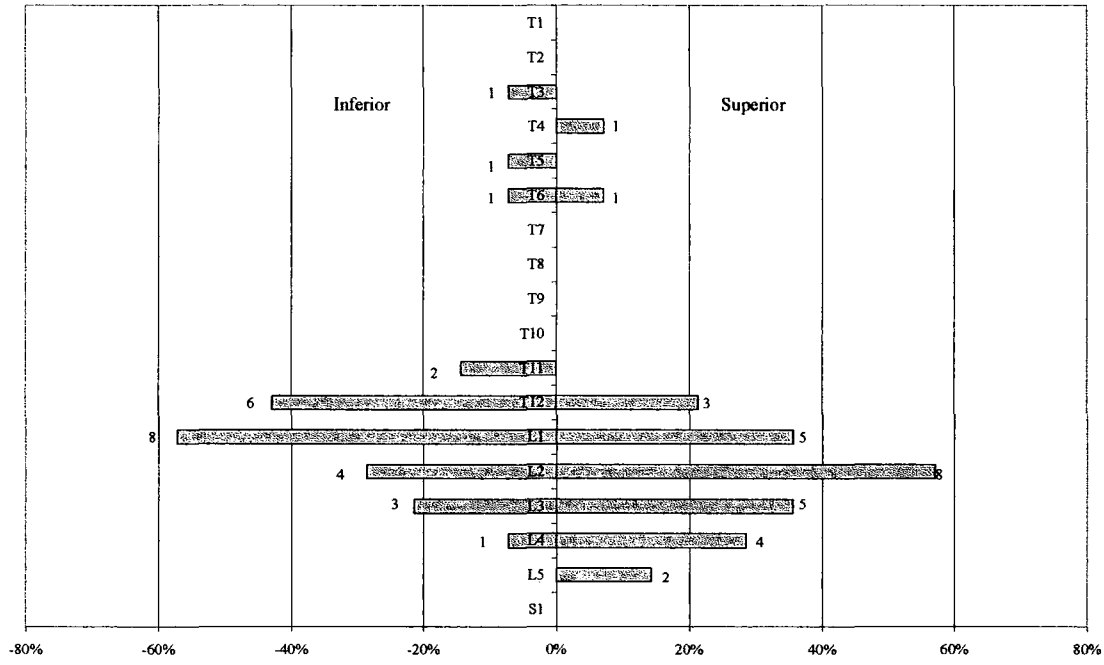


Figure 6.26 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1995 Pinderfields Hospital sample aged 36 to 45

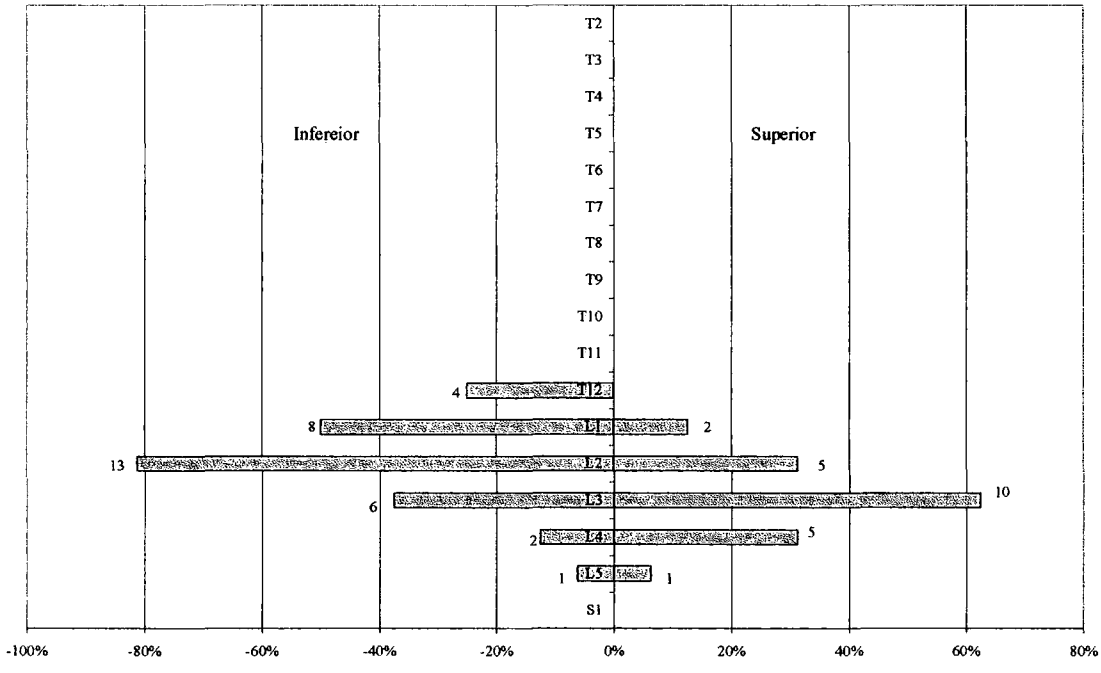


Figure 6.27 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels for 1995 Pinderfields Hospital sample aged >45

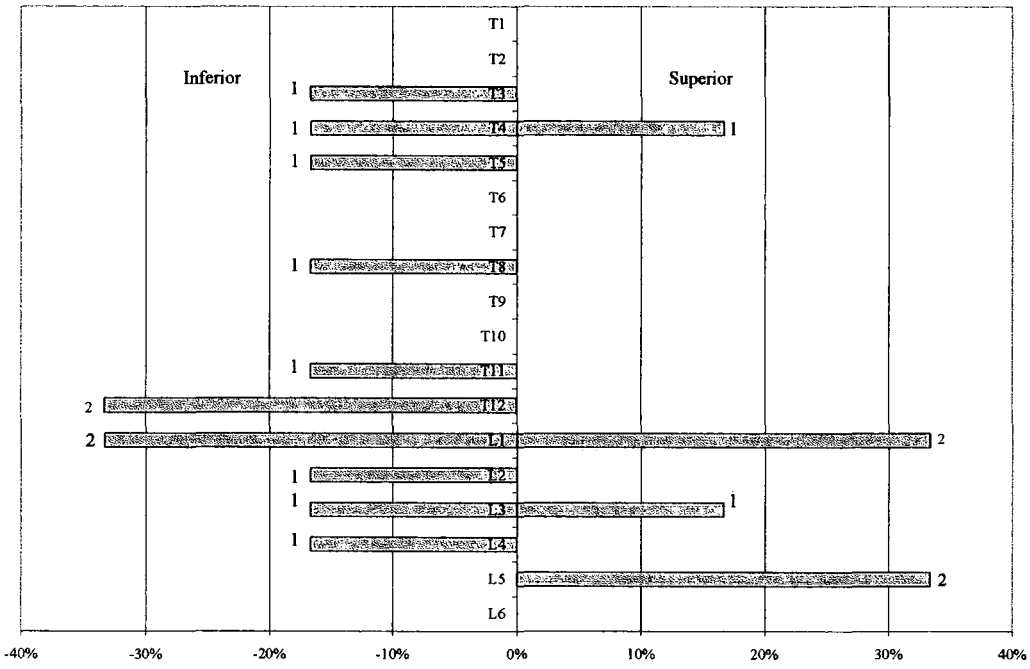


Figure 6.28 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels in the Royal Hospital for Sick Children sample aged 6 to 10

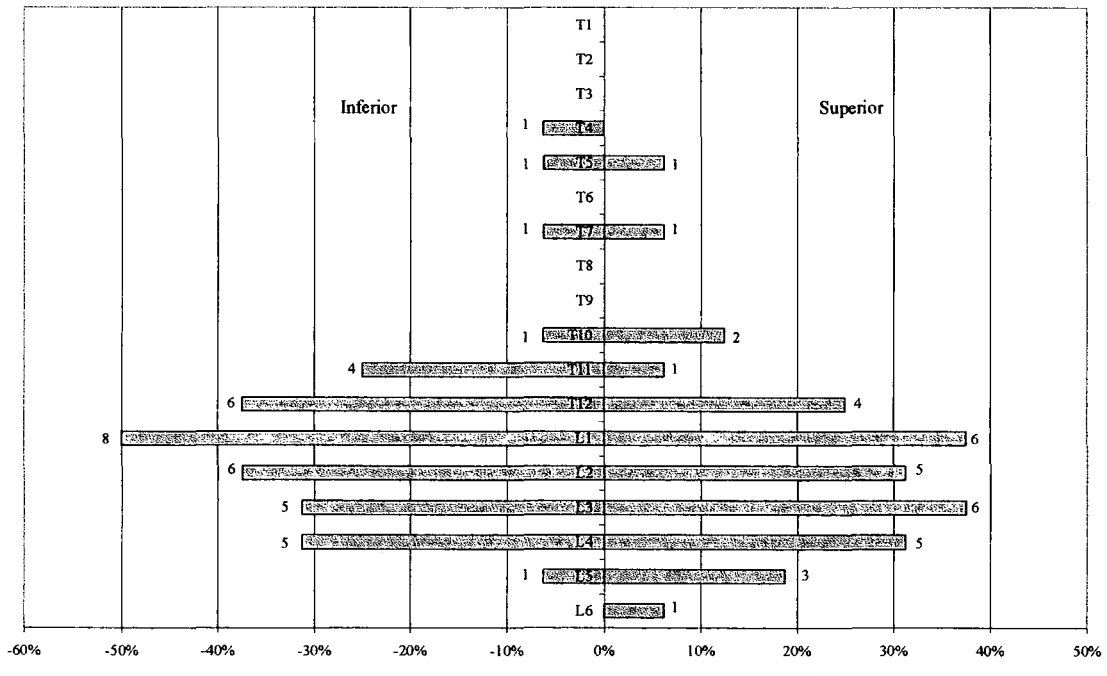


Figure 6.29 Numbers, percentages and levels of end plate intrusions for Schmorl's nodes at different levels in the Royal Hospital for Sick Children sample aged 11 to 16

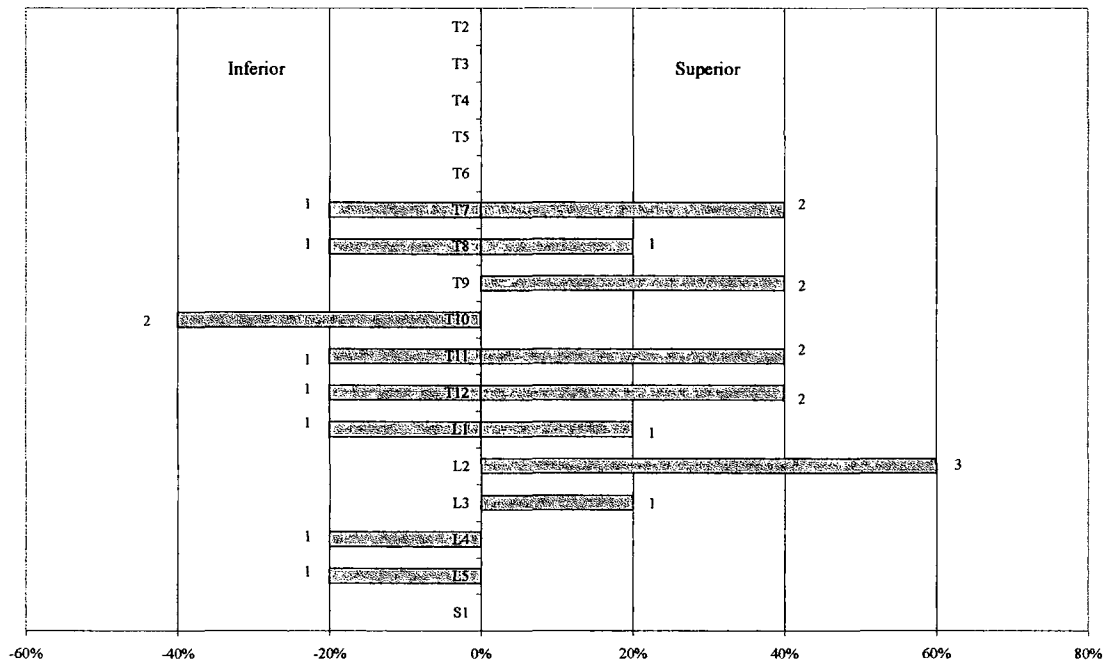


Figure 6.30 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Captain's Cabin, Dunbar sample aged 26-35

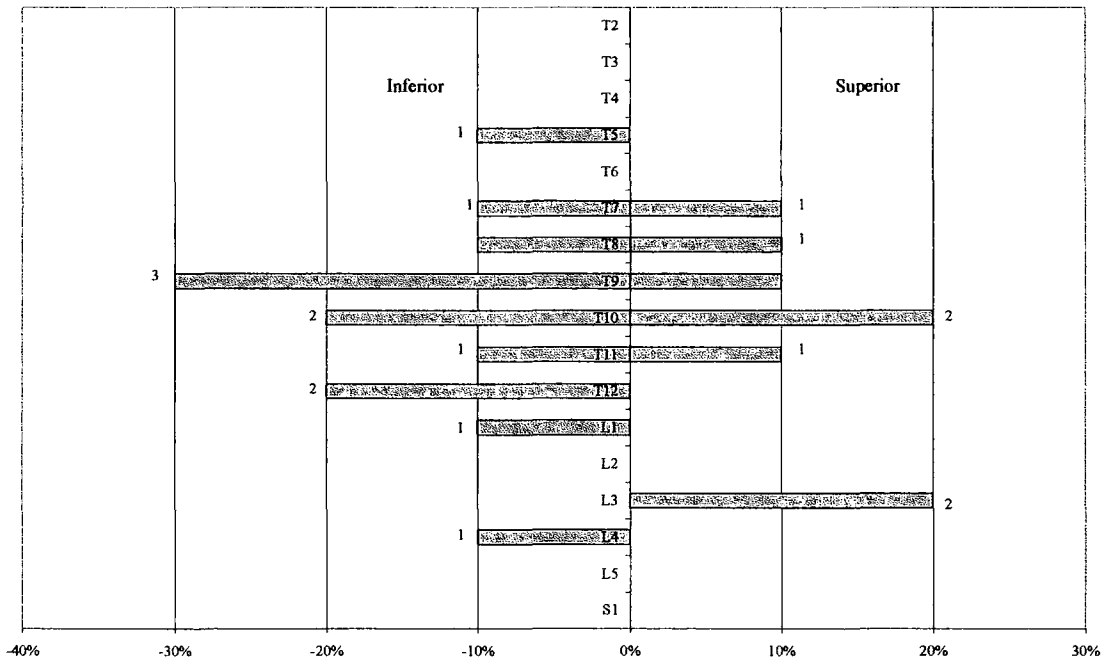


Figure 6.31 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Captain's Cabin, Dunbar sample aged 36-45

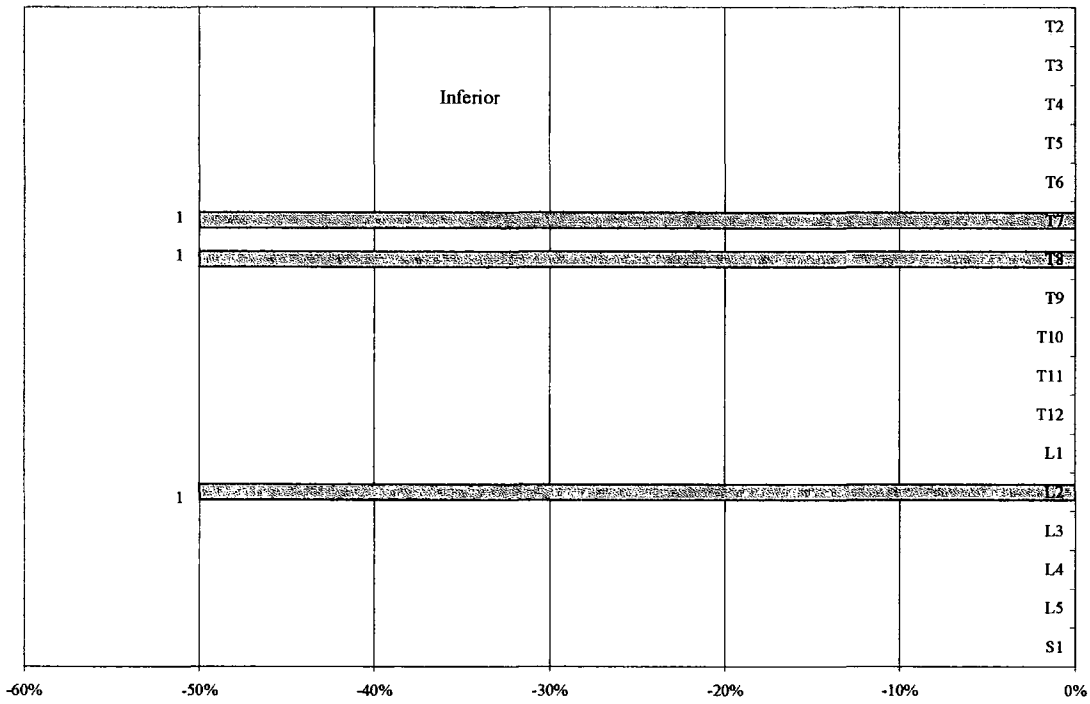


Figure 6.32 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes in the Captain's Cabin, Dunbar sample aged >45

