AN EVALUATION OF THE SIGNIFICANCE OF "SCARS OF PARTURITION" IN THE CHRIST CHURCH SPITALFIELDS SAMPLE.

Volume 1.

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An Evaluation of the significance of "scars of parturition" in the Christ Church, Spitalfields sample.

Abstract.

The relationship between the preauricular sulcus and pitting on the dorsal aspect of the pubic corpus in association with pregnancy and parturition has aroused considerable interest since the early 1970's. The major limitation of much of the discussion is that it has been based on data derived from skeletal samples with either unknown or uncertain obstetric histories.

The excavation of the crypts beneath Christ Church, Spitalfields between 1984 and 1986 produced 968 skeletons, 387 of which were recovered in association with securely associated, legible coffin plates. Of the 138 adult females in this sample the parity status of 94 has been reconstructed from historical documentation.

Such obstetric factors as parity status, number of births, age at first and last births and birth spacing have been examined in relation to the presence or absence of the preauricular sulcus, its type and size, pubic pitting, sacral scarring and the extension of the pubic tubercle.

The results suggest that the preauricular sulcus and sacral scarring are independent of obstetric events and that although the small numbers of females with more than one pubic pit or an extended pubic tubercle had born children, the absence of these features is associated with both parous and nulliparous females.

Unlike previous studies, both localised cortical resorption and tubercle extension were evaluated as a

component part of the obstetric pelvis. The more capacious pelvis proved to be associated with wider and longer preauricular sulci and with the presence of pubic pitting.

In order to facilitate comparative studies the Christ Church females are described as part of the sample from which they are derived. Their environmental and cultural backgrounds are discussed.

This thesis is dedicated to Molly Wicks and to all others for whom circumstance denies opportunity.

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Chapter 1 Introduction

1.1 Introduction.

It is a truism that both in the past and today, child bearing and motherhood are of great importance in the lives of most women. There are many contemporary cultures which maintain a position, which prevailed world-wide until the twentieth century, whereby either religious rules, primitive technology and / or economic dependence create a situation where a woman's fundamental role and value in society is as a mother. Today, only a minority of women are in a position where motherhood is a matter over which there is real freedom of choice and where there are viable alternatives serving both personal needs and those of society.

If it is sought to understand both women's roles in society and the quality of their lives in the past, it is crucial that the significance of so called "scars of parturition" on the female skeletal pelvis is understood. Do they indicate whether or not a woman has borne one or more children? Is it possible to assess the number of births a woman has experienced? This area of inquiry is also of great importance to palaeodemography. The question of female fertility is fundamental to the understanding of both spatial and temporal fertility rates and trends.

Morphological variation of the cortex at specific areas adjacent to the articular areas of the pelvis, has attracted the attention of both anatomists and anthropologists for over 100 years. Such morphological features as the preauricular sulcus and pubic pitting have been examined in terms of sexual dimorphism and as cortical resorption and remodelling resulting from pregnancy and parturition.

This thesis seeks to examine the significance of these features, with particular reference to the question of parity assessment and pelvimetry, a crucial factor in obstetrics. The reference sample used for this project is the skeletal collection exhumed from the vaults beneath Christ Church, Spitalfields, London between 1984 and 1986.

1.2 Anatomy: The bones, joints and ligaments of the pelvis.

Skeletally, the pelvis comprises the two innominates and the sacrum. Each innominate consists of the ilium superiorly, the ischium posteriorly and inferiorly and the pubis anteriorly. These bones, which each have one primary ossification centre, are joined by a cartilaginous strip at the acetabulum. Tripartite fusion usually occurs between the ages of twelve and seventeen (Bass W.M. 1971, 148).

The stability of the pelvic joints and any changes they may undergo during pregnancy and parturition are important considerations. The pelvic joints comprise the pubic symphysis and the two sacroiliac joints.

The innominates articulate anteriorly at the pubic bodies. A secondary cartilaginous symphysis, the articular surfaces of the pubes are covered with hyaline cartilage. The supporting ligaments are the superior pubic ligament, which attaches to the superior aspect, and the arcuate pubic ligament, which is attached to the inferior aspect.

An interpubic disc of fibrocartilage connects the two bones, in which a cavity of variable size may develop. The surface fibrous tissue of the bones and cartilage (periosteum and perichondrium respectively) are continuous.