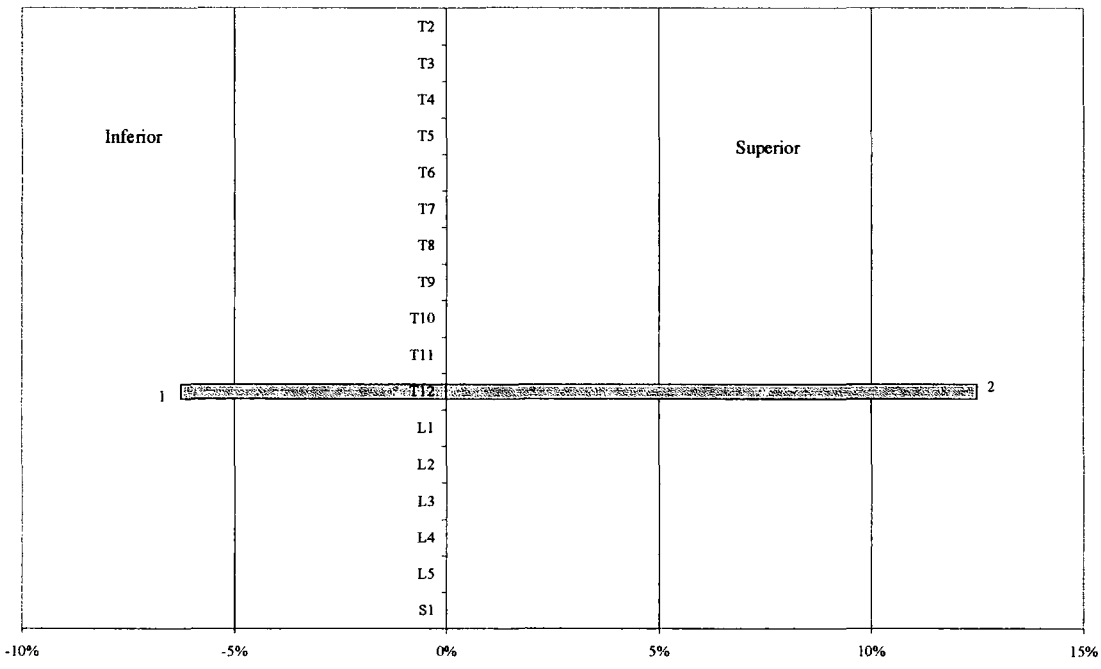


Figure 6.33 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes in the Hirsel, Coldstream sample for aged 26-35

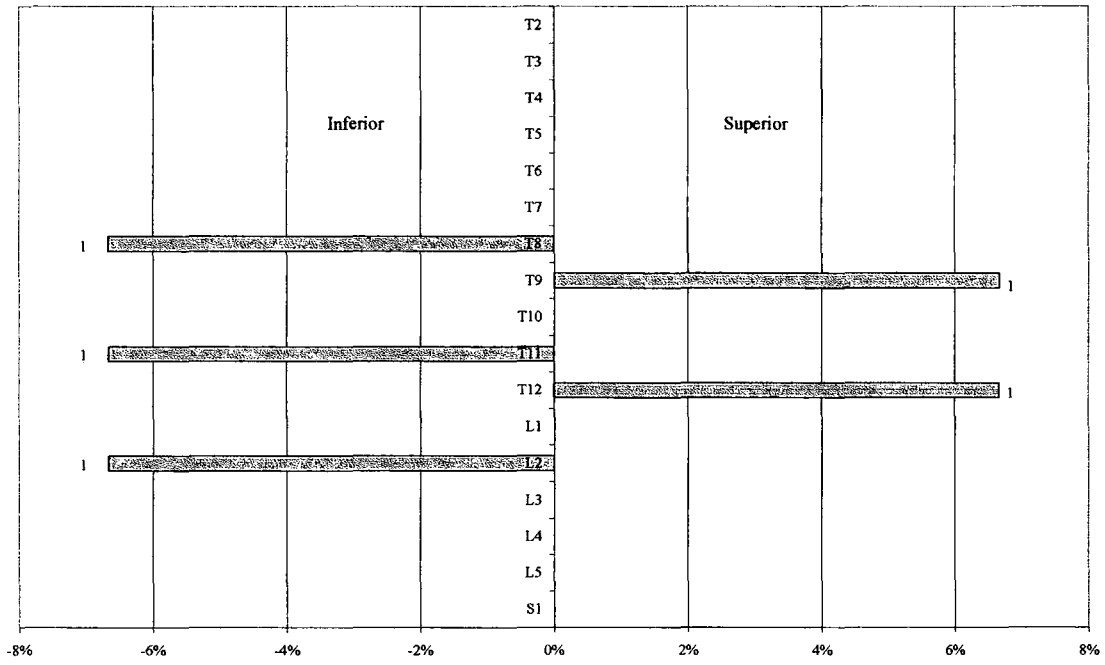


Figure 6. 34 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Hirsel, Coldstream sample aged 36-45

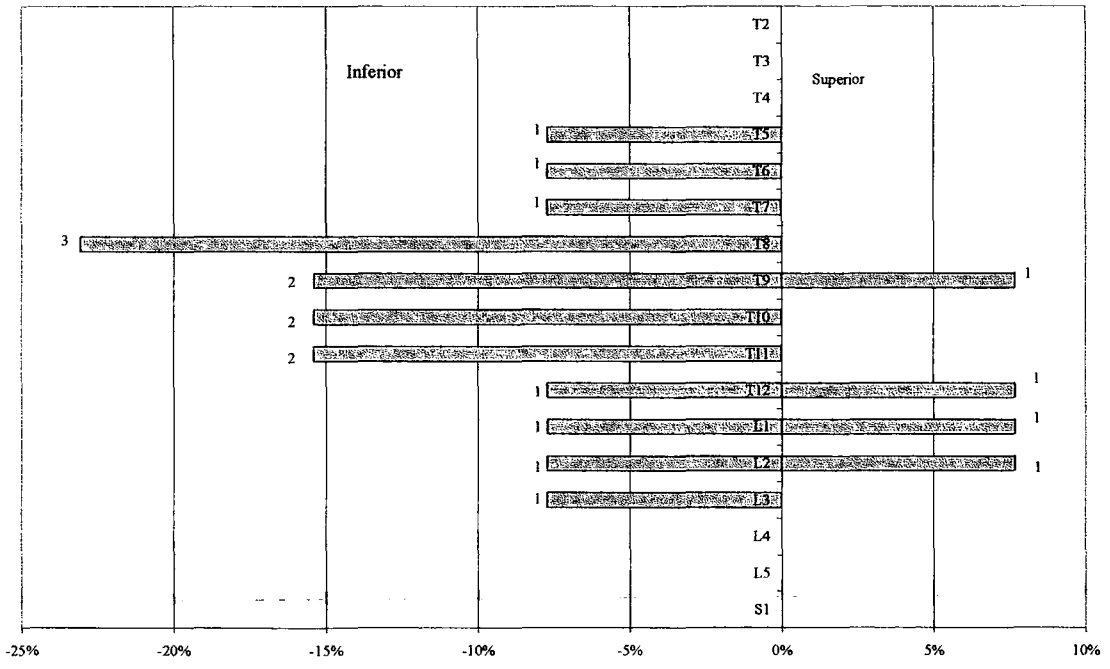


Figure 6.35 Numbers, percentages and levels offend plate intrusions by Schmorl's nodes for the Hirsel, Coldstream sample aged >45

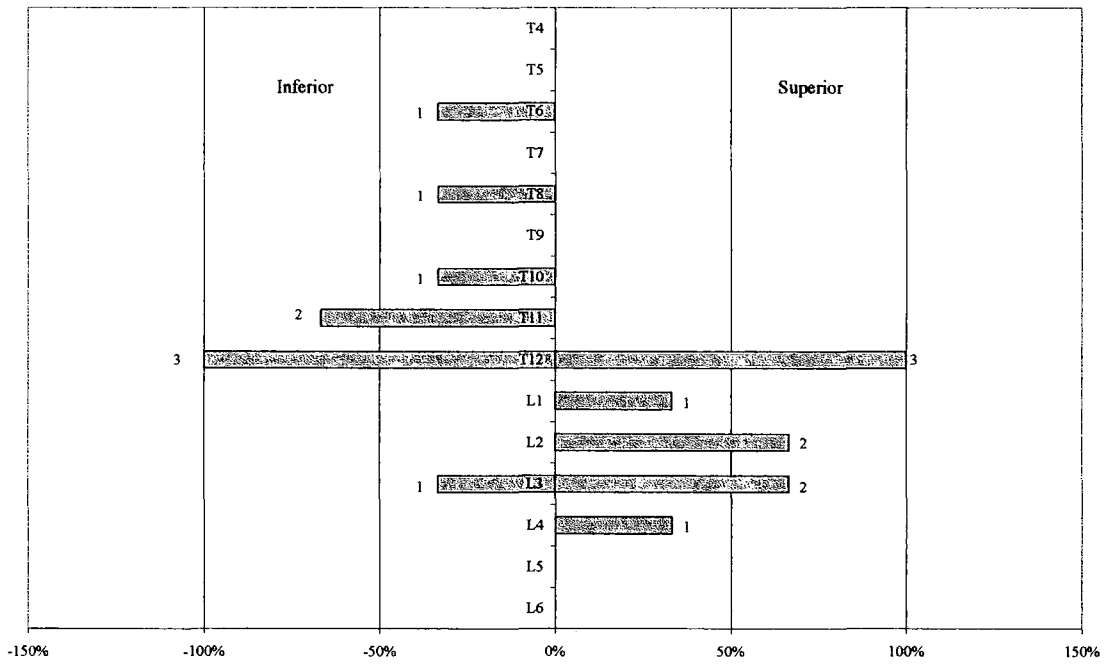


Figure 6.36 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Whithorn Priory, Galloway sample aged 11 to 20

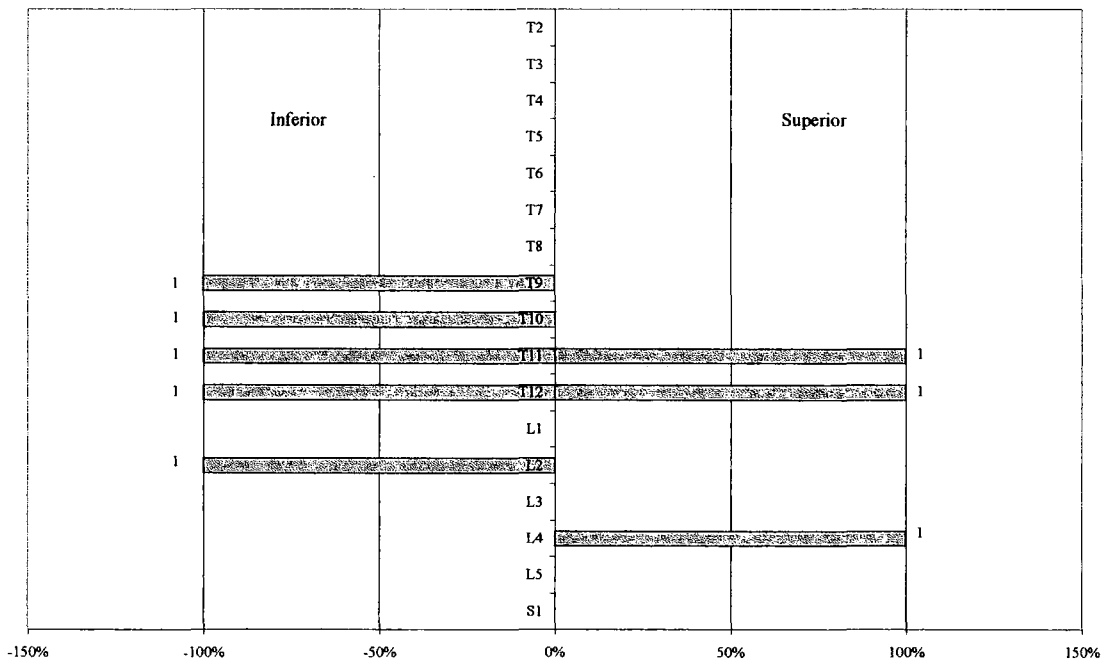


Figure 6.37 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Whithorn Priory, Galloway sample aged 26-35

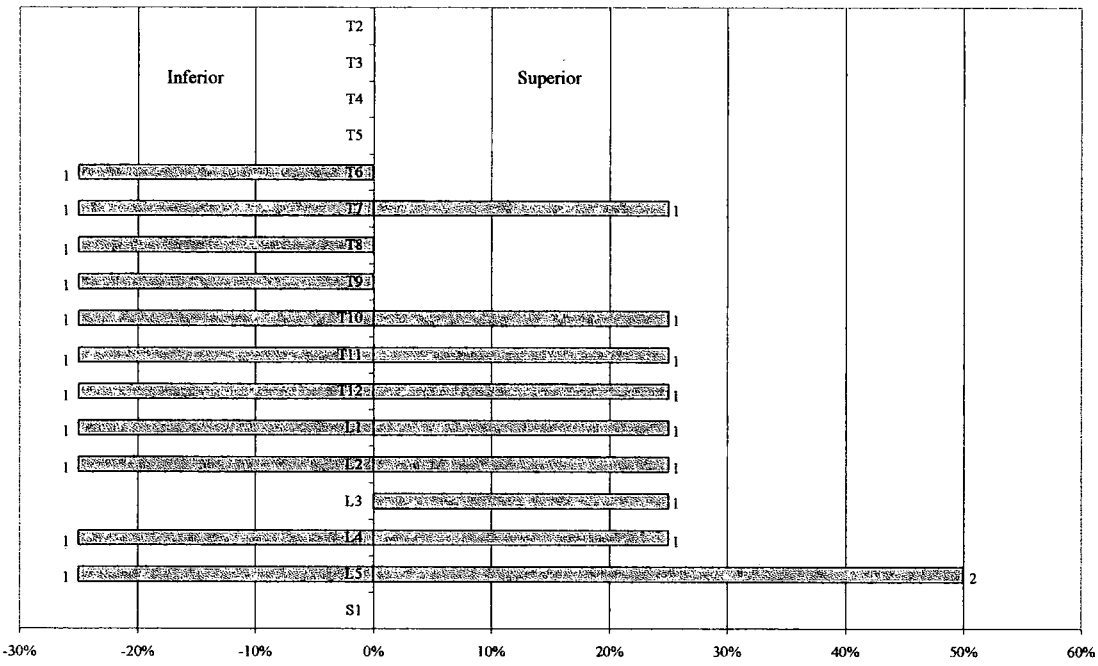


Figure 6.38 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Whithorn Priory, Galloway sample aged 36-45

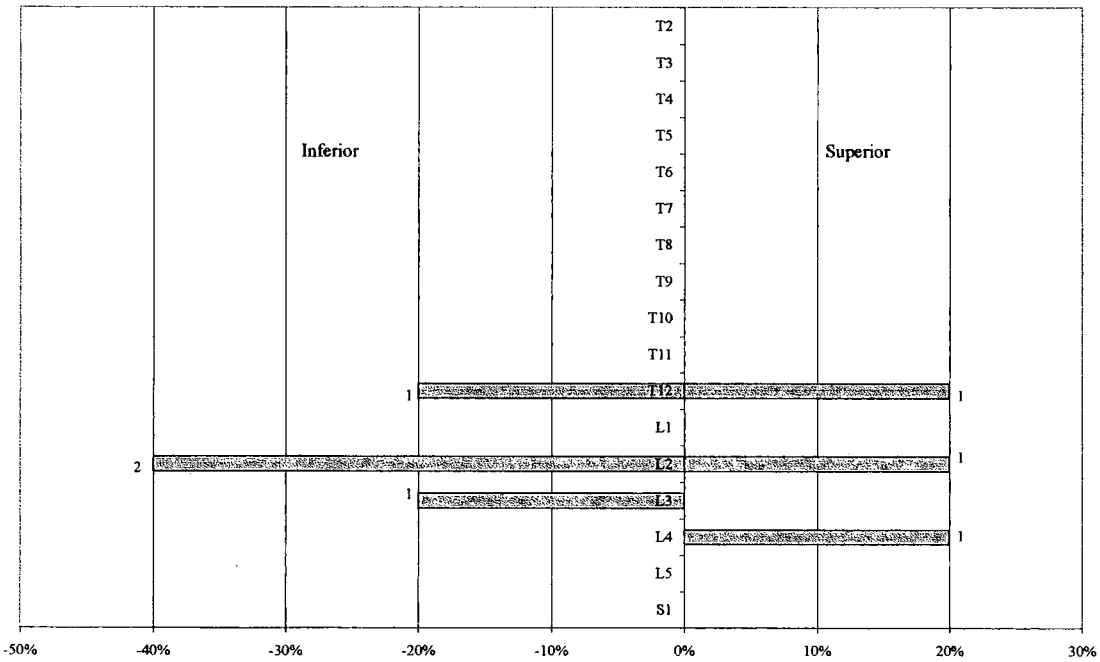


Figure 6.39 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Whithorn Priory, Galloway sample aged >45

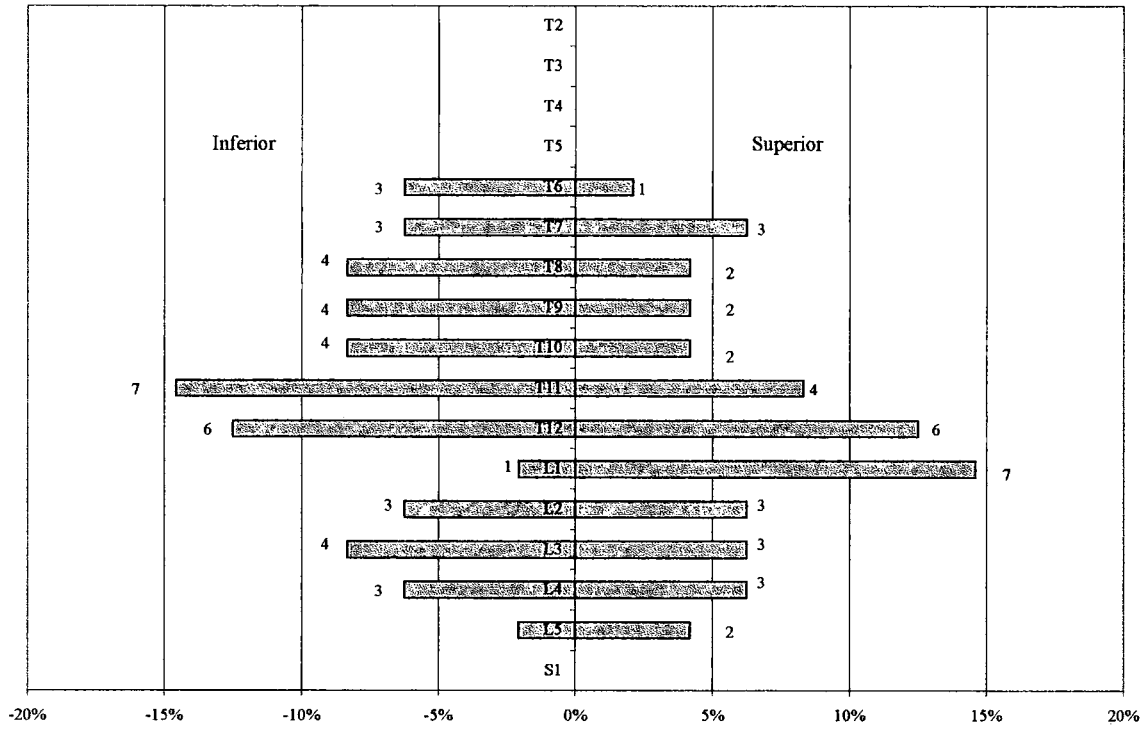


Figure 6.40 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the St. Andrew, Fishergate sample aged 26-35