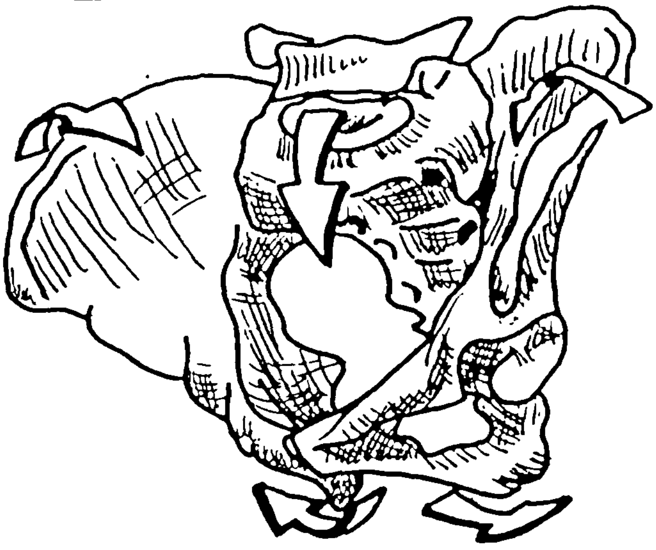
There is minimal movement at this joint (see figure 1), except in pregnancy. In pregnancy the ligaments are considered to soften due to dissociation of the collagen bundles, an increase in the amount of collagen and decreased viscosity of the ground substance (Philipp E. et al. 1986, 92). There are also bony changes, thinning and resorption of the cortical bone with irregularity of the edges of the symphyseal space (ibid).

The symphyseal gap in adults is about 4 mm . In pregnant females during the last trimester the mean gap is 7.7 mm , with a range of 3-20 mm . The return to the non-parous state is complete in 3 to 5 months. Pelvic osteopathy of pregnancy occurs in only 0.75% of pregnancies (ibid).

The auricular surfaces of the ilia articulate with the auricular surfaces of the sacrum. The sacro-iliac joints are synovial plane joints. The auricular surface of the ilia are covered with hyaline cartilage, and those of the sacrum with fibrocartilage. A fibrous capsule is attached medially to the sacrum and laterally to the ilium, a synovial membrane lines the capsule and this secretes synovial fluid which lubricates the joint.

The sacro-iliac joints are supported by the following ligaments (Gunn C. 1984, 93-94). The ventral

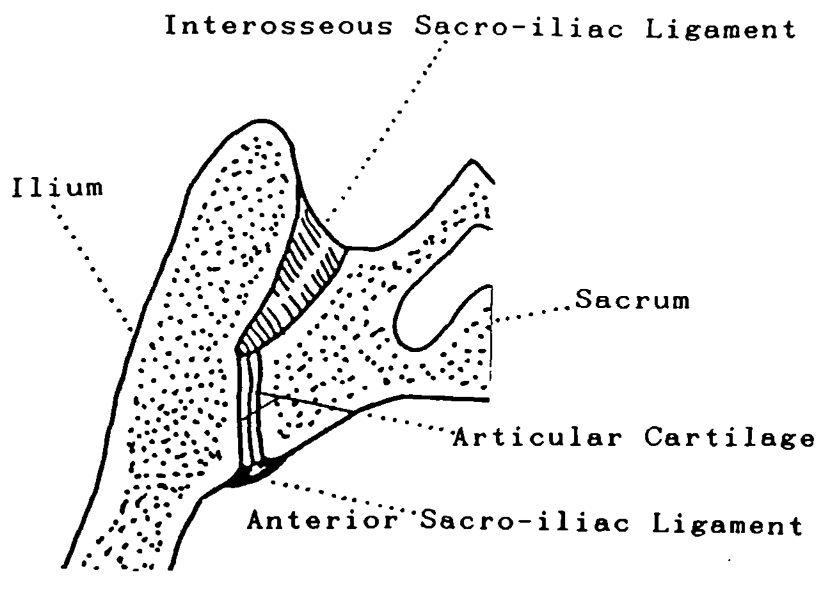
Figure 1.



Movements at the Joints of the Pelvis.

After The Physiology of the Joints. A.Kapandji.

Figure 2.



A Coronal Section Through the Second Sacral Vertebra.