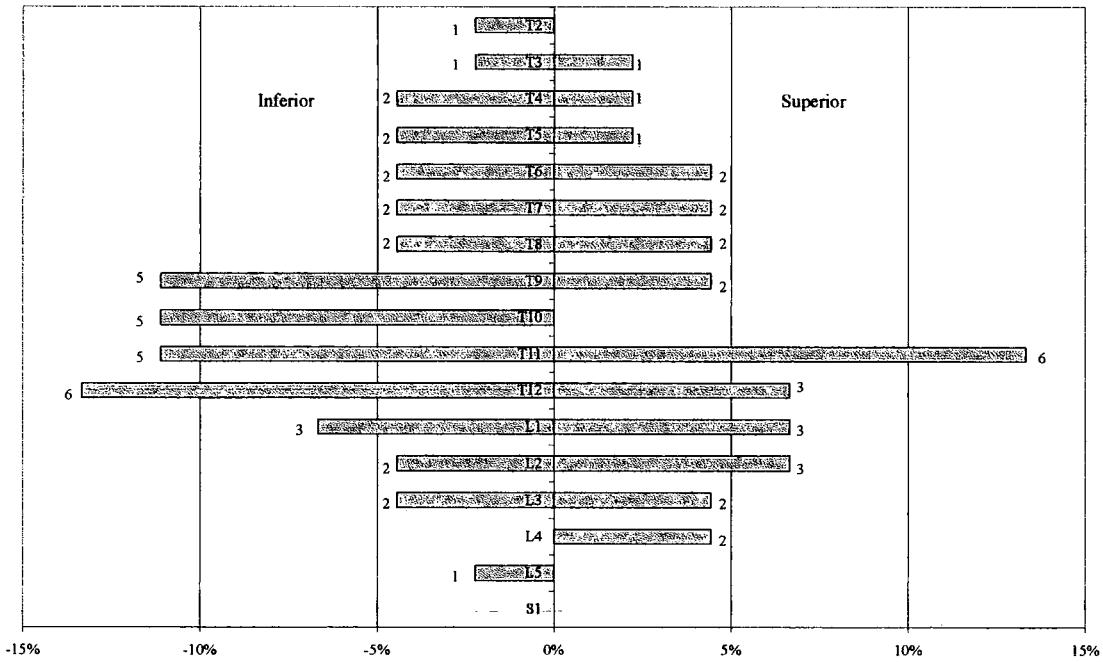


Figure 6.41 Numbers, percentages and levels of end plate intrusions of Schmorl's nodes for the St. Andrew, Fishergate sample aged 36-45

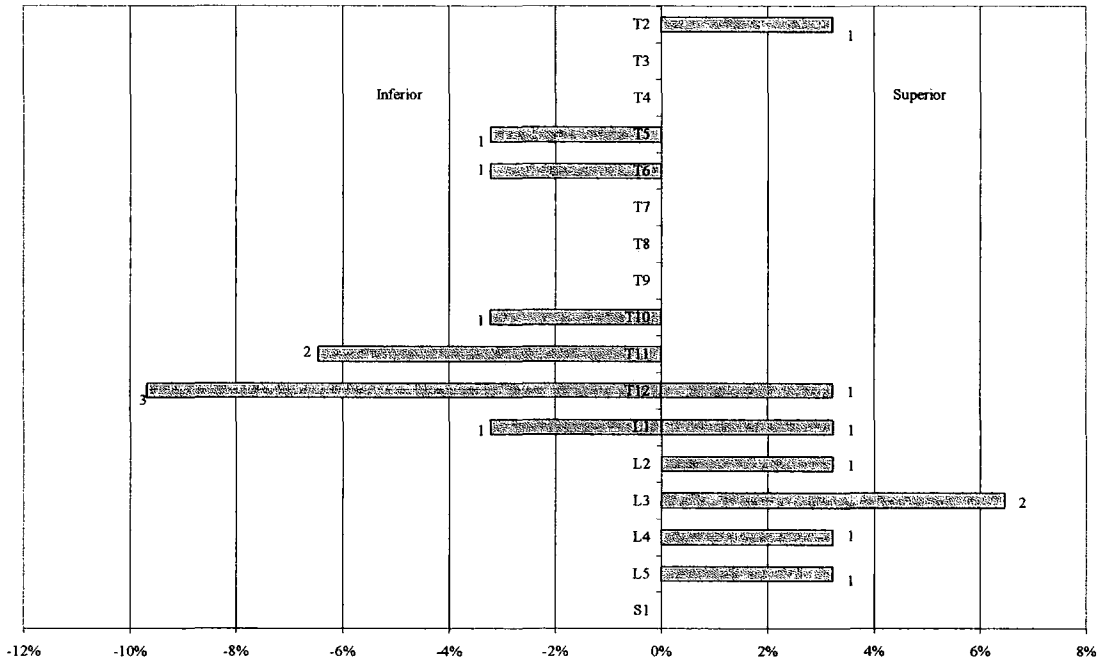


Figure 6.42 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the St. Andrew, Fishergate sample aged >45

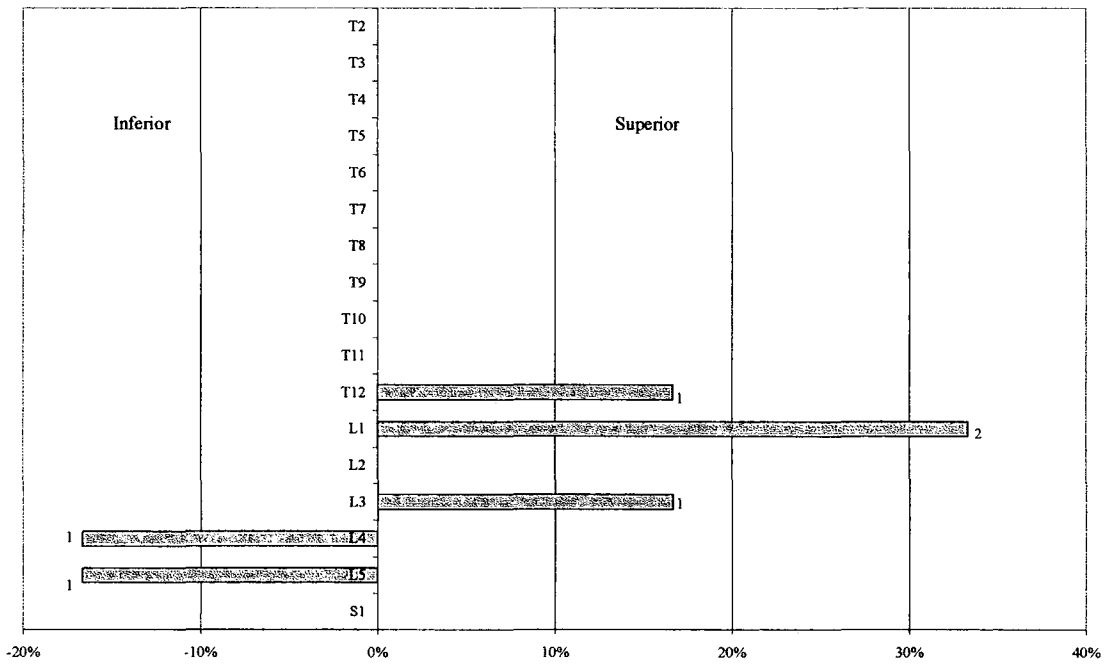


Figure 6.43 Numbers, percentages and levels of end plate intrusions by Schmorl's nodes for the Tanners Row, Pontefract sample aged 26-35

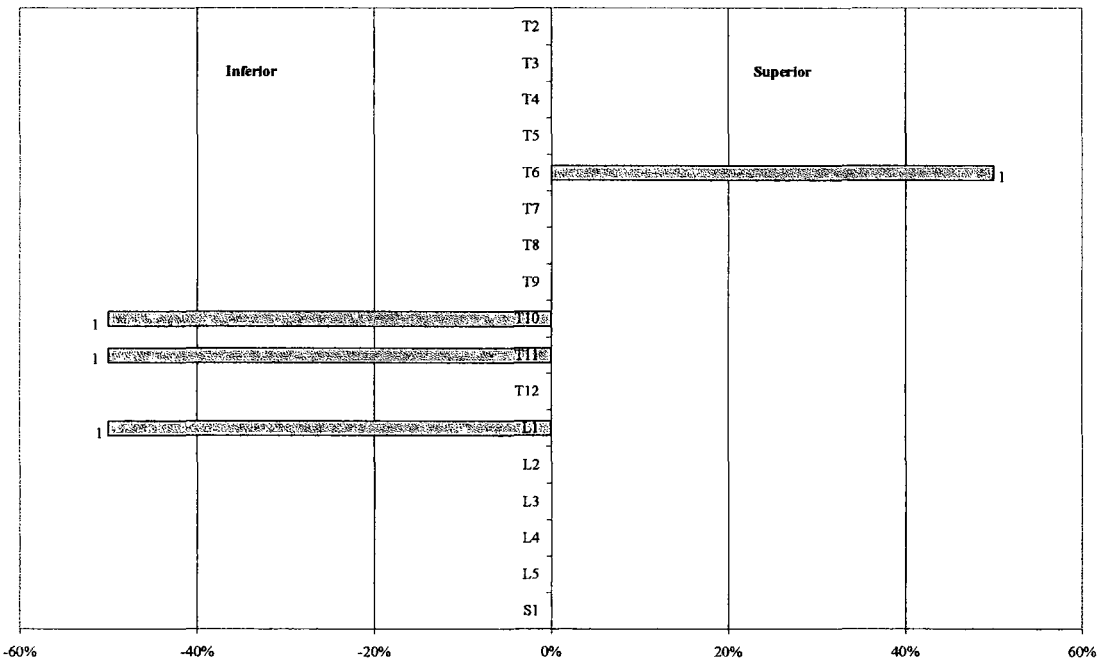


Figure 6.44 Numbers, percentages and levels offend plate intrusions by Schmorl's nodes for the Tanners Row, Pontefract sample aged >45

Appendix 6: Demographic data, for both clinical and archaeological samples

Barcode	Age	Sex	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	Lumbar 6	Sacral 1
AB137	21	M	-	-	-	-	-	-	-	-	-	-	S/I	I	S/I	S/I	-	-	-		-
BC139	21	M	-	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	-		-
CD142	24	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	I	-		-
DE867	25	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	I	I	-		-
EF258	25	M	-	-	-	-	-	-	-	-	-	-	-	I	S	S	-	-	-		-
FG580	26	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-	-		-
GH189	29	M	-	-	-	-	-	-	-	-	-	-	I	S	S/I	S	-	-	-		-
HJ251	29	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S/I	-		-
JK314	30	M	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-		-
KL132	30	M	-	-	-	-	-	-	-	-	-	-	-	I	-	-	I	-	-		-
LM82	30	M	-	-	-	-	-	-	-	-	-	S	S	-	-	-	-	-	-		-
MN258	31	M	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-	-		-
NP222	33	M	-	-	-	-	-	-	-	-	-	I	S	-	I	S	S/I	-	-		-
PR215	33	M	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S	-	-	-		-
RS791	35	M	-	-	-	-	-	-	-	-	-	-	-	-	I	S	I	-	-		-
ST167	38	M	-	-	-	-	-	-	-	-	-	-	-	-	S	I	-	I	-		-
TU266	38	M	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-		-
UV282	39	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-		-
VW323	40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	I	-		-
WX334	40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-		-
XY224	41	M	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
YZ847	42	M	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
ZA314	44	M	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-		-
BA150	46	M	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-	-	-		-
CB144	46	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-		-
DC141	47	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-		-
ED557	47	M	-	-	-	-	-	I	I	-	-	-	-	-	-	-	-	-	-		-
FE450	48	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-		-
GF324	48	M	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S	-	-	-	-		-
HG423	52	M	-	-	-	-	-	-	-	-	-	-	-	-	S	S/I	-	-	-		-
JH189	58	M	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-	-		-
KJ285	61	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-		-
LK216	64	M	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
ML679	65	M	-	-	-	-	-	-	-	-	-	-	-	-	S	-	S	-	-		-
NM209	89	M	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-	-		-

Table 6.14a Male data for Schmorl's nodes in the 1994-5 Pinderfields Hospital sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body

Barcode	Age	Sex	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	Lumbar 6	Sacral 1
BA170	15	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-		-
CB132	19	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	-	-	-		-
DC122	23	F	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-	-		-
ED268	24	F	-	-	-	-	-	-	-	-	-	S	S	I	-	-	-	-	-		-
FE205	28	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-		-
GF338	29	F	-	-	-	-	-	-	-	-	-	-	-	I	S	-	S/I	S/I	-		-
HG370	32	F	-	-	-	-	-	-	I	I	I	-	-	-	-	-	-	-	-		-
JH979	34	F	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-		-
KJ571	36	F	-	-	-	-	-	-	-	-	-	I	S	-	S/I	-	-	-	-		-
LK196	36	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-		-
LM216	37	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	S	-	-		-
NM114	37	F	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-		-
PN113	39	F	-	-	-	-	-	-	-	-	-	I	-	I	-	-	-	-	-		-
QP157	40	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-		-
RQ266	41	F	-	-	-	-	-	-	-	-	I	I	I	-	-	-	-	-	-		-
SR174	41	F	-	-	-	-	-	-	-	-	I	S/I	I	-	-	-	-	-	-		-
TS166	41	F	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-		-
UT208	41	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-		-
VU276	44	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	S	S	-
WV289	44	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-		-
XW530	45	F	-	-	-	-	-	-	-	-	-	-	-	S	S/I	S/I	S/I	-	-		-
YX259	46	F	-	-	-	-	-	-	-	-	-	-	-	I	I	S	-	-	-		-
ZY909	46	F	-	-	-	-	-	-	-	-	-	-	-	-	I	-	I	-	-		-
AZ662	47	F	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-		-
AB126	49	F	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-		-
BC100	50	F	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S	-	-		-
CD843	51	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-		-
DE207	51	F	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-	-	-		-
EF246	52	F	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-	-		-
FG469	55	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-		-
GH533	57	F	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-		-
HJ326	61	F	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
JK134	62	F	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-	-		-
KL837	70	F	-	-	-	-	-	-	-	-	-	I	-	-	I	-	-	-	-		-
LM574	72	F	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-	-		-

Table 6.14b Female data for Schmorl's nodes in the 1994-5 Pinderfields Hospital sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body.

Barcode	Age	Sex	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	Lumbar 6	Sacral 1
ML578	23	M	-	-	-	-	-	I	I	-	-	-	-	I	S/I	-	S/I	S	-		-
NK265	24	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-		-
PJ523	28	M	-	-	-	-	I	I	I	S	-	-	-	-	-	-	-	-	-		-
FJ661	30	M	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-		-
RB393	31	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S/I	S	-		-
EC403	37	M	-	-	-	-	-	-	-	-	-	-	-	-	S	S	S	S	-		-
HF548	39	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-		-
FS470	44	M	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-	-	-		-
AT402	48	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-	-	-		-
AS538	49	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I		-
TJ587	50	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S		-
RH409	50	M	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-		-
JS451	58	M	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-		-
EH473	64	M	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-		-
AB537	15	F	-	-	-	-	-	-	-	-	-	-	-	S	S	S/I	S/I	S	-		-
BC585	19	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-		-
CD44	31	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-		-
DE546	33	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-		-
EF531	35	F	-	-	-	-	-	-	-	-	-	-	-	-	I	I	I	-	-		-
FG133	36	F	-	-	-	-	-	-	-	-	-	-	-	-	I	I	-	-	-		-
HJ463	36	F	-	-	-	-	-	-	-	-	-	-	-	S/I	I	S/I	I	S/I	S		-
JK389	36	F	-	-	-	-	-	-	-	-	-	-	I	I	S	-	-	-	-		-
KL601	37	F	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
LM491	37	F	-	-	-	-	-	-	-	-	-	-	-	S	I	S/I	S	-	-		-
MN353	38	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-		-
NP417	39	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S	S		-
PQ322	41	F	-	-	I	S	I	S/I	-	-	-	-	-	-	-	-	-	-	-		-
QR383	41	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-		-
RS476	44	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	S	-	-		-
ST545	44	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S	S	-	-		-
TU256	48	F	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S/I	-	-		-
UV451	48	F	-	-	-	-	-	-	-	-	-	-	-	I	-	I	S	-	-		-
VW473	50	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S/I	-		-
WX474	57	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-		-
XY476	58	F	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S	-		-
YZ429	60	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	I	-	-	-		-
BA595	60	F	-	-	-	-	-	-	-	-	-	-	-	-	I	I	S	-	-		-
CB451	63	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-		-
DC274	71	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-		-
ED454	82	F	-	-	-	-	-	-	-	-	-	-	-	I	I	I	S	-	-		-

Table 6.15 Male and female data for Schmorl's nodes in the 1995 Pinderfields Hospital sample showing the levels and surfaces affected; superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body

Barcode	Age	Sex	Thoracic 1	Thoracic 2	Thoracic 3	Thoracic 4	Thoracic 5	Thoracic 6	Thoracic 7	Thoracic 8	Thoracic 9	Thoracic 10	Thoracic 11	Thoracic	Lumbar 1	Lumbar 2	Lumbar 3	Lumbar 4	Lumbar 5	lumbar 6	Sacral 1
123AB	7	M	-	-	-	-	-	-	-	-	-	-	-	-	I	I	S/I	-	-		-
123DE	9	M	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-	-		-
122BA	9	M	-	-	I	I	I	-	-	I	-	-	I	I	-	-	-	-	-		-
373GH	10	M	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-		-
101MN	11	M	-	-	-	-	-	-	I	-	-	-	I	-	-	-	-	-	-		-
121YZ	12	M		-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S/I	-		-
160CD	13	M	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	I	S	-
170HJ	13	M	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-		-
353ST	13	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S/I	-		-
170EF	14	M	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	I	S/I	I	S		-
120NP	14	M	-	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-		-
310KL	6	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S		-
372FG	10	F	-	-	-	-	-	-	-	-	-	-	-	-	S			-	S		-
121JK	11	F	-	-	-	-	-	-	-	-	-	S/I	S/I	S	-	-	-	-	-		-
121VW	11	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S/I	S	-	-		-
170BC	11	F	-	-	-	-	-	-	-	-	-	-	-	-	S/I	S/I	S/I	S/I	S		-
364LM	12	F	-	-	-	-	-	-	-	-	-	-	-	I	S/I	-	-	-	-		-
121TU	12	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-		-
318RS	13	F	-	-	-	-	-	-	-	-	-	-	-	I	S	-	-	-	-		-
346XY	15	F	-	-	-	-	-	-	-	-	-	-	-	-	-	I	S/I	S	-		-
303ZA	16	F	-	-	-	-	-	-	-	-	-	I	I	S/I	I	S/I	S/I	S/I	S		-
308PQ	16	F	-	-	-	I	S/I	-	S	-	-	-	-	I	S/I	-	-	-	-		-

Table 6.16 Male and female data for Schmorl's nodes in the Royal Hospital for Sick Children sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body.