After Figure 139. Textbook of Human Anatomy. W.J. Hamilton.

sacro-iliac ligament which covers the anterior and inferior aspects of the joint, the interosseous ligament between the two bones and the dorsal sacro-iliac ligament which covers the posterior aspect of the joint (see figure 2), this merges with the sacrotuberous ligament.

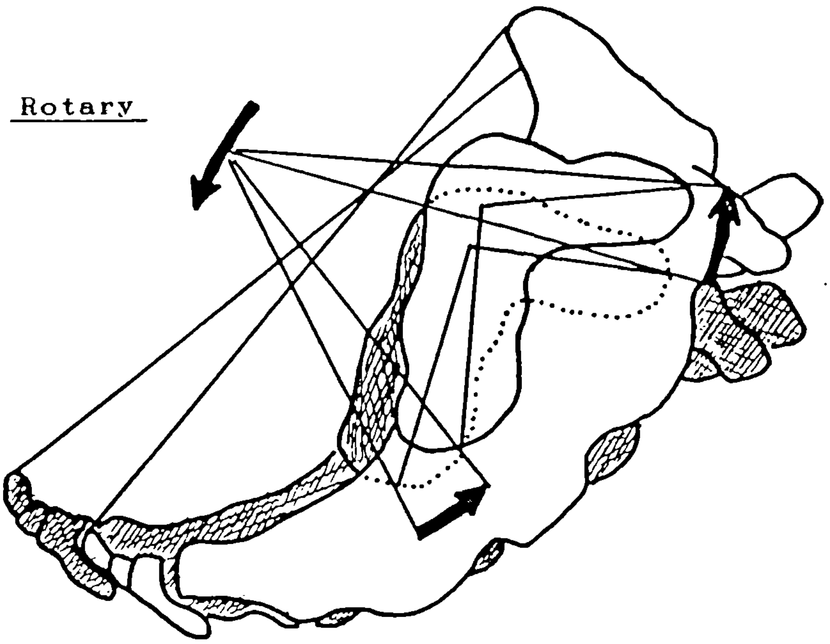
Movement at this joint is restricted to slight antero-posterior rotation during flexion and extension of the trunk (see figures 1 & 3). When an individual (of either sex) moves from a recumbent to a standing position the sacral promontory moves from its dorsal to its ventral limit, a distance of approximately 5-6 mms. (Weisl 1955, 85). This reduces the conjugate diameter of the pelvic inlet in 77% of individuals. The cranially situated ligaments are stretched as a consequence since their fasciculi, passing dorsally and laterally from the sacrum, are parallel to the direction of movement. The caudally situated ligaments suspend the sacrum from the ilia (Weisl 1954, 210).

The sacro-iliac joint is extremely stable for several reasons. The apposed auricular surfaces are irregular and lock, usually at the level of the second sacral vertebra. Strong posterosuperior interosseous ligaments and the sacro-iliac ligament prevent body weight from driving the sacrum downward. The sacrotuberous and sacrospinous ligaments prevent the sacrum from rotating forwards. Furthermore, the sacrum's extended superior shape wedges it between the ilia (Philipp E. et al. 1986, 89).

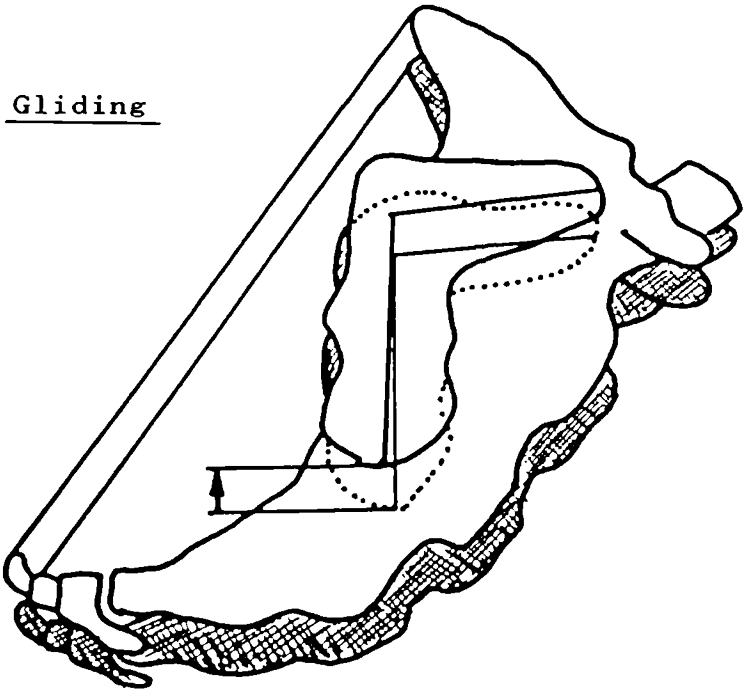
There has been a great deal of conflicting discussion in the medical literature concerning which of

Figure 3.