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
66	<0	peri-natal	P	P	P	P	A	A	A	A	A	A	A	A	P	P	P	P	A		A
69	<0	peri-natal	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
75	<0>	infant	P	P	P	A	A	A	A	A	A	A	A	A	P	P	P	P	A		A
35	0-1	Infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
32	1-2	Infant	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P		P
67	2-3	Infant	A	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P		A
3	3-5	Child	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P		A
34	4-5	Child	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
10	4-8	Child	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
47	4-8	Child	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P		P
63	4-8	Child	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
28	7-10	Child	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
37	<10>	Youth	P	P	P	P	P	P	P	A	A	A	A	A	A	#	p	#	P		P
53b	10-12	Youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
71	12-18	Youth	P	P	P	P	P	P	P	I	S	I	P	P	P	P	P	P	P		P
19	15-16	Sub-adult	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
22	<18	Sub-adult	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A		A
25	18-25	M	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	P	P		P
55	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
36	26-35	M	P	P	P	P	P	P	P	I	S	P	P	P	I	S	P	P	P		P
38	26-35	M	P	P	P	P	P	P	P	P	S	I	SI	S/I	S	S	S	P	P		P
45	30-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
29	30-45	M	A	P	P	P	P	P	S/I	P	I	S/I	S/I	I	#	P	P	P	P		P
72	30-45	M	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
14	36-45	M	A	A	A	P	P	P	P	P	P	P	P	P	P	P	S	P#	P#		A
21	36-45	M	A	A	P	P	P	P	P	S/I	I	S/I	P	P	I	P	S	I	P		A
68	26-35	F	P	P	P	P	P	P	S#	S#	P	P	S	S	P	P	P	P	P		P
46	26-35	F	A	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	P		P
64	26-45	F	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A		A
56	26-45	F	P	P	P	P	P	P	P	P	P	P	P	I	P	P	P	P	P	P	P
33	30-40	F	A	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A		A
2	30-40	F	P	P	P	P	P	P	P	P	P	A	A	A	A	P	P	P	P		P
54	36-45	F	A	P	P	A	A	A	A	A	A	P	P	P	A	A	A	P	P		A
18	36-45	F	P	P	P	P	P	P	P	P	I	P	P	P	P	P#	P	P	P#		A
20	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		
4	>40	F	P	P	P	P	I	P	P	P	S	P	P	P	P	P	P	P	P		A
44	>45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	I	P	P	P		A
52	>45	F	P	P	P	P	P	P	I	I	P	P	P	P	P	P	P	P	P		P
57	36-45	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
8	>40	?	P	P	P	P	P	P	P	I	I	P	P	P	A	A	A	A	A		A
9b	>40	?	A	A	A	A	P	P	P	P	P	P	A	A	A	A	A	A	A		A
62	Adult	?	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	P	P		A

Table 6.17 Data for Schmorl's nodes in the Captain's Cabin, Dunbar sample showing the levels and surfaces affected, superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Skele. No	Age	Sex	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	Lumbar 6	Sacral 1
113	<0	peri	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
296	<0	peri	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
17	<0>	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
120	<0>	infant	A	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P		A
9	1-2	infant	P	P	P	P	P	P	P	P	A	A	A	A	P	P	P	P	P		P
16	1-2	infant	P	P	P	A	A	A	A	A	A	A	A	A	P	P	P	P	P		P
179	2-4	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
83	3-4	child	A	A	A	A	A	A	A	A	P	P	P	A	A	P	P	P	A		P
28	4-5	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
284	4-5	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
280	4-5	child	A	A	A	A	A	A	P	P	P	P	P	P	P	P	P	A	A		P
224	4-6	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
252	5-6	child	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P#		P
299	5-6	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
143	6-7	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
218	6-7	child	A	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P		P
310	7-8	child	A	P	P	P#	P	P	P	P#	P#	P	P#	P	P	P	P	P	P		P
20	7-9	child	P	P	P	P#	P	P	P	P	P	P	P	P	P	P	P	P	P		P
300	7-9	child	A	A	A	A	A	A	A	I	P	P	P	P	P	P	P	P	P		P
78	7-10	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
233	8-9	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
270	8-9	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
285	8-9	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
107	11-12	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
324	11-13	youth	P	A	A	A	A	A	P	P	P	P	P	P	P#	P	P	P	P	SBO	P
128	12-13	youth	A	A	A	A	A	A	P#	P#	P	P	P	P	P	P	P	P	P		A
223	16-20	sub-adult	A	A	A	A	A	A	P	P	P	P	P	A	P	P	P	P	P		P
246	21-30	M	P	P	P	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
297	21-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
303	21-35	M	A	A	A	A	A	A	A	A	A	S/I	P	P	P	I	P	P	P	SBO	P
247	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
278	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
335	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
69	26-35	M	P#	P#	P	P	P	P	P	P	P	P	P	S	P#	P#	P	P	P		P
97	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
207	30-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
121	36-45	M	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
325	36-45	M	P	P#	P#	P	P	P	P	P	P	P	P	P	P	P	P#	P	P	SBO	P
234	36-45	M	A	A	A	A	A	A	P#	P#	P	P	P	P	P	P	P	P	P		P
265	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
323	36-45	M	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
85	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	I	P	P	P		P

Table 6.18a Data for Schmorl's nodes in the Hirsel, Coldstream sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#), and each occurrence of spina bifida occulta (SBO) was recorded.

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
104	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
153	36-45	M	P	P	P	P	P	P	P	P	P	P	I	S	P	P	P	P	P		P
172	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
222	36-45	M	P	P	P	P	P	P	P	I	S	P	I	P	P	P	P	P	P		P
108	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A		A
198	>45	?M	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
209	>45	M	P	P	P	P	P	P	P	I	P	P	P	P	P	P	P	P	P		P
276	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
279	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
282	>45	M	P	P	P	P	I	I	I	I	I	I	I	I	I	I	I	P	P		P
288	>45	M	P	P	P	P	P	P	P	P	P	P	P	S	P	P	P	P	P		P
292	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
306	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
232	15-30	?M	P	P	P	P	P	P	P	P	P	P	A	P	P	P	P	P	P		A
188	15-20	?M	A	P	P	P	P	P	P	P	A	A	A	P	P	P	P	A	A		P
27	25-35	?M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
84	>45	?M	P	P	P	P#	P#	P	P	P#	P	P	P	P	P	P	P	P	P		P
289	16-25	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
309	18-20	F	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
190	21-25	F	A	P	P	P	P	P	P	P	P	P	P	P	I	I	P	P	P		P
200	21-25	F	A	A	P	P	P	P	P	P	P#	P	P	P	P	P	P	P	P		P
255	21-25	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
314	21-25	F	P	P	P	P	P	P	P	P	P#	P#	P#	P	P	P	P	P	P		P
293	21-30	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
331	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
26	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
65	26-35	F	P	P	P	P	P	P	P	P	P	P	P	S	P	P	P	P	P		P
147	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
174	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
210	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
44	36-45	F	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
94	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
184	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
225	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
243	36-45	F	P#	P#	P#	P#	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	P
239	>45	F	P#	P#	P#	P#	P#	P#	P#	P#	P#	P#	P	P	P	P#	P	P	P		P
240	>45	F	P	P	P	P	P	P	P#	P	P	P	P	A	A	A	A	A	A		A
294	>45	F	P	P	P	P	P	P	P	I	I	I	I	P	S	S	P	P	P		P
144	>45	F	P	P	P	P	P	P	P	P	S	P	P	P	P	P	P	P	P		P
187	16-18	?F	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
221	26-35	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
173	36-45	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P

Table 6.18b Data for Schmorl's nodes in the Hirsel, Coldstream sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#), and each occurrence of spina bifida occulta (SB0) was recorded.

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
454	6-8	child	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P		A
463	6-10	child	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P		P
471	6-10	child	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
444	8-10	child	P	P	P	A	A	A	A	A	A	A	A	P	P#	P	P#	P	P		P
470	8-10	child	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
483	8-10	child	A	A	A	A	A	P	P	P	P#	P	P	P	A	A	P#	P#	P		P
498	8-10	child	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P		P
445	11-15	youth	A	A	P	P	P	P	P	P	P	P	P	P	P#	P#	P	A	P		P
461	11-15	youth	P	P	P	P	P	P	P	P	P	P	P#	P	P	P	P	P	P		P
552	11-15	youth	P	P	P	P	P	I	P	I	P	I	I	S/I	P	P	S/I	S	P		P
468	11-15	youth	A	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A		A
452	11-15	youth	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P		P
500	12-15	youth	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P	P		P
538	12-15	youth	A	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
447	12-18	sub-adult	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P	P		P
460	12-20	sub-adult	P	P	P	P	P	P	P	P	P	P	P	S/I	S	S	S	P	P		P
508	16-18	sub-adult	A	P	P	P	P	P	P	P	P#	P	I	S/I	P	S	P	P	P		P
506	16-20	sub-adult	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
532	18-25	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
554	18-25	M	A	P	P	P	P	I	I	S/I	S/I	S/I	S/I	I	S/I	P	P	I	I		A
531	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
561	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
511	>45	M	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
504	>45	M	A	A	A	A	A	A	A	A	A	I	S/I	S/I	S/I	S/I	S/I	S/I	A		A
537	>45	?M	P	P	P	P	P	P	P	P	P	P	P	P	P	S/I	P	P#	P		P
558	16-25	F	A	A	A	A	P	P	P	S	S	P	I	S/I	A	A	P	A	P		P
569	16-25	F	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
535	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
556	36-45	F	P	P	P	P	P	I	P	P	P	P	P	P	P	P	P	I	S		P
519	>45	F	A	A	P	P	P	P	P	P	P	P	P	S	P	P	I	S	P		P
559	>45	F	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
539	35-45	?F	P	P	P	P	P	P	S/I	I	I	S/I	S/I	S/I	S/I	S/I	S	S	S/I		P
549	<25	?	A	A	A	A	P	P	P	P	P	P	P	P	A	P	P	P	P		P
482	<25	?	P#	P#	P#	P	P	P	P	P	P#	P	P	P	A	A	P	P	P		P
509	25-35	?	P	P	P	P	P	P	P	P	I	I	S/I	S/I	P	I	P	S	P		A
507	35-45	?	A	A	A	P	P	P	P	P	P	P	P	P	P#	P#	P	P	P		P
517	35-45	?	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
510	>45	?	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P

Table 6.19 Data for Schmorl's nodes in the Whithorn Priory sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
194	<1>	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
269	1-2	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
272	1-2	infant	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
431	1-3	infant	P	P	A	A	A	A	A	P	P	P	P	P	P	P	P	P	P		P
100	1-3	infant	A	A	A	A	A	P	P	P	P	A	P	P	A	A	A	P	P		A
317	1-3	infant	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
271	2-3	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
360	2-3	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
359	3-4	child	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
419	3-6	child	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
287	4-5	child	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
384	4-6	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P#		P
407	4-6	child	P#	P#	P	P	P	P	P	P	P	P#	P	P	P	P	P	P	P		P
217	5-7	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
412	5-7	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
277	5-8	child	P	P	P	P	P	P	P	P	A	A	P	P	A	A	P	P	P		P
292	5-8	child	A	A	A	A	A	A	P	P	P	P	A	A	P	A	P	P	P		P
275	5-8	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
300	5-8	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
76	6-8	child	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
278	6-10	child	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P#	P		P
434	6-10	child	P	P	A	P	P	P	A	A	A	A	P	A	A	P	P	P	P		P
327	7-9	child	P	P	P#	P	P	P	A	A	A	A	A	A	A	A	A	A	A		A
233	7-12	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
51	8-12	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
193	10-12	youth	A	A	A	P	P	P	P	P	P	P	P	P	A	A	A	P	P		P
358	11-14	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
348	11-14	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
354	12-14	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
318	12-15	youth	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
62	13-16	sub-adult	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
15	13-18	sub-adult	A	P	P	P	A	A	A	P	P	P	P	P	P	P	P#	P	P		A
261	14-16	sub-adult	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
370	16-20	sub-adult	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A		A
323	17-20	sub-adult	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P		A
190	17-20	sub-adult	A	A	A	A	P	P	P	A	A	A	A	A	S	P	P	P	P		A
351	18-25	M	P	A	P	P	A	A	P	P	P	A	P	P	P	P	P	P	S		P
379	18-25	M	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
268	18-25	M	A	P	P	P	P	P	P	I	P	P	I	P	P	P	P	P	P	SBO	P

Table 6.20a Data for Schmorl's nodes in the St. Andrew, Fishergate sample showing the levels and surfaces affected superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#), and each occurrence of spina bifida occulta (SBO) was recorded.

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
56	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
61	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	S	P	I	I	P#		P
149	21-30	M	A	P	P	P	P	P	P	P	P	P	P	I	S	I	P	P	P		P
262	21-30	M	A	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P		P#
294	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
373	21-30	M	A	A	P	P	A	A	A	P	P	P	P	A	P	P	P	P	A		A
377	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
413	21-30	M	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
161	21-30	M	A	A	A	A	A	I	I	P#	P	P	I	I	P	I	P	P	P		P#
256	21-30	M	P	P	P	P	A	A	P	P	P	P	P	P	P	P	P	P#	P#		P#
57	21-30	M	P	P	P	P	P	I	P	I	P	P	P	P	P	P	P	P	P		P
58	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
204	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
226	21-30	M	P	P	P	P	P	P	P	P	S	S/I	S/I	S	P	P	P	P	P		P
355	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
283	21-30	M	P	P	P	P	P	P	S	P	P	P	I	S	P	P	P	P	P		P
329	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
414	21-30	M	P	P	P	P	P	I	P	P	P	P	S/I	S/I	S	S/I	P	P#	P#		P
430	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P	P		P
41	21-30	M	P	P	P	P	P	S/I	S/I	S/I	S/I	S/I	S/I	S/I	P	S	S/I	S/I	S		P
50	21-30	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
49	21-30	M	A	A	A	A	A	P	P	P	P	P	P	I	P	P	P	P	P		P
138	26-30	M	A	A	P#	P#	P#	A	A	A	A	A	P	P	P	P	P	P	P		P
249	26-30	M	P	P	P	P	P	P#	P	P	P	P#	P#	P	P	P	P	P	P		P#
164	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P#	P	P	P	P		P
258	26-35	M	A	P	P	P	P	P	P	P	P	P	P	I	S	P	P	P	P#		A
259	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	S	S	P#	A	A		A
73	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
89	26-35	M	P	P	P	P	P	P	P	P	P	P	I	I	P	P	P	P	P		P
104	26-35	M	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
140	26-35	M	A	A	A	A	A	A	A	A	A	S	S	P	P	P	P	P	P		P
245	26-35	M	P	P	P	P	P	P	P	P	P	P	S	I	P	P	P#	P#	P		P
188	26-35	M	P	P	P	P	P	P	P	P	I	I	P	P#	P	P	P	P	P		P
192	26-35	M	A	A	A	A	A	A	P	P	A	P	P	P	P	P	P	P#	P#		P#
273	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
284	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P#	P	P	P	P		P
340	26-35	M	P	P	P	P	P	P	P	P	P	P	P	I	S	P	P	P	P		P
356	26-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
101	26-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
365	26-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	U	P		P#
77	26-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A		A
141	26-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P

Table 6.20b Data for Schmorl's nodes in the St. Andrew, Fishergate sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
123	30-35	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
109	30-40	M	A	A	A	A	A	P#	P#	P#	P#	P#	P#	P#	P	P	P	P	P		P
263	30-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	S		P
299	30-40	M	P	P	P	P	P	P	P	P	P	I	S	I	P	P	S	P	P		P
7	30-40	M	P	A	P	I	S	S	S/I	P	S/I	P	P	P	P#	S	I	P	P		P
9	30-40	M	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
16	30-40	M	A	P	P	P	P	P	P	P	P	P	P#	P	P	P	P	S	P		P
239	30-40	M	A	P	P	A	A	P	P	I	P	P	I	P	S	P	P	P	A		A
243	30-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
276	30-40	M	P	P	P#	P	P	P	P	P	P	P	P	P	P#	P	P	P	P		P
289	30-40	M	P	P	P	P	P	P	P	P	I	I	S/I	S/I	I	S	P	P	P		P
366	30-45	M	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P	P	A
162	30-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
151	30-45	M	P	P	P	P	P	P	P	P	P	P	S/I	P	P	P	P	P	P		P
234	36-40	M	P	P	P	P	P	P	A	I	P	P	A	I	P	P	P	P	P		P
369	36-40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#		P
99	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
417	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P	P	P		P
6	36-45	M	A	A	A	A	A	A	A	A	A	I	S	I	P	P	P	P	P		P
23	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P#	P	P	P	P	I		P
25	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
62	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
71	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
222	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
235	36-45	M	A	A	A	P#	P	P	P	P#	P	P	P	P	P	P	P	P	P		P
380	36-45	M	A	P	P	P	A	A	P	P	P	P	P	P	P	P	P	P	P		P#
14	36-50	M	P	P	P	P	I	S/I	S/I	S/I	S/I	P	P	P	P	P	P	P	P		P
106	36-45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
156	36-50	M	P	P	P	P	P	P	P	P	P	P	S/I	P	S	P	P	P	P		P
53	40-45	M	P	A	A	P	P	P	A	A	P	I	P	P	S	P	P	P	P		A
144	40-45	M	P	P	P	P	P	P	P	P	P	P	P	I	S/I	S	P	P	P		P
383	>40	M	P	P	P	P	P	P	P	P	I	S	P	P	S	A	A	A	P		P
227	>40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
130	>40	M	A	P	P	P	P	P	P	P	P	P	P	P#	P	I	P	P	P		P#
143	>40	M	A	A	A	P#	P#	P#	P#	P	P	P	P	P	P#	P	P#	P#	P		P#
29	>40	M	A	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	P		P
30	>40	M	P	P	P	P	P	P	P	P	P	P	P	I	I	S/I	S/I	S	P		P
135	>40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
357	>40	M	P	P	P	P	P	P	P	P	P	I	I	P	P	P	P	P	P		P
285	>40	M	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A		A

Table 6.20c Data for Schmorl's nodes in the St. Andrew, Fishergate sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
184	40-50	M	P	I	S/I	S/I	I	I	P#	S/I	I	I	S/I	I	P	P	P	P	P		P
238	>45	M	P	P	A	A	A	P	P	P#	P#	P	P	P#	P	P	P	P	P	P	P
350	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
349	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
389	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	S	P		P
113	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
136	>45	M	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
159	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
163	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
231	>45	M	P	P	P	P	P	P	P	P	P	P	P	I	I	S	S	P	P		P#
344	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A		A
60	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
131	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P		P#
42	>45	M	P	P	P	P	P	P	P	I	P	I	P	P	P	P	P	P	P		P
22	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
93	>45	M	A	A	A	A	A	P	P	P	P	P	P	P#	P	P	P	P	P		P
38	>45	M	P	P	P	P	P	P	P	P	I	I	P	S	P	P	A	A	A		A
45	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
154	>45	M	P	P	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P		P
88	>45	M	P	P	P	P	I	I	P	P	P	P	P	P	P	P	P	P	P		P
92	>45	M	A	A	A	A	A	P	P	P	P	P	P	P	P	P	P	P	P		P
237	>45	M	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
353	>45	M	P	P	P	P	P	P	P	P	P	P	P	A	P#	P	P	P	P		P#
280	>45	M	A	P	P	P	P	P	P	P	P#	P#	P#	A	P	P	P	P	P		P
314	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
333	>45	M	P	S	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P#		P
339	>45	M	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P#	P#	P	P#
251	>45	M	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
250	>45	M	P	P	P	P	P	P	P	P	P	P	I	I	P	P	S	P	S		P
96	>45	M	A	A	A	A	P	P	I	P	P	I	S	P	P	I	P	S	P		P
223	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
240	>45	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
172	adult	M	P	P	P	P	P	P	P	P	P	P	I	P	P	P	P	P	P		P
364	adult	?M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
52	adult	?M	A	A	A	P#	P#	P#	P#	P#	P#	P#	P#	P#	P#	P#	S/I	S/I	S/I		P
328	21-30	F	P	P	P	P	P	I	P	S/I	I	I	S	S	P	P	P	P	P		P
213	21-30	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P

Table 6.20d Data for Schmorl's nodes in the St. Andrew, Fishergate sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
218	21-30	F	P#	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
435	21-30	F	A	P	P	P	P	P	P	P	P	P	P	P	I	S/I	S/I	S	P		P
363	21-30	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
81	21-35	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
208	26-30	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
148	26-30	F	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
145	26-35	F	A	P	P	P	P	P	P	P	I	P	I	I	S/I	I	S/I	P	P		P#
158	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
216	26-35	F	A	P	P	P	P	P	P	I	I	I	P	P	P	P	P	P	P		P
391	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
253	30-40	F	P	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P		P
316	30-40	F	A	P	P	P	P	P	P	P	P	P	I	S	S	P	P	P	P		P
325	30-40	F	P#	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	SBO	P
347	30-40	F	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
372	30-40	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
65	30-40	F	P	P	P	P	P	P	P	P	P	P	P	P	I	P	P	P	P#		A
90	30-40	F	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
320	30-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
18	36-45	F	P	P	P	A	A	A	P	P	P	P	P	P	P	P	P	P	P		P
306	36-5	F	P	P	P	P	P	P	P	P	P	P	S	P	P	P	P	P	P		P
346	36-45	F	A	P	P	P	P	P	P	P	P	I	P	P	P	P	P	P	P		P
436	36-45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P#	P#	P#		P#
241	40-50	F	P	P	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P		P
242	40-50	F	A	P	P	P#	P	P	P	P	P	P	P	P	P	P	P	P	P#		P#
303	40-50	F	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A		A
371	40-50	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
153	>40	F	A	A	A	A	P	P	P	P	A	P	A	P	P	P	P	P	P		P
267	>40	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
410	>40	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
215	>45	F	P	P	P	P	P	P	P	P	I	P	P	P	P	P	P	P	P		P
305	>45	F	P	P	P	P	P	P	P	P	P	P	P	S/I	S	P	P	P	P		P
427	>45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P#
84	>45	F	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
102	>45	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		
378	adult	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
381	adult	F	A	P	P	P	A	A	A	A	A	P	P	P	P#	P	P	P	P		A
415	>40	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		A
225	21-30	?	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P

Table 6.20e Data for Schmorl's nodes in the St. Andrew, Fishergate sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#), and all occurrences of spina bifida occulta (SBO) were recorded.

Skele. No.	Age	Sex	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	Lumbar 6	Sacral 1
56O/1	<0>	neo	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A		A
562/1	<0>	neo	A	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	P		A
563/1	<0>	neo	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P	P		A
38	<0>	neo	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P		A
538/1	<0>	infant	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
51	1-2	infant	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P	A	A		A
52	1-2	infant	P	P	P	A	A	A	A	A	P	P	P	P	P	P	P	P	P		P
556	1-3	infant	A	A	A	I	P	P	P	A	A	A	A	A	A	A	A	A	A		A
60	3-5	child	A	A	A	A	A	A	A	A	P	P	P	P	P	P	P	P	P		A
54	7-10	child	P	P	P	P	P	P	A	A	A	A	A	A	A	A	P	S	S		P
56	7-10	child	P	P	P	P	P	P#	P#	P#	P#	P#	P#	P	P	P	P	P	P		A
17	11-12	youth	A	A	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A		A
36	11-12	youth	P	P	P	P	P	P	P	P	P	A	A	A	A	A	P	P	P		P
37	13-15	youth	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A		A
64	16-18	sub-adult	A	A	A	A	A	A	A	A	A	A	A	A	I	I	I	I	P		P
32	16-20	sub-adult	A	A	A	A	P	I	I	A	A	A	A	A	A	A	A	A	A		A
18	36-45	M	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P		P
26	>45	M	P	P	P	P	P	S	P	P	P	P	P	P	I	P	P	P	P		P
67	>45	M	A	A	A	A	A	P	P	P	P	P	P	P	A	P	P	P	P		P
4	21-25	F	P	P	P	P	P	P	P	P	P	P	P	P	S	S	P	P	P		P
29	21-30	F	P	P	P	P	P	P	P	P	P	P	P	P	S	P	P#	P	P		P
526/1	21-30	F	P	P	P	P	P	P	P	P	P	P	A	A	A	A	I	A	A		A
2	26-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
566/2	30-35	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P
567/2	30-35	F	A	A	A	P	P	P	P	P	P	P	P	S	S	P	S	P	P		P
1	>45	F	A	P	P	P	P	P	P	P	P	I	I	P	P	P	P	P	P		P
21	21-30	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	I	P	P		P
10	26-35	?F	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A		A
582	30-35	?F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	I	I		P
569/2	adult	?	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	P	P		A

Table 6.21 Data for Schmorl's nodes in the Tanners Row, Pontefract sample showing the levels and surfaces affected: superior (S) being the superior end plate of the vertebral body and inferior (I) being the inferior end plate of the vertebral body. Vertebra present (P), vertebra absent (A), and vertebra present but fractured (P#).

Appendix 7: Associated disorders and diseases, and other relevant conditions (clinical and archaeological)

Barcode	Age	Sex	Post Neural Arch Disorder	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Juvenile Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Loss of Disc Height	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
AB137	21	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	R	P
BC139	21	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	R	P
CD142	24	M	-	√	-	-	-	-	-	√	-	-	-	-	-	-	R	P
DE867	25	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
EF258	25	M	-	-	-	-	-	-	-	-	-	-	√	-	-	-	R	C
FG580	26	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
GH189	29	M	-	-	-	-	-	-	-	√	-	√	√	-	-	-	S/R	P
HJ251	29	M	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	P
JK314	30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
KL132	30	M	-	-	√	-	-	-	-	-	-	-	-	-	-	-	R	P
LM828	32	M	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	P
MN258	31	M	-	√	-	-	-	-	-	√	-	-	√	-	-	-	R	A/P
NP222	33	M	-	-	-	-	-	-	-	√	-	√	√	-	-	√	R	P
PR215	33	M	-	√	-	-	-	-	-	-	-	-	√	-	-	-	R	P
RS791	35	M	-	√	-	-	-	-	-	√	-	-	-	-	-	-	S	C
ST167	38	M	-	√	√	-	-	-	-	-	-	-	√	-	-	-	S	P
TU266	38	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
UV282	39	M		√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
VW323	40	M	-	√	-	-	-	-	-	-	-	-	-	-	-	-	R	P
WX334	40	M	-	-	-	-	√	√	-	-	-	-	-	-	-	-	R	A/P
XY224	41	M	-	-	-	-	-	-	-	-	-	-	√	-	-	-	R	P
YZ847	42	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
ZA314	44	M	-	√	-	√	-	-	√	-	-	-	√	-	-	-	R	A
BA150	46	M	√	-	-	√	-	-	√	-	-	-	√	-	-	-	R	P
CB144	46	M	√	-	√	-	-	-	-	-	-	-	-	-	-	-	R	P
DC141	47	M	-	√	-	√	-	-	√	-	-	-	√	-	-	-	S	P
ED557	47	M	-	-	√	√	-	-	-	-	-	-	-	-	-	-	R	P
FE450	48	M		√	-	-	-	-	-	-	-	-	√	-	-	-	R	P
GF324	48	M	-	-	-	√	-	-	√	-	-	-	-	-	-	-	R	P
HG423	52	M	-	√	-	-	-	-	-	-	-	-	-	-	-	√	R	P
JH189	58	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-	R	P
KJ285	61	M	-	√	√	√	-	-	-	-	-	-	√	-	-	-	S	P
LK216	64	M	-	√	-	√	-	-	-	-	-	-	√	-	-	-	S	P
ML679	65	M	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
NM209	89	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P

Table 6.22a Disorders and diseases associated with Schmorl's nodes occurrences for the males of the 1994-5 Pinderfields Hospital sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R) or smooth (S), and positions were recorded as anterior (A), central (C), or posterior (P).

Barcode	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Juvenile Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Loss of Disc Height	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type f Schmorl's node	Position of Schmorl's node
BA170	15	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P/C
CB132	19	F	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
DC122	23	F	-	-	-	-	-	-	-	√	-	-	√	-	-	-	R	P
ED268	24	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
FE205	28	F	√	-	-	-	-	-	-	-	-	√	-	-	-	-	R	P
GF338	29	F	-	-	-	-	-	-	-	-	-	-	√	-	-	-	R	P
HG370	32	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	C
JH979	34	F	-	√	-	√	-	-	-	-	-	-	√	√	-	-	S	P
KJ571	36	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	P
LK196	36	F	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
LM216	37	F	-	-	√	√	-	-	-	-	-	-	-	-	-	-	R	P
NM114	37	F	-	√	-	-	-	-	-	-	-	-	-	-	√	-	R	P
PN113	39	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
QP157	40	F	-	-	√	√	-	-	-	-	-	√	√	-	-	-	R	P
RQ266	41	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	P
SR174	41	F	-	-	√	-	-	-	-	√	-	-	-	-	-	-	R	P
TS166	41	F	-	-	-	-	-	-	-	√	-	-	-	-	-	-	R	C
UT208	41	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
VU276	44	F	-	√	-	-	-	-	-	-	-	-	√	-	-	-	S	P
WV289	44	-	-	-	-	-	-	-	√	-	-	-	-	-	-	-	R	P
XW530	45	F	-	-	-	-	-	√	-	-	-	-	-	-	-	-	R	P
YX259	46	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
ZY909	46	F	-	√	-	√	-	-	-	-	-	√	-	-	-	-	R	P
AZ662	47	F	√	√	-	-	-	-	-	√	-	-	-	-	-	-	R	P
AB126	49	F	-	-	-	-	-	√	√	-	-	-	√	-	-	-	R	P
BC100	50	F	-	-	-	-	√	-	-	-	-	-	√	-	-	-	R	P
CD843	51	F	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
DE207	51	F	-	-	-	√	-	-	-	-	-	√	-	-	-	-	R	P
EF246	52	F	-	-	√	-	-	-	-	-	√	-	√	-	-	-	R	P
FG469	54	F	-	-	-	-	-	-	-	√	-	-	-	-	-	-	R	A
GH533	57	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-	R	P
HJ326	61	F	-	-	√	√	-	-	-	-	-	-	√	-	-	-	R	C
JK134	62	F	-	-	√	-	-	-	-	√	-	-	√	-	-	-	S	P
KL837	70	F	√	-	√	-	-	-	-	-	-	-	-	-	-	-	R	P
LM574	72	F	-	√	√	-	-	-	-	-	-	-	√	√	-	-	R	P

Table 6.22b Disorders and diseases associated with Schmorl's nodes occurrences for the females of the 1994-5 Pinderfields Hospital sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R) or smooth (S), and positions were recorded as anterior (A), central (C), or posterior (P).

Barcode	Age	Sex	Post Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Juvenile Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Loss of Disc Height	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
ML578	23	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
NK265	24	M	-	-	-	-	-	-	-	-	-	-	√	-	-	√	S	P
PJ523	28	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	S	C
FJ661	30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	P
RB393	31	M	-	-	√	-	-	-	-	√	-	-	√	-	-	-	R	P
EC403	37	M	-	√	√	-	-	√	-	-	-	-	√	-	-	-	R	P
HF548	39	M	-	√	-	-	-	-	-	-	-	-	-	-	-	-	R	P
FS470	44	M		-	-	-	√	-	-	√	-	-	-	-	-	-	S	C
AT402	48	M	-	-	-	-	-	-	-	√	-	-	-	√	-	-	S	C
AS538	49	M	-	-	-	-	-	-	-	-	-	-	√	-	-	-	S	C
TJ587	50	M	-	-	-	-	-	-	-	√	-	-	-	-	-	√	S	P
RH409	50	M	-	-	-	√	-	-	-	-	-	-	√	-	-	-	S	C
JS541	58	M		√	√	-	-	-	-	-	-	-	-	-	-	-	R	P
EH473	64	M	-	√	√	-	-	-	-	-	-	-	√	-	-	-	R	P
AB537	15	F	-	-	-	-	√	√	-	-	-	-	-	-	-	-	R	P
BC585	19	F	-	√	√	-	-	-	-	-	-	-	-	-	-	-	R	P
CD444	31	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	P
DE546	33	F	-	√	-	-	-	-	-	-	√	-	√	-	-	-	R	P
EF531	35	F	-	√	-	-	-	-	-	-	√	√	-	-	-	-	R	P
FG133	36	F	-	-	-	-	-	-	-	-	-	-	√	-	-	-	S	P
HJ463	36	F	√	√	-	-	-	-	-	√	-	-	-	-	-	-	R	P
JK389	36	F	-	√	-	-	√	-	-	-	-	-	√	-	-	-	S	C
KL601	37	F	-	√	-	-	-	√	--	-	-	-	√	-	-	-	R	P
LM491	37	F	-	-	-	-	-	-	-	-	-	-	√	-	-	-	R	P
MN353	38	F	-	-	-	-	-	-	-	√	-	-	√	-	-	-	R	P
NP417	39	F	-	-	-	-	-	√	√	-	-	-	√	-	-	-	R	A
PQ322	41	F	-	√	-	-	-	-	-	-	-	-	√	-	-	-	S	P
QR383	41	F	-	√	-	-	-	-	-	-	-	-	√	-	-	-	R	C
RS476	44	F	-	-	-	-	-	-	√	-	-	-	-	-	-	-	S	P
ST545	44	F	-	√	√	√	-	-	-	√	-	√	√	-	-	-	R	A/P
TU256	48	F	-	√	-	-	-	-	-	√	-	-	√	-	-	-	R	P
UV451	48	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-	S	P
VW473	50	F	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
WX474	57	F	-	√	-	√	-	-	-	-	-	-	√	-	-	-	R	P
XY476	58	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	C
YZ429	60	F	-	√	-	-	-	√	-	√	-	-	√	-	-	-	R	A
BA595	60F	F	-	√	-	√	-	-	√	-	-	-	√	-	-	-	R	P
CB451	63	F	-	√	-	√	-	-	-	√	-	-	√	-	-	-	S	C
DC274	71	F	-	-	-	-	√	-	-	-	-	-	√	-	-	-	S	C
ED545	82	F	-	√	√	√	-	-	-	√	-	√	√	-	-	-	R	P

Table 6.23 Disorders and diseases associated with Schmorl's nodes occurrences for the males and females of the 1995 Pinderfields Hospital sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R) or smooth (S), and positions were recorded as anterior (A), central (C), or posterior (P).