Rotary



Gliding



Movements at the Sacro-iliac Joint

After The Physiology of the Joints. A.Kapandji.

the pelvic joints, if any, are moulded during parturition. One of the most important studies has been carried out by Ohlsen (1973,417-434). Ohlsen's assessment of pelvic moulding was based on a sample of 20 primiparae and 9 multiparae with mean ages of 24 years and 29 years respectively. His material comprised antero-posterior and lateral radiographic views of the pelvis during parturition. A bi-plane film roller was utilised at intervals of 0.5 seconds. A distance of 100 cm was constant. The maternal gonads were exposed to 2-3 R. and the foetal gonads to less than 0.1 R. (This series was collected in the mid fifties.).

Ohlsen's results indicate that there is no widening of the pubic symphysis during parturition, although it does undergo compression as the foetal head descends. The effects upon the sacro-iliac joints are more complex. During the widening of the posterior circumference of the inlet, the intersacroiliac measurement increases by a mean of 4 mms., although there is no widening apparent of the articular spaces. Furthermore, there is a backward displacement and a gliding movement of the sacrum (see figure 3).

Ohlsen concludes (ibid. 432) that there is an increase of approximately 1-2 cm of the sagittal diameter and 0.5 cms. of the transverse diameter of the pelvic outlet as the foetal head descends. The bispinous diameter increases by a mean of 4 mm . A mean increase of 5.2 mm . was observed in the interobturator diameter shortly after the bispinous increase. Simultaneously, an increase in the sacroiliac distance occurs with a backward gliding of the sacrum. Ohlsen estimates that there is an approximate increase of 20% in the area of outlet during normal parturition. Interestingly, there was a significantly greater ($p \sim 0.025$) increase in the bispinous diameter in those individuals with a reduced bispinous diameter. This would suggest that the smaller the bispinous diameter, the greater the stress upon the pelvic ligaments during parturition.

1.3 The Preauricular Sulcus.

The preauricular sulcus of the ilium was first described in 1866 by Zaaiger (Derry D.E. 1909, 266-276). He correctly considered it to be the site of, and a response to the attachment of the ventral sacro-iliac ligament. In 1909 Derry discussed the sexual dimorphism of the sulcus. He observed that morphologically and metrically the sulcus differed in males and females. However, Derry does not indicate what percentage of his study sample were indisputably sexed.

Until 1974, the value of the pre-auricular sulcus was seen only in terms of its sexual dimorphism (Smith 1955, Cornwall 1956, Krogman 1962, and Bass 1971). In 1974 Houghton put forward the hypothesis that there were two types of sulcus. He noted that a "groove of pregnancy" (see plate 1), a sulcus with a "scooped" appearance and an irregular inferior margin, was found only in females and that a "groove of ligament" (see plate 2), a smooth floored sulcus, with a correspondingly smooth inferior margin, was found both in males and females. Although the sex of the material he studied was skeletally deduced, and the parity status unknown, he suggested that

Plate 1. Type 1 sulcus, "groove of pregnancy". CAS 2438 - 56 year old female of unknown parity status.

the groove of pregnancy indicated that a female had borne one or more children, and that a groove of ligament, because it was common to both sexes, indicated that a female had not born children.

In 1975, Ullrich published a paper taking Houghton's thesis, plus theories about the significance of pitting of the dorsal aspect of the pubic symphysis and sacral scarring, and devised a scheme for assessing not only the parity status of females, but also the number of births each had experienced. The number of "scoops" within a preauricular sulcus and number of "pits" on the pubis indicating the number of obstetric events a woman had

Plate 2. Type 2 sulcus, "groove of ligament". CAS 2438 - 56 year old female of unknown parity status.

experienced. Again, this methodology was established on an archaeological series of skeletally assessed sex with unknown obstetric histories.

The rationale behind the belief that certain sulci imply multiparity rested upon the following theory; "...a

> relaxation of the joints during pregnancy is followed by a hyperaemia of the joint capsules and ligaments as well as by minor haemorrhages at the bone / cartilage interfaces during parturition. In the joint cartilage, cracks and fissures occur, mainly near the ventral end of the joint. The ventral ligaments are heavily stretched and in part lacerate, and besides the joints

the periosteum may be lifted. The disintegrated masses injected into the ligaments ... will lead to pea-size bulges in the joint capsule. After several or hard childbirths, the disintegrated masses emerge from the bulged joint capsule, mainly in the region of the sulcus preauricularis of the ilium, into the tissue part of the periosteum, there forming debris cysts which cause lacunar bone resorptions in a manner similar to that found in the symphyseal region" (Ullrich H. 1975, 23-39).

The results of the analysis of 198 females from the Hammond Todd collection by Kelly was published in 1979 (541-546). Obstetric histories were deduced from soft tissue observations and, whilst certain applied criteria are acceptable, for example, fourchette appearance of the peritoneum, others are not. Peritoneal scars can be the result of child bearing but also of rape and accidents (Saunders J.R. M.B. F.R.C.O.G. personnel communication). Equally, a female bearing caesarean section scars has been pregnant, but may not have undergone the mechanical stresses associated with childbirth. Kelly concluded that the pre-auricular sulcus is the most reliable indicator of pregnancy and parturition but that no one area of cortical variation was sufficiently discriminating to determine parity status consistently.

Analysis of a sample of females of known parity status is presented by Dunlap, 1981, in an unpublished Ph.D. thesis from the university of Michigan. Dunlap examined 67 females and 30 males from the "willed body programs" in the departments of anatomy in Michigan University and the Wayne State University. All of his sample were of post reproductive age. Parity status was deduced from either medical records or obituaries. His specimens comprised the fifth lumbar vertebrae, the sacra, the posterior ilia, and the pubic bones. Complete pelves were available for only 19 females and eight males. He additionally examined 69 undocumented archaeological cases, 42 forensic cases (33 females and 9 males) and 182 (132 females and 50 males) from the Hammond Todd collection.

Dunlap analysed the morphology and the metrical variation of the pre-auricular sulcus in relation to age, body weight at death, obstetric histories, degenerative joint disease of the pelvis, sexual dimorphism and the location of the sacro-iliac joint (the cuneate index).

Dunlap's analysis showed that both the "area" and the width of the pre-auricular sulcus are positively correlated with the angle of the sciatic notch. He concluded that accurate prediction of obstetric events is not possible but that the "groove of pregnancy" (Houghton) is associated with obstetric events. The weakness of this thesis lies in the use of obituary data to infer parity status and the aged nature of the sample; all were post-menopausal.

Radiographic analysis of the association between the pre-auricular sulcus and parturition was undertaken by Spring et al. (1984 220-221). Based on a sample with known parity status the authors concluded that the presence of a deep radiographic pre-auricular sulcus does not appear to be associated with obstetric histories. They were also unable to demonstrate a radiographic change when comparing pre and post partum radiographs of the same individuals.