Barcode	Age	Sex	Post Neural Arch Defect	Osteoarthritis	Osteoporosis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Juvenile Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Loss of Disc Height	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
123AB	7	M	-	-	-	-	-	-	√	√	-	-	-	-	-	-	S	C
123DE	9	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	R	A
122BA	9	M	√	-	√	-	-	-	-	√	-	-	-	-	-	-	R	P
373GH	10	M	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	A
101MN	11	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	S	P
121YZ	12	M	-	-	-	-	-	-	√	-	-	√	-	√	√	-	R	P
160CD	132	M	-	√	-	-	-	-	-	-	-	√	-	-	-	-	S	C/A
170HJ	13	M	-	-	-	-	-	-	-	-	-	√	-	-	-	√	R	A
353ST	13	M	-	-	-	-	-	-	-	√	-	-	-	-	-	-	S	P
170EF	14	M	-	-	-	-	-	-	-	√	√	√	-	-	-	-	S/R	A/P
120NP	14	M	-	-	-	-	-	-	-	-	√	√	-	-	√	√	R	P
310KL	6	F	-	-	-	-	-	-	-	-	√	√	-	-	-	-	R	P
372FG	10	F	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	C
121JK	11	F	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	A
121VW	11	F	-	-	-	-	-	-	-	-	√	√	-	-	-	-	S	P
170BC	11	F	-	-	√	-	-	-	-	-	-	√	-	-	-	-	R	C/A
364LM	12	F	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	P
121TU	12	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	C/P
318RS	13	F	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	C
346XY	15	F	-	-	-	-	-	-	√	-	√	√	-	-	-	-	S	P
303ZA	16	F	-	-	-	-	-	-	√	√	-	√	-	-	-	-	R	C
308PQ	16	F	-	-	-	-	-	-	-	-	-	√	-	-	-	-	R	A

Table 6.24 Disorders and diseases associated with Schmorl's nodes occurrences for the sub-adults of the Royal Hospital for Sick Children, Edinburgh sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R) or smooth (S), and positions were recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Disorder	Osteoarthritis	Osteoporosis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
66	<0	peri-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	<0	peri-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	<0>	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	0-1	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67	2-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	3-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	4-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	4-8	child	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
47	4-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	4-8	chid	-	√	-	√	√	-	-	-	-	-	-	-	-	-	-
28	7-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	<10>	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53b	10-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	12-18	youth	-	-	-	√	√	-	-	-	-	-	-	-	-	R	C
19	15-16	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	<18	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	18-25	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	26-35	M	-	√	√	√	√	√	-	-	-	-	-	-	-	-	-
36	26-35	M	-	√	-	√	√	√	-	-	-	-	-	-	-	R/T	C/P
38	26-35	M	-	√	-	√	-	-	-	-	√	-	-	-	-	S	C/P
45	30-40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	30-45	M	-	√	√	√	-	-	√	-	-	-	-	-	-	R	A/C/P
72	30-45	M	-	√	-	√	√	√	-	-	-	-	-	-	-	-	-
14	36-45	M	-	√	√	√	√	√		-	-	√	-	-	R	P	
21	36-45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	R	P
68	26-35	F	-	√	√	√	√	-	-	-	-	√	√	-	R	P	
46	26-35	F	-	√	√	√	√	-	-	-	-	-	-	-	-	-	-
64	26-45	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56	26-45	F	-	√	√	√	-	-	-	-	-	-	-	-	-	R	P
33	30-40	F	-	√	√	-	-	-	-	-	-	-	-	-	-	-	-
2	30-40	F	-	√	-	√	-	√	-	-	-	-	-	-	-	-	-
54	36-45	F	-	-	-	-	-	√	√	-	-	-	-	-	-	-	-
18	36-45	F	-	√	-	√	-	√	-	-	-	-	-	-	-	R	P
20	36-45	F	-	√	-	√	√	√	√	-	-	-	-	-	-	-	-
4	>40	F	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
44	>45	F	-	√	-	√	√	-	-	-	-	-	-	-	-	G/T	C
52	>45	F	-	√	√	√	√	√	-	-	-	-	-	-	-	R	P
57	36-45	?F	-	√	√	√	√	-	√	-	-	-	-	-	-	-	-
8	>40	?	-	√	-	√	√	√	-	-	-	-	-	-	-	R/S	P
9b	>40	?	-	√	-	-	-	√	-	-	-	-	-	-	-	-	-
62	adult	?	-	-	-	-	-	-	-	-	-	-	√	-	-	-	-

Table 6.25 Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the Captain's Cabin, Dunbar sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R), smooth(S), grape(G), or tunnelling(T), and position was recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Loss of Disc Height	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
113	<0	per-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
296	<0	peri-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	<0>	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
120	<0>	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
179	2-4	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	3-4	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	4-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
284	4-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
280	4-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
252	5-6	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
299	5-6	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
143	5-7	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
218	6-7	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
310	7-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	7-9	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300	7-9	child	-	-	-	-	-	-	-	-	-	-	-	-	-	S	C
78	7-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
233	8-9	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
270	8-9	child	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
285	8-9	child	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107	11-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
324	11-13	youth	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
128	12-13	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223	16-20	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	√	-	-
224	16-20	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
297	21-30	M	-	-	-	√	-	√	-	-	-	-	-	-	-	-	-
246	21-35	M	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
303	21-35	M	√	-	-	√	-	-	-	-	-	-	-	-	-	R	A/P
247	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
278	26-35	M	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
335	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	26-35	M	√	√	-	√	√	-	-	-	-	-	-	-	√	R	P
97	26-35	M	-	-	-	√	-	-	-	-	-	-	-	-	-	-	-
121	26-35	M	√	-	-	-	-	-	-	-	-	-	-	-	-	R	C
207	30-45	M	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
325	36-45	M	√	-	-	√	-	-	-	-	-	-	-	-	-	-	-
234	36-45	M	-	√	√	√	-	√	√	-	-	-	-	-	-	-	-
265	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
323	36-45	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-	-
85	36-45	M	-	√	√	√	-	-	√	-	-	-	-	-	-	R	C/P

Table 6.26a Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the Hirsel, Coldstream sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R), smooth(S), and position was recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
104	36-45	M	-	-	-	√	-	-	-	-	-	-	-	-	-	-
153	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
172	36-45	M	√	-	-	-	-	-	-	-	-	-	-	-	-	-
222	36-45	M	-	√	√	-	-	-	-	-	-	-	√	-	R	P
108	>45	M	-	√	-	√	-	-	√	-	-	-	-	-	-	-
198	>45	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-
209	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	R	C
276	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-
279	>45	M		√	-	√	--	-	-	-	-	-	-	-	-	-
282	>45	M	-	√	√	√	-	-	-	-	-	-	-	-	R	C
288	>45	M	-	√	-	√	-	-	√	-	-	-	-	-	R	P
292	>45	M	-	√	√	√	-	-	√	-	-	-	-	-	-	-
306	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-
232	16-20	?M	-	-	-	-	-	-	-	-	-	-	-	√	-	-
188	16-20	?M	-	√	-	-	-	-	-	-	-	-	-	-	-	-
27	26-35	?M	√	√	-	√	-	-	-	-	-	-	-	-	-	-
84	>45	?M	-	√	√	√	√	-	-	-	-	-	-	-	-	-
289	16-25	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
309	16-20	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
190	21-25	F	-	-	-	-	-	√	-	-	-	-	-	-	R	C/P
200	21-25	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
255	21-25	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
314	21-30	F	-	√	-	-	√	-	-	-	√	-	-	-	-	-
293	21-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
331	26-35	F	-	-	-	-	√	-	-	-	-	-	-	-	-	-
26	26-35	F	-	-	√	-	-	-	-	-	-	-	-	-	-	-
65	26-35	F	-	-	-	-	-	-	-	-	-	-	-	√	R	A
147	26-35	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-
210	26-35	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
174	36-45	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	36-45	F	-	-	-	√	-	-	√	-	-	-	-	-	-	-
94	36-45	F	-	√	√	-	-	-	-	-	-	-	-	-	-	-
184	36-45	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-
225	36-45	F	-	-	√	-	-	-	-	-	-	-	-	-	-	-
243	36-45	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
239	>45	F	-	√	√	√	-	-	-	-	-	-	-	-	-	-
240	>45	F	-	√	-	√	-	-	-	-	-	-	-	-	-	-
294	>45	F	-	-	-	-	-	-	-	-	-	-	-	-	R	P
144	>45	?F	-	√	√	√	-	-	-	-	-	-	-	-	R	A
187	16-18	?F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
221	26-35	?F	-	√	-	-	-	-	-	-	-	-	-	-	-	-
173	36-45	?F	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.26b Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the Hirsel, Coldstream sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R), smooth(S), and position was recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteoporosis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
454	6-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
463	6-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
471	6-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
444	8-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
470	8-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
483	8-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
498	8-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
445	11-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
461	11-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
552	11-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
468	11-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
452	11-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500	12-15	youth	-	-	-	√	-	-	-	-	-	-	-	-	-	-	-
538	12-15	youth		√	-	√	-	-	-	-	-	-	-	-	-	-	-
447	12-18	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
460	12-20	sub-adult	-	-	-	√	-	-	-	-	-	-	-	-	-	R	C
508	16-18	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
506	16-20	sub-adult	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-
532	18-25	M	-	-	-	-	-	-	√	-	√	-	-	-	-	-	-
554	18-25	M	-	√	-	√	-	-	-	-	-	-	-	-	-	R	C/P
531	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
561	36-45	M	-	√	-	√	-	-	-	-	-	-	-	-	√	-	-
511	>45	M	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
504	>45	M	√	-	-	√	-	-	-	-	-	-	-	-	-	R	A/C/P
537	>45	?M	√	√	√	√	-	-	-	-	-	-	-	-	-	R	P
558	16-25	F	-	-	-	-	-	-	-	-	-	-	-	-	-	S	C
569	16-25	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
535	36-45	F	-	√	-	√	-	-	-	-	-	-	-	-	-	-	-
556	36-45	F	-	-	-	√	-	-	-	-	-	-	√	-	√	S	A/P
519	>45	F	-	√	-	√	√	√	-	-	-	-	-	-	-	G	P
559	>45	F	-	-	-	√	√	√	-	-	-	-	-	-	-	-	-
539	36-45	?F	√	-	-	-	-	-	√	-	√	-	-	-	-	R	A/C/P
549	<25	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
482	<25	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
509	26-35	?	√	√	-	√		-	-	-	√	-	-	-	-	R	A/C/P
507	36-45	?	-	√	-	√	-	-	-	-	-	-	-	-	-	-	-
517	36-45	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
510	>45	?	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.27 Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the Whithorn Priory sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R), smooth(S), or grape (G), and position was recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Disorder	Osteophyte Formation	Osteoporosis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
194	<1>	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
269	1-2	infant	-	-	-	-	-	-	-	-	-	√	-	-	-	-	-
272	1-2	infant	-	-	-	-	-	-	-	-	-	√	-	-	-	-	-
431	1-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100	1-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
317	1-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
271	2-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
360	2-3	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
359	3-4	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
419	3-6	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
287	4-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
384	4-6	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
407	4-6	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
217	5-7	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
412	5-7	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
277	5-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
292	5-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
275	5-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300	5-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76	6-8	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
278	6-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
434	6-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
327	7-9	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
233	7-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	8-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
193	10-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
358	11-14	youth	-	-	-	-	-	-	-	-	√	√	-	-	-	-	-
348	11-14	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
354	12-14	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
318	12-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	13-16	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	13-18	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
261	14-16	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
370	16-20	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
323	17-20	sub-adult	-	√	-	-	√	√	-	-	-	-	-	-	-	-	-
190	17-20	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	S	P
351	18-25	M	-	-	-	-	√	-	-	-	-	-	-	-	-	R	A
379	18-25	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
268	18-25	M	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P

Table 6.28a Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the St. Andrew, Fishergate sample. Schmorl's nodes were recorded by type and position; types were recorded as rough (R), or smooth(S), and position was recorded as either anterior (A) or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
56	21-30	M	-	-	-	-	√	-	-	-	-	-	-	-	-	-
61	21-30	M	-	-	-	√	√	-	-	-	-	-	-	-	R	P
149	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	R	C
262	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
294	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
373	21-30	M	-	-	-	√	√	-	-	-	-	-	-	-	-	-
377	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
413	21-30	M	-	-	-	√	-	-	-	-	-	-	-	-	-	-
161	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	R/S	A/P
256	21-30	M	-	√	√	-	-	-	-	-	-	-	-	-	-	-
57	21-30	M	-	-	-	√	-	-	-	-	-	-	-	-	R	P
58	21-30	M	-	-	-	√	-	√	-	-	-	-	-	-	-	-
204	21-30	M	-	-	-	-	-	-	-	-	-	-	√	√	-	-
226	21-30	M	-	-	-	-	-	-	√	-	-	-	-	-	-	-
355	21-30	M	√	-	-	-	-	-	-	-	√	-	-	-	-	-
283	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
329	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
414	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	S	C
430	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	21-30	M	√	-	-	-	√	√	-	-	-		-	-	R	A/C/P
50	21-30	M	-	-	-	-	-	√	-	-	-	-	-	-	-	-
49	21-30	M	-	-	-	-	-	-	-	-	-	-	-	-	S	P
138	26-30	M	-	-	-	-	-	-	√	-	-	-	-	-	-	-
249	26-30	M	-	√	√	-	-	-	-	-	-	-	-	-	-	-
164	26-35	M	-	-	√	-	√	-	√	-	-	-	-	-	-	-
258	26-35	M	-	-	-	√	-	-	-	-	-	-	-	-	R/S/T	C/P
259	26-35	M	-	-	-	√	-	-	-	-	-	-	-	-	R	C/P
73	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89	26-35	M	-	-	-	√	-	-	-	-	-	-	-	-	R	P
104	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
140	26-35	M	-	-	-	-	-	-	-	-	√	-	-	-	R	P
245	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	R	C
188	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
192	26-35	M	-	√	√	-	-	-	-	-	-	-	-	-	-	-
273	26-35	M	-	-	-	-	√	-	-	-	-	-	-	-	-	-
284	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
340	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
356	26-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
101	26-40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
365	26-40	M	-	-	-	√	-	-	-	-	-	-	-	-	R	A
77	26-40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
141	26-45	M	-	√	-	√	-	√	-	-	-	-	-	-	-	-

Table 6.28b Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the St. Andrew, Fishergate sample. Schmorl's nodes were recorded by type and position; type was recorded as rough (R), smooth(S) or tunnelling (T), and position as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
123	30-35	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
109	30-40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
263	30-40	M	-	√	-	√	-	-	-	-	-	-	-	-	R	C/P
299	30-40	M	-	-	√	√	-	-	-	-	-	-	-	-	R	P
7	30-40	M	-	√	-	√	√	√	√	-	-	-	-	-	R	P
9	30-40	M	-	√	-	-	√	√	-	-	-	-	-	-	-	-
16	30-40	M	-	√	-	-	√	-	-	-	√	-	-	-	R	A
239	30-40	M	-	√	-	√	-	√	√	-	-	-	-	-	T	P
243	30-40	M	-	-	-	-	-	-	-	-	-	-	-	√	-	-
276	30-40	M	-	√	-	√	-	√	√	-	-	-	-	-	-	-
289	30-40	M	-	-	-	√	-	-	-	-	-	-	-	-	R	C
366	30-45	M	-	√	-	-	-	√	-	-	-	-	-	-	-	-
162	30-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
151	30-45	M	-	-	√	-	-	-	-	-	-	-	-	-	-	-
234	36-40	M	-	√	√	√	-	√	-	-	-	-	-	-	-	-
369	36-40	M	-	√	-	√	√	-	-	√	√	-	-	-	-	-
99	36-45	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-
417	36-45	M	-	-	-	√	-	-	-	-	-	-	-	-	-	-
6	36-45	M	√	√	-	-	√	√	-	-	-	-	-	-	R/S	C/P
23	36-45	M	-	√	-	√	-	√	-	-	-	-	-	-	R	A/P
25	36-45	M	-	√	-	√	√	-	√	-	-	-	-	-	-	-
62	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
222	36-45	M	-	√	-	-	-	-	√	-	-	-	-	-	-	-
235	36-45	M	-	-	√	√	-	-	-	-	-	-	-	-	-	-
380	36--45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-
14	36-45	M	-	√	-	√	√	√	√	-	-	-	-	-	R	C
106	36-45	M	-	√	√	-	-	-	-	-	-	-	-	-	-	-
156	36-45	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-
53	40-45	M	-	-	-	-	-	-	√	-	-	-	-	-	R	P
144	40-45	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
383	>40	M	√	√	-	√	-	-	-	-	-	-	-	-	R	P
227	>40	M	-	√	-	√	-	√	-	-	√	-	-	-	-	-
130	>40	M	-	√	√	√	-	-	√	-	-	-	-	-	R	A/C/P
143	>40	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	>40	M	-	√	-	√	√	√	√	-	√	-	-	-	-	-
30	>40	M	-	√	-	√	√	√	-	-	√	-	-	-	R	C/P
135	>40	M	-	√	-	√	√	-	-	-	-	-	-	-	-	-
357	>40	M	-	-	-	-	-	-	-	-	-	-	-	-	R	P
285	>40	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-

Table 6.28c Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the St. Andrew, Fishergate sample. Schmorl's nodes were recorded by type and position; type was recorded as rough (R), smooth (S) or tunnelling, and position was recorded as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
184	40-50	M	-	√	-	-	-	-	-	-	-	-	-	-	R/S	C/P
238	>45	M	-	√	√	√	-	-	√	-	-	-	-	-	-	-
350	>45	M	-	√	-	√	-	√	-	-	-	-	-	-	-	-
349	>45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
389	.45	M	-	-	-	√	√	-	-	-	-	-	-	-	R	A
113	>45	M	-	-	-	√	-	-	-	-	-	-	-	-	-	-
136	>45	M	-	√	√	√	√	-	√	-	-	-	-	-	-	-
159	>45	M	-	√	-	√	-	√	√	-	-	-	-	-	R	P
163	>45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
231	>45	M	-	√	√	√	√	√		-	√	-	-	-	S	P
344	>45	M	-	√	-	√	-	√	-	-	-	-	-	-	-	-
60	>45	M	-	√	-	√	√	-	-	-	-	-	-	-	-	-
131	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-
42	>45	M	-	√	-	√	-	-	√	-	-	-	-	-	R	C
22	>45	M	-	√	-	√	√	√	-	√	√	-	-	-	-	-
93	>45	M	-	√	-	√	-	√	-	-	√	-	-	-	-	-
38	>45	M	-	√	√	√	√	√	-	-	√	-	-	-	T	P
45	>45	M	-	√	-	√	√	-	√	-	-	-	-	-	-	-
154	>45	M	-	√	-	√	-	√	√	-	-	-	-	-	-	-
88	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	R	P
92	>45	M	-	√	-	√	-	√	-	-	-	-	√	-	-	-
237	>45	M	-	√	√	√	-	-	-	-	-	-	-	-	-	-
353	>45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
280	>45	M	-	√	√	√	-	-	-	-	√	-	-	-	-	-
314	>45	M	-	√	-	√	√	-	-	-	-	-	-	-	-	-
333	>45	M	-	-	-	√	-	√	√	-	-	-	-	-	R	P
339	>45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
251	>45	M	-	√	-	√	-	-	-	-	-	-	-	-	-	-
250	>45	M	-	√	√	√	-	√	-	-	-	-	-	-	R	P
96	>45	M	-	√	√	√	-	√	√	-	-	-	-	-	R	A/C/P
223	>45	M	-	√	√	√	-	√	-	-	-	-	-	-	-	-
240	>.45	M	-	√	√	√	-	√	-	-	-	-	-	-	-	-
172	adult	M	-	√	√	√	√	-	√	-	-	-	-	-	-	-
364	adult	?M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	adult	?M	-	√	√	√	√	-	-	-	-	-	-	√	R	C
328	21-30	F	-	-	-	√	-	-	-	-	√	-	-	-	R/T	C/P
213	21-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.28d Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the St. Andrew, Fishergate sample. Schmorl's nodes were recorded by type and position; type was recorded as rough (R), smooth(S), or tunnelling(T), and position as anterior (A), central (C), or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteopenia Osteoporosis	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
218	21-30	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-
435	21-30	F	-	-	-	√	-	√	-	-	-	-	-	-	R	C
363	21-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	21-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
208	26-30	F	-	-	√	√	-	-	√	-	-	-	-	-	-	-
148	26-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
145	26-30	F	-	-	-	√	-	-	√	-	-	-	-	-	R	P
158	26-30	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
216	26-35	F	-	-	-	-	-	-	√	-	-	-	-	-	R	P
391	26-35	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
253	30-40	F	-	√	-	√	-	-	-	-	-	-	-	-	-	-
316	30-40	F	-	-	√	√	-	-	-	-	-	-	-	-	R	P
325	30-40	F	-	-	-	√	-	-	-	-	-	-	-	-	-	-
347	30-40	F	-	-	-	√	-	-	-	-	-	-	-	-	-	-
372	30-40	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	30-40	F	-	-	√	-	-	-	-	-	-	-	-	-	R	C
90	30-40	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
320	30-45	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	36-45	F	-	√	-	√	-	-	-	-	-	-	-	-	-	-
306	36-45	F	-	-	-	-	-	-	-	-	-	-	√	√	R	P
346	36-45	F	-	√	-	√	-	-	-	-	-	-	-	-	R	P
436	36-45	F	-	-	-	√	-	-	-	-	-	-	-	-	-	-
241	40-50	F	-	-	√	√	-	-	√	-	-	-	-	-	-	-
242	40-50	F	-	√	√	√	-	√	√	-	-	-	-	-	-	-
303	40-50	F	-	-	√	√	√	-	-	-	-	-	-	-	-	-
371	40-50	F	-	√	-	√	√	-	-	-	-	-	-	-	-	-
153	>40	F	-	√	√	√	-	-	-	-	-	-	-	-	R	P
267	>40	F	√	√	√	√	-	√	√	-	-	-	-	-	-	-
410	>40	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-
215	>45	F	-	√	√	√	√	√	√	-	-	-	-	-	R	P
305	>45	F	-	√	√	√	√	-	-	-	-	-	-	-	R	P
427	>45	F	-	√	√	√	-	-	√	-	-	-	-	-	-	-
84	>45	F	-	√	-	√	-	√	√	-	-	-	-	-	-	-
102	>45	F	-	√	√	√	√	-	-	-	-	-	-	-	-	-
378	adult	?F	-	√	-	√	√	-	-	-	-	-	-	-	-	-
381	adult	?F	-	-	-	√	-	-	-	-	-	-	-	-	-	-
415	>40	?F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
225	21-30	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-
134	adult	?	-	√	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.28e Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the St. Andrew, Fishergate sample. Schmorl's nodes were recorded by type and position; type was recorded as rough (R) or smooth(S), and position as central (C) or posterior (P).

Skele. No.	Age	Sex	Posterior Neural Arch Defect	Osteoarthritis	Osteoporosis	Osteopenia	Osteophyte Formation	Mild Osteochondritis	Loss of Lordosis	Scoliosis	Sclerotic End Plates	Irregular End Plates	Retrolisthesis	Spondylolisthesis	Spondylolysis	Type of Schmorl's node	Position of Schmorl's node
560/1	<0>	neo-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
562/1	<0>	neo-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
563/1	<0>	neo-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
538/1	<0>	neo-natal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	1-2	infant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
556	1-3	infant	-	√	-	√	√	-	-	-	-	-	-	-	-	G?	P
60	3-5	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54	7-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	R	P
56	7-10	child	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	11-12	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	1-12	youth	-	-	-	-	-	-	-	-	-	-	-	√	√	-	-
37	13-15	youth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
64	16-18	sub-adult	-	-	-	√	√	-	-	-	-	-	-	-	-	-	-
32	16-20	sub-adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	36-45	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	>45	M	-	√	-	√	√	√	-	-	-	-	-	-	-	R	C
67	>45	M	-	√	√	√	√	-	-	-	-	-	-	-	-	-	-
4	21-25	F	-	-	-	-	-	-	-	-	√	-	-	-	-	R	C
29	21-25	F	-	-	-	-	√	-	-	-	-	-	-	-	-	R	P
526/1	21-30	F	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
2	26-35	F	-	√	-	-	√	-	-	-	-	-	-	-	-	-	-
566/2	30/35	F	-	√	√	√	-	-	-	-	-	-	-	-	-	-	-
567/2	30-35	F	-	√	√	√	-	-	-	-	-	-	-	-	-	S	C
1	>45	F	-	√	√	√	-	√	-	-	-	-	-	-	-	R	C
21	26-35	?F	-	-	-	-	-	-	-	-	-	-	-	-	-	R	C
10	26-35	?F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
582	30-35	?F	-	√	-	-	-	-	-	-	-	√	-			R	P
569/2	adult	?	-	√	-	-	√	-	-	-	-	-	-	-	-	-	-

Table 6.29 Disorders and diseases associated with Schmorl's nodes occurrences for the individuals of the Tanners Row, Pontefract sample. Schmorl's nodes were recorded by type and position; type was recorded as rough (R), smooth(S), or Grape (G)., and position was recorded as central (C), or posterior (P).

Appendix 8: Other relevant information

Barcode	Age	Sex	Low Back Pain	Left leg pain	Right leg pain	Referred for treatment	Case History
AB137	21	M	√	√	√		back stiffness in the morning; previous right knee injury
DCI39	21	M	√				nothing of note
CD142	24	M	√				recurring low back pain
DE867	25	M	√				chronic low back pain
EF258	25	M	√				sciatica; swelling over dorsum of L5/ S1
FG580	26	M					nothing of note
GH189	29	M	√				low back pain for seven years
HJ251	29	M	√	√	√		"creaking" in the back
JK314	30	M	√			Orthopaedics	nothing of note
KL132	30	M	√			Rheumatology	nothing of note
LM82	30	M	√			Orthopaedics	having a course of physiotherapy
MN258	31	M	√				chronic low back pain
NP222	33	M	√				chronic low back pain; spondylolysis of L4/L5
PR215	33	M	√			Rheumatology	wedging of T11/T12
RS791	35	M	√				nothing of note
ST167	38	M	√				large Schmorl's node at T12
TU266	38	M				Orthopaedics	having course of physiotherapy; 6 lumbar vertebrae
UV282	39	M	√				nothing of note
VW323	40	M					nothing of note
WX334	40	M	√				left sided sacralisation
XY224	41	M	√				large Schmorl's nodes
YZ847	42	M	√				right sided sciatica
ZA314	44	M	√				left sided sciatica
BA150	46	M	√				spasm causing loss of flexion and extension
CB144	46	M					nothing of note
DC141	47	M	√				stiffness
ED557	47	M	√				nothing of note
FE450	48	M	√				Large Schmorl's node which has a white opaque centre
GF324	48	M					repeat x-ray examination in 1998
HG423	52	M	√				deceased
JH189	58	M					nothing of note
KJ285	61	M	√				osteophytes to the left of the Schmorl's nodes
LK216	64	M	√				nothing of note
ML679	65	M	√			Orthopaedics	left sided sciatica
NM209	89	M	√				nothing of note

Table 6.30a Other relevant information for the males of the 1994 – 5 Pinderfields Hospital sample

Barcode	Age	Sex	Low Back Pain	Left Leg Pain	Right Leg Pain	Referred for treatment	Case History
BA170	15	F	√			Orthopaedics	Low back pain for two months
CB132	19	F	√			Orthopaedics	nothing of note
DC122	23	F	√			Back pain clinic	care assistant; sclerotic end plates after lifting injury
ED268	24	F					pain between scapulae, ? Early Scheuermann's disease
FE205	28	F	√	√	√		limited flexion; fractured end plate
GF338	29	F					posterior end plate separation, aneriot Schmorl's node
HG370	32	F					nothing of note
JH979	34	F	√			Neurology	pain starts at the height of the second lumbar vertebra
KJ571	36	F					pain after whiplash injury
LK196	36	F					previous road traffic injury
LM216	37	F	√				nothing of note
NM114	37	F				Orthopaedics	nothing of note
PN113	39	F	√				reduced lordosis and reduced thoracic curve
QP157	40	F	√			Physiotherapy	x-ray examination repeated in 1998
RQ266	41	F				Physiotherapy	nothing of note
SR174	41	F	√				nothing of note
TS166	41	F					x-ray examination repeated in 2000
UT208	41	F				Rheumatology	nothing of note
VU276	44	F					six lumbar vertebrae; paraesthesia
WV289	44	F					nothing of note
XW530	45	F	√				low back pain on straightening; transitional vertebra L5
YX259	46	F	√				calcified discs at T10/T11; unfused epiphyseal ring at L5
ZY909	46	F					nothing of note
AZ662	47	F				Orthopaedics	nothing of note
AB126	49	F					nothing of note
BC100	50	F				Physiotherapy	nothing of note
CD843	51	F				Physiotherapy	nothing of note
DE207	51	F				Orthopaedics	nothing of note
EF246	52	F				Neurology	nothing of note
FG469	55	F	√		√	Orthopaedics	sciatica
GH533	57	F					nothing of note
HJ326	61	F	√			Radiology meeting	calcification within the disc space
JK134	62	F	√			Orthopaedics	anterior osteophytes
KL837	70	F				Rheumatology	x-ray examination repeated 2000
LM574	72	F				Orthopaedics	nothing of note

Table 6.30b Other relevant information for the females of the 1994–5 Pinderfields Hospital sample

Barcode	Age	Sex	Low Back Pain	Left Leg Pain	Right Leg Pain	Referred for treatment	Case History
ML578	23	M	√			Neurology	irregular end plates; low back pain for six months
NK265	24	M	√				previous x-ray examination reported as no abnormality detected
PJ523	28	M	√			Physiotherapy	low back pain for three years
FJ661	30	M					stiff back
RB393	31	M					low back pain for six months
EC403	37	M	√				nothing of note
HF548	39	M	√				back pain as a child, follow up x-ray examination suggested
FS470	44	M	√			Orthopaedics	previous x-ray examination reported as no abnormality detected
AT402	48	M	√			Neurology	nothing of note
AS538	49	M					early calcification of longitudinal ligaments
TJ587	50	M					recurring low back pain; was examined in Accident and Emergency in 2001
RH409	50	M	√				stiff back
JS451	58	M	√	√	√	Physiotherapy	sciatica
EH473	64	M	√				no previous radiographs; sudden onset of pain, checking phosphate levels
AB537	15	F	√			Orthopaedics	
BC585	19	F	√				low back pain for six months; irregular end plates
CD444	31	F	√				low back pain for two months; /early Scheuermann's disease
DE546	33	F	√			Orthopaedics	sent to Orthopaedics in 2001
EF531	35	F				Orthopaedics	x-ray examination repeated in 1999
FG133	36	F	√			Leeds Infirmary	low back pain for three months
HJ463	36	F				Ophthalmic	posterior soft tissue swelling; posterior neural arch defect
JK389	36	F	√				noting of note
KL601	37	F	√	√		MRI	Magnetic resonance imaging; low back pain for five months
LM491	37	F	√		√		nothing of note
MN353	38	F	√			Physiotherapy	nothing of note
NP317	39	F	√		√	Rheumatology	loss of reflexes left leg; ?early Scheuermann's disease
PQ322	41	F					thoracic spondylosis
QR383	41	F	√		√		nothing of note
RS476	44	F					limited flexion and extension
ST545	44	F	√			Physiotherapy	chronic back pain
TU256	48	F	√			Leeds Infirmary	pain left side of thoracic and lumbar spine; degenerative changes
UV451	48	F	√				previous x-ray examination in 1992; continuing pain
VW473	50	F	√				degenerative changes
WX474	57	F	√		√	Surgical ward	low back pain for three months
XY476	58	F	√				nothing of note
YZ429	60	F	√				persistent low back pain
BA595	60	F					nothing of note
CB451	63	F					tender back
DC274	71	F			√		pain and tenderness right femur and shin
ED454	82	F	√			Urology	nothing of note

Table 6.31 Other relevant information for the individuals of the 1995 Pinderfields Hospital sample

Barcode	Age	Sex	Low Back Pain	Case History
123AB	7	M	√	loss of lumbar lordosis
123DE	9	M	√	leg length radiographed, reported as loss of "bone density"
122BA	9	M	√	fusion defects of several posterior elements of the lumbar vertebrae; transitional vertebra at L1; general skeletal osteoporosis
373GH	10	M	√	fell from a height; concavity at T5 with loss of vertebral height
101MN	11	M	√	transitional vertebra at the L5/S1 junction; right side only
121YZ	12	M	√	grade 1 spondylolisthesis; reduced vertebral height; taking steroids
160CD	13	M	√	recent fall; pain++, radiating to left hip; Schmorl's nodes to the right of the centrum
170HJ	13	M	√	taken to Orthopaedic hospital for MRI, querying spondylolysis
353ST	13	M	√	exaggerated lumbar lordosis
170EF	14	M	√	active Scheuermann's disease with end plate disruption
120NP	14	M	√	increased sclerosis at L2; spondylolysis at L5/S1 with grade 2 spondylolisthesis
310KL	6	F	√	bi-lateral leg pain; soft tissue mass protruding at the level of L2/3
372FG	10	F	√	fell from a height twelve hours ago; presenting with pain on flexion and extension
121JK	11	F	√	tender at L3/L4; first x-ray examination was negative for Schmorl's nodes
121VW	11	F	√	transitional vertebra at L5/S1 junction (sacralisation)
170BC	11	F	√	pain when rising from a sitting position
364LM	12	F	√	fell from a height; radiographs not reported
121TU	12	F	√	L2/L3 congenital defects/spinal disraphism; now presents as kyphotic when compared to previous radiographs; laminae appear as residual spikes
318RS	13	F	√	three year old jumping injury; now has bony tenderness
346XY	15	F	√	first radiographed in 1999 with two follow up series of films; 1) moth-eaten 2) sclerotic 3) smoothing off
303ZA	16	F	√	history of a fall from a horse
308pq	16	F	-	thoracic kyphosis upper scoliosis to the right and lower scoliosis to the left

Table 6.32 Other relevant information for the sub-adults of the Royal Hospital for Sick Children sample

Skele. No.	Age	Sex	Information
66	<0	peri-natal	no weak spot visible from notochord regression
69	<0	peri-natal	no weak spot visible from notochord regression
75	<0>	infant	no weak spot visible from notochord regression
35	0-1	infant	no weak spot visible from notochord regression
32	1-2	infant	no weak spot visible from notochord regression
67	2-3	infant	thoracic vertebrae still stud shaped; no Schmorl's nodes
3	3-5	child	no weak spot visible from notochord regression
34	4-5	child	this may be co-mingled bones therefore not viable
10	4-8	child	no weak spot visible from notochord regression
47	4-8	child	conservation poor therefore not viable
63	4-8	child	no weak spot visible from notochord regression
28	7-10	child	posterior neural arches complete
37	<10>	youth	Schmorl's nodes deep and tunnelling with fractured cortex onto posterior neural arch space
53b	10-12	youth	vertebrae light weight and crumbling
71	12-18	youth	nothing of note
19	15-16	sub-adult	no weak spot visible from notochord regression
22	<18	sub-adult	nothing of note
25	18-25	M	nothing of note
55	26-35	M	cancellous bone visible through the vertebral end plates
36	26-35	M	kyphosis of the upper thoracic spine
29	30-45	M	deep Schmorl's nodes
72	30-45	M	nothing of note
14	36-45	M	osteopenia; heart shaped bodies with osteophytes to the right side; marked thoracic kyphosis
21	36-45	M	large, deep Schmorl's nodes with protrusion into posterior neural arch space; loss of height at T8
68	26-35	F	gracile; several fractures through the end plates
46	267-35	F	gross eburnation of L4 superior surface
64	26-45	F	nothing of note
56	26-45	F	very narrow posterior neural arch space in lumbar vertebrae; osteoporosis or soil leaching
33	30-40	F	nothing of note
2	30-40	F	osteoarthritic articular joints of the vertebrae
54	36-45	F	preservation of vertebrae poor
18	36-45	F	nothing of note
20	36-45	F	sacrum which has six segments
4	>40	F	thoracic kyphosis; loss of lordosis altering posture to single primary/senile curvature
44	>45	F	osteoarthritic arthritic articular joints of the vertebrae; right sided osteophytosis of the thoraco-lumbar vertebrae
52	>45	F	Schmorl's nodes into posterior neural arch space; cortex of vertebrae very thin, therefore liable to collapse
57	36-45	?F	L3 superior end plate: Schmorl's node, or is this calcified disc?
8	>40	?	osteophytic splaying of vertebral bodies to the right
9B	>40	?	nothing of note
62	adult	?	nothing of note
38	26-35	M	bony spurs projecting into the posterior neural arch space
45	30-40	M	nothing of note

Table 6.33 Other relevant information for the individuals for the Captain's Cabin, Dunbar sample

Skele. No.	Age	Sex	Information
113	<0	peri-natal	same cut as Sk.112; against the south wall of the church
296	<0	peri-natal	no weak spot visible from notochord regression
17	<0>	infant	no weak spot visible from notochord regression; spinal elements unfused
9	<0>	infant	no weak spot visible from notochord regression
16	1-2	infant	no weak spot visible from notochord regression
179	1-2	infant	no weak spot visible from notochord regression; posterior arch unfused
83	2-4	child	no weak spot visible from notochord regression
28	3-4	child	no weak spot visible from notochord regression
284	4-5	child	no weak spot visible from notochord regression
280	4-5	child	no weak spot visible from notochord regression
224	4-6	child	no weak spot visible from notochord regression
252	5-6	child	no weak spot visible from notochord regression
299	5-6	child	no weak spot visible from notochord regression
143	6-7	child	bifid first sacral segment; bones in a neat pile as if wrapped in a bag or cloth
218	6-7	child	incomplete
310	7-8	child	fractured and fragmentary
20	7-9	child	no weak spot visible from notochord regression; Sacral segments unfused
300	7-9	child	no weak spot visible from notochord regression
78	7-10	child	grave marker
233	8-9	child	no weak spot visible from notochord regression
270	8-9	child	posterior neural arch defect at T12
285	8-9	child	no weak spot visible from notochord regression
107	11-12	youth	buried on back with legs bent to the right
324	11-13	youth	nothing of note
128	12-13	youth	no weak spot visible from notochord regression
223	16-20	sub-adult	vertebral column missing,; box says complete
246	21-30	M	nothing of note
297	21-35	M	very short spinous processes; bulbous process on dorsum of sacrum (photo)
303	21-35	M	nothing of note
247	26-35	M	nothing of note
278	26-35	M	nothing of note
335	26-35	M	post mortem damage to vertebrae
69	26-35	M	L5 spondylolisthesis bi-laterally; T12 Schmorl's node into posterior neural arch space
97	26-35	M	nothing of note
325	26-35	M	spina bifida occulta L5 and sacrum; wedging at T5
207	30-45	M	nothing of note
121	36-45	M	spina bifida occulta without flaring
234	36-45	M	nothing of note
265	36-45	M	nothing of note
323	36-45	M	osteoporosis? Large holes in lumbar vertebral bodies
85	36-45	M	very narrow (vertically) elongated vertebrae

Table 6.34a Other relevant information for the individuals of the Hirsel, Coldstream sample

Skele. No.	Age	Sex	Information
104	36-45	M	nothing of note
153	36-45	M	nothing of note
172	36-45	M	L5 posterior arch absent; sacrum was spin bifida occulta
222	36-45	M	osteoarthritis and osteopenia of the vertebral column
108	>45	M	? Early diffuse idiopathic skeletal hyperostosis
209	>45	M	very dirty; cleaned with curator's permission
276	>45	M	osteophytosis with anterior wedging at T11
279	>45	M	extra articular facet on spinous processes of thoracic vertebrae (photo)
282	>45	M	nothing of note
288	>45	M	nothing of note
292	>45	M	vertebral osteophytosis with wedging; early stages of vertebral collapse
306	>45	M	nothing of note
232	16-30	?M	nothing of note
188	16-20	?M	incomplete vertebral column
27	26-35	?M	posterior neural arch absent at T12 (photo)
84	>45	?M	fragmentary vertebrae
309	18-20	F	nothing of note
289	16-25	F	? Still birth; baby laid in mother's arms
190	21-25	F	nothing of note
200	21-25	F	nothing of note
255	21-25	F	nothing of note
314	21-25	F	fragmentary vertebrae
293	21-30	F	L4/L5 spondylolisthesis
331	26-35	F	nothing of note
26	26-35	F	osteoporotic; shroud burial
65	26-35	F	nothing of note
147	26-35	F	nothing of note
210	26-35	F	nothing of note
44	36-35	F	osteophytosis from T9 to T11; right side only
94	36-35	F	nothing of note
184	36-35	F	nothing of note
225	36-35	F	osteopenia of vertebrae or soil leaching
243	36-35	F	nothing of note
239	>45	F	thoracic spine kyphotic; some fractured thoracic vertebrae
240	>45	F	T8/T12 resolving tuberculosis; C7 remodelled; lumbar vertebrae absent from box
294	>45	F	nothing of note
144	>45	F	no end plates present
187	16-18	?F	nothing of note
221	26-35	?F	nothing of note
173	36-45	?F	nothing of note

Table 6.34b Other relevant information for the individuals of the Hirsel, Coldstream sample

Skele. No.	Age	Sex	Information
454	6-8	child	no weak spot visible from notochord regression
463	6-10	child	no weak spot visible from notochord regression
471	6-10	child	nothing of note
444	8-10	child	nothing of note
470	8-10	child	nothing of note
483	8-10	child	sacral fusion at S1/2 incomplete
498	8-10	child	thoracic vertebra fragmentary; no Schmorl's nodes
445	11-15	youth	posterior neural arch of sacrum incomplete
461	11-15	youth	fragmentary
552	11-15	youth	T6 has fractured cortex into the posterior arch space
468	11-15	youth	nothing of note
452	11-15	youth	cystic lesion on inferior vertebral body surfaces
500	12-15	youth	nothing of note
538	12-15	youth	nothing of note
447	12-18	sub-adult	nothing of note
460	12-20	sub-adult	L1 fractured on inferior surface
508	16-18	sub-adult	nothing of note
506	16-20	sub-adult	nothing of note
532	18-25	M	lumbar vertebrae have asymptomatic end plate splaying
554	18-25	M	nothing of note
531	36-45	M	fragmentary vertebrae
561	36-45	M	fragmentary vertebrae
511	>45	M	osteoarthritic vertebral joints; osteophytosis of the vertebrae
504	>45	M	tunnelling Schmorl's node mimicking myeloma; ?osteoporotic collapse
537	>45	?M	narrow triangular cord space
558	16-25	F	kyphosis of the thoracic vertebrae
569	16-25	F	end plate fusion incomplete within age limits
535	36-45	F	foetus; obstetric death?
556	36-45	F	nothing of note
519	>45	F	osteophytosis greater on same side as Schmorl's nodes
559	>45	F	nothing of note
539	36-45	?F	Scheuermann's disease; tunnelling Schmorl's node at T12?
549	<25	?	nothing of note
482	<25	?	fragmentary; no Schmorl's nodes
509	26-35	?	nothing of note
507	36-45	?	only two whole vertebrae
517	36-45	?	nothing of note
510	>45	?	fragmentary; no Schmorl's nodes

Table 6.35 Other relevant information for the individuals of the Whithorn Priory, Galloway sample

Skele. No.	Age	Sex	Information
194	<1>	infant	no weak spot visible from notochord regression
269	1-2	infant	hollow space in anterior superior surface of centrum
272	1-2	infant	no weak spot visible from notochord regression
431	1-3	infant	no weak spot visible from notochord regression
100	1-3	infant	no weak spot visible from notochord regression
317	1-3	infant	no weak spot visible from notochord regression
271	2-3	infant	no weak spot visible from notochord regression
360	2-3	infant	no weak spot visible from notochord regression
359	3-4	child	no weak spot visible from notochord regression
419	3-6	child	no weak spot visible from notochord regression
287	4-5	child	T3 to L5 present
384	4-6	child	no weak spot visible from notochord regression
407	4-6	child	no weak spot visible from notochord regression
217	5-7	child	lumbar vertebra and sacrum present
412	5-7	child	no weak spot visible from notochord regression; T11 very hollow waisted
277	5-8	child	no weak spot visible from notochord regression
292	5-8	child	T4 to L4 present
275	5-8	child	no weak spot visible from notochord regression
300	5-8	child	asymmetrical S1/S2 joint; greater height to the right side
76	6-8	child	T13 or sixth lumbar vertebrae
278	6-10	child	no weak spot visible from notochord regression
434	6-10	child	no weak spot visible from notochord regression
327	7-9	child	no weak spot visible from notochord regression
233	7-12	youth	nothing of note
51	8-12	youth	nothing of note
193	10-12	youth	L2/3 grade 1 spondylolisthesis
358	11-14	youth	irregular end plates; drawn back from edge of body
348	11-14	youth	shallow long notch on T9
354	12-14	youth	posterior longitudinal ligament calcification on all thoracic vertebrae
318	12-15	youth	nothing of note
62	13-16	sub-adult	nothing of note
15	13-1`8	sub-adult	no weak spot visible from notochord regression; deep anterior herniation
261	14-16	sub-adult	nothing of note
370	16-20	sub-adult	osteochondritis
323	17-20	sub-adult	nothing of note
190	17-20	sub-adult	nothing of note
351	18-25	M	L5 left sided sacralisation and large anterior Schmorl's node
379	18-25	M	healed/smooth Schmorl's nodes
268	18-25	M	nothing of note

Table 6.36a Other relevant information for the individuals from the St. Andrew, Fishergate sample

Skele. No.	Age	Sex	Information
56	21-30	M	nothing of note
61	21-30	M	right sided sacralisation of L5
149	21-30	M	nothing of note
262	21-30	M	nothing of note
294	21-30	M	T12 transitional vertebra
373	21-30	M	nothing of note
377	21-30	M	T7 Schmorl's node in anterior cortex
413	21-30	M	fissures not Schmorl's nodes
161	21-30	M	posterior neural arch affected by Schmorl's nodes
256	21-30	M	tuberculosis at the level of L1; wedging of vertebrae
57	21-30	M	nothing of note
58	21-30	M	central fissure
204	21-30	M	spondylolisthesis of second and third sacral segments
226	21-30	M	nothing of note
355	21-30	M	nothing of note
283	21-30	M	nothing of note
329	21-30	M	complete sacralisation of L5
414	21-30	M	nothing of note
430	21-30	M	partial sacralisation of L6
41	21-30	M	impact injury of vertebrae or Scheuermann's disease
50	21-30	M	nothing of note
49	21-30	M	nothing of note
138	26-30	M	nothing of note
249	26-30	M	nothing of note
164	26-35	M	first sacral segment reduced height on the right side
258	26-35	M	posterior neural arch damaged by Schmorl's nodes
259	26-35	M	nothing of note
73	26-35	M	nothing of note
89	26-35	M	nothing of note
104	26-35	M	fissures not Schmorl's nodes
140	26-35	M	lateral pedicles tiny
245	26-35	M	nothing of note
188	26-35	M	fissures not Schmorl's nodes
192	26-35	M	post mortem fractures of the vertebrae
273	26-35	M	nothing of note
284	26-35	M	L1 and L4 compression fractures
340	26-35	M	horse shoe nails presentation may represent Schmorl's nodes
356	26-35	M	thoraco-lumbar wedging; L3 has a shiny anterior area of sclerosis
101	26-40	M	nothing of note
365	26-40	M	nothing of note
77	26-40	M	anterior end plates drawn back; ?Scheuermann's disease or Schmorl's nodes
141	26-45	M	L4 bi-lateral depression; anterior growth of porous bone

Table 6.36b Other relevant information on the individuals of St. Andrew, Fishergate sample

Skele. No.	Age	Sex	Information
123	30-35	M	nothing of note
109	30-40	M	vertebrae fragmentary
263	30-40	M	posterior longitudinal ligament calcifications of thoracic vertebrae
299	30-40	M	T11 ?myeloma or large Schmorl's node
7	30-40	M	Schmorl's nodes or fissures and butterfly vertebra
9	30-40	M	incomplete spine
16	30-40	M	nothing of note
239	30-40	M	integrity of cortex to posterior edge of vertebral body at T11 about to be lost
243	30-40	M	T10 to L5 spondylolysis
276	30-40	M	T10 has a fissure; osteophyte bracing for scoliosis
289	30-40	M	Scheuermann's disease
366	30-45	M	nothing of note
162	30-45	M	posterior longitudinal ligament calcification of thoracic vertebrae
151	30-45	M	T11 myeloma?
234	36-40	M	osteoporosis of vertebrae
369	36-40	M	thoracic kyphosis; anterior wedging from T8 to L1
99	36-45	M	spondylolysis of L5, S1/S2; articular facets on the left face medially, those on the right face posteriorly
417	36-45	M	nothing of note
6	36-45	M	T10 fissure or deep Schmorl's node
23	36-45	M	L5 anterior Schmorl's node causing collapse braced by osteophytes
25	36-45	M	nothing of note
62	36-45	M	no vertebral changes associated with ageing
71	36-45	M	no vertebral changes associated with ageing
222	36-45	M	nothing of note
235	36-45	M	nothing of note
380	36-45	M	L5 bi-lateral foramina; right sacro-iliac joint ankylosed; DISH at T9/T10/T11
106	36-45	M	L4/L5 wedging; osteoporosis L5 and S1
14	36-50	M	L5 sacralisation; scoliosis to left with osteophytes to the right
156	36-50	M	nothing of note
53	40-45	M	Scheuermann's disease
144	40-45	M	nothing of note
383	>40	M	nothing of note
227	>40	M	early DISH
130	>40	M	scoliosis to the right; osteophytes to the right
143	>40	M	nothing of note
29	>40	M	lower lumbar vertebrae fused
30	>40	M	early DISH; posterior longitudinal ligament calcified in the thoracic region
135	>40	M	slight wedging of thoracic vertebrae; porosity
357	>40	M	horse shoe nail lesion; ?Schmorl's node
285	>40	M	early DISH

Table 6.36c Other relevant information on the individuals of the St. Andrew, Fishergate sample

Skele. No.	Age	Sex	Information
184	40-50	M	?Schmorl's nodes caused by impact injury
238	>45	M	T12/L1 transitional vertebrae; early DISH
35O	>45	M	T6/7 kissing vertebrae; early DISH
349	>45	M	nothing of note
389	>45	M	nothing of note
113	>45	M	nothing of note
136	>45	M	scoliosis to the right; osteophytes to the right;
159	>45	M	DISH from T4 to T8; lumbar scoliosis to the left
163	>45	M	spondylolysis: DISH
231	>45	M	osteoporosis
344	>45	M	nothing of note
60	>45	M	L4/L5 ankylosed: lumbar vertebrae twisted to the right
131	>45	M	nothing of note
42	>45	M	Thoracic scoliosis to left; lumbar scoliosis to right
93	>45	M	wedging and bone erosion
38	>45	M	nothing of note
45	>45	M	lateral pedicles very short and drawn back
154	>45	M	nothing of note
88	>45	M	T1 the posterior spine is pulled to the right
92	>45	M	L5/S1; spondylolisthesis and ankylosis
237	>45	M	nothing of note
353	>45	M	T3 calcified posterior longitudinal ligament
280	>45	M	L5 partial sacralisation; early DISH
314	>45	M	nothing of note
333	>45	M	scoliosis to the left; osteophytes to the left
339	>45	M	?tuberculosis; L6 has spondylolysis
251	>45	M	nothing of note
250	>45	M	nothing of note
96	>45	M	nothing of note
223	>45	M	nothing of note
240	>45	M	DISH; similar calcification to the left
172	adult	M	DISH
364	adult	?M	many posterior neural arch elements missing
52	adult	?M	nothing of note
328	21-30	F	Scheuermann's disease
213	21-30	F	nothing of note

Table 6.36d Other relevant information on the individuals of the St. Andrew, Fishergate sample

Skele. No.	Age	Sex	Information
218	21-30	F	nothing of note
435	21-30	F	Scheuermann's disease
363	21-30	F	nothing of note
81	21-30	F	nothing of note
208	26-30	F	nothing of note
148	26-35	F	nothing of note
158	26-35	F	nothing of note
216	26-35	F	asymmetrical sacral region
391	26-35	F	nothing of note
253	30-40	F	nothing of note
316	30-40	F	nothing of note
325	30-40	F	nothing of note
347	30-40	F	T4 to T9 wedging with osteophytes to the right
372	30-40	F	L5 right sided sacralisation
65	30-40	F	nothing of note
90	30-40	F	post mortem fractures of several vertebrae
320	36-45	F	diminutive person using vertebral column as a guide
18	36-45	F	nothing of note
306	36-45	F	L4 left sided spondylolysis; T12 narrower to the right
346	36-45	F	nothing of note
436	36-45	F	nothing of note
241	40-50	F	fissures and not Schmorl's nodes
242	40-50	F	signs of vertebral narrowing
303	40-50	F	nothing of note
371	40-50	F	L5/S1 surface erosion; ? Prior to ankylosis
153	>40	F	nothing of note
267	>40	F	L4 concave inferior surface; non union of posterior neural arch
410	>40	F	nothing of note
215	>45	F	wedged vertebrae
305	>45	F	tuberculosis with sinuses, trabecular overgrowth and osteophyte bracing
427	>45	F	nothing of note
84	>45	F	scoliosis to left; osteophytes to left
102	>45	F	nothing of note
381	adult	F	nothing of note
378	adult	?F	nothing of note
415	>40	?F	wedging of lower thoracic and lumbar vertebrae with bone to bone contact
225	21-30	?	nothing of note

Table 6.36e Other relevant information for the individuals of the St. Andrew, Fishergate sample

Skele. No.	Age	Sex	Information
560/1	<0>	infant	nothing of note
562/1	<0>	infant	no weak spot visible from notochord regression
563/1	<0>	infant	nothing of note
38	<0>	infant	no weak spot visible from notochord regression
538/1	<0>	infant	thoracic kyphosis
51	1-2	infant	nothing of note
52	1-2	infant	nothing of note
556	103	infant	nothing of note
60	3-5	child	no weak spot visible from notochord regression
54	7-10	child	nothing of note
56	7-10	child	nothing of note
17	11-12	youth	nothing of note
36	11-12	youth	nothing of note
37	13-15	youth	nothing of note
64	16-18	sub-adult	nothing of note
32	16-20	sub-adult	nothing of note
18	36-45	M	sacralisation of L5
26	>45	M	nothing of note
67	>45	M	nothing of note
4	21-25	F	nothing of note
29	21-30	F	nothing of note
526/1	21-30	F	nothing of note
2	26-35	F	nothing of note
266/2	30-35	F	nothing of note
567/2	30-35	F	nothing of note
1	>45	F	vertebral osteophytes increasing in size cranio-caudadly
21	21-30	?F	nothing of note
10	26-35	?F	nothing of note
582	30-35	?F	nothing of note
569/2	adult	?	nothing of note

Table 6.37 Other relevant information for the individuals of the Tanners Row, Pontefract sample