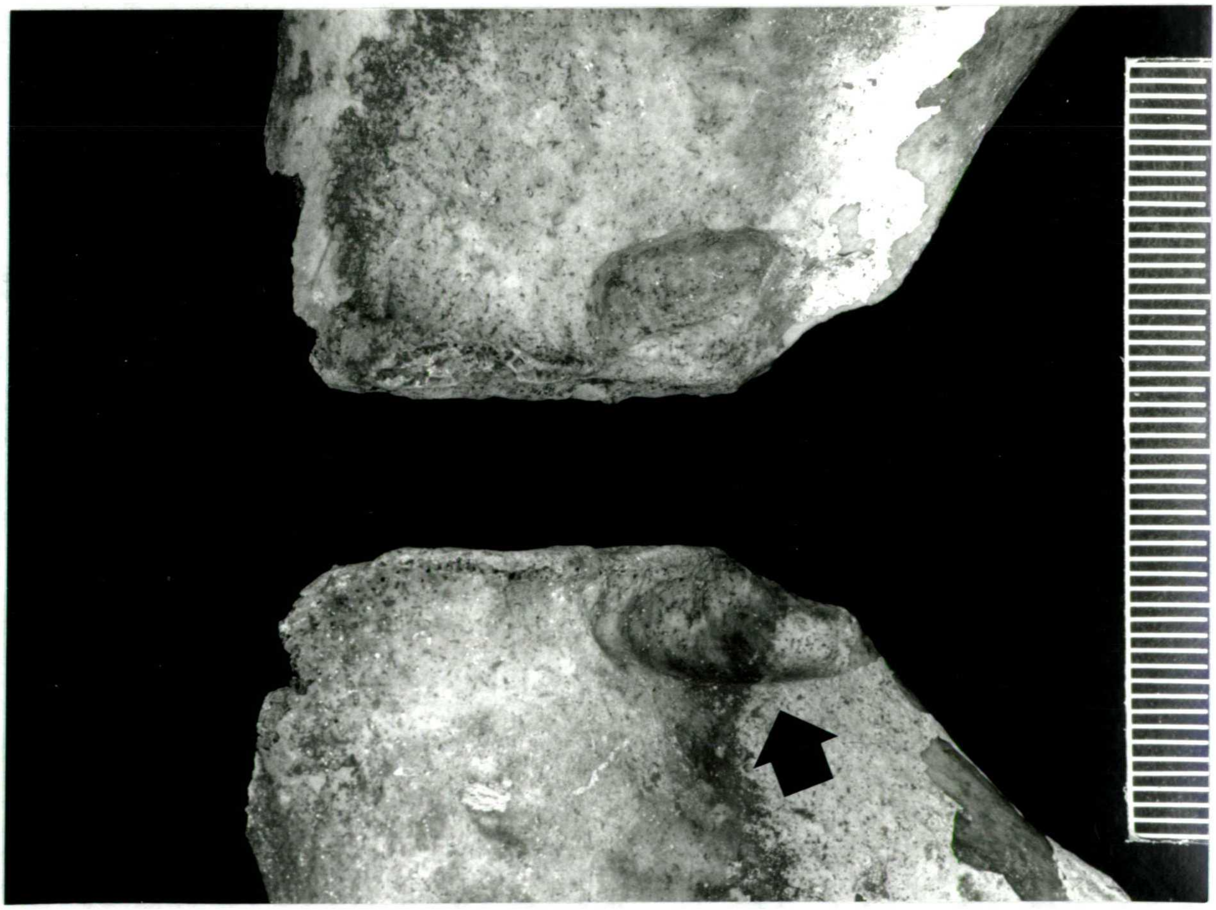
The theory that "scars of parturition" are a consequence of "excessive movement of the bony pelvis" has been put forward (Anderson B.C. 1988, 181). Thanks to the courtesy of the author it has been possible to study the unpublished paper from which the published abstract was derived. Based on the Hammond Todd collection which, as mentioned above, has obstetric data of questionable quality, the author examined 151 female and 87 male pelves. The main purpose of this study was to examine the possibility of a relationship between pelvic scarring and "loosely articulated pelvic girdles" (p.7). Each pelvis was "expanded to its bony limits" (p.7) using wooden spacers, measuring between 1-7cm , inserted between the pubic symphysis and the sacroiliac joints. The purpose of this exercise being to "estimate the amount of flexibility possible for the pelvic girdle" (p.8). The conclusion was that "as flexibility increased pelvic scarring increased".

However, as the sacroiliac joints never separate in the manner suggested, their only movement being slight backward gliding and rotation (see above), regardless of her conclusion, Anderson's hypothesis is based on a false premise at the outset. If the pelvic girdle was flexible in the manner suggested, human beings could not maintain erect posture as the weight of the trunk would force the sacrum out of line with the innominates. This study also concludes that scars of parturition are not related to obstetric events.

Previous work on the relationship between the preauricular sulcus and parity assessment has been beset with problems. These arise from either the fact that the parity status of the reference sample is unknown, or that the reliability of the obstetric data which has been deduced, is questionable. The conflicting results of this work may result from the quality of the obstetric data, or may reflect inter-population variation.

1.4 Pitting of the Dorsal Aspect of the Pubic Symphysis.

Plate 3. Pitting of the dorsal aspect of the pubic corpus. CAS 2070 - 35 year old female with 5 children.



Putschar (1931; 1976, 589-594) describing his observations of post mortem material in the early 1930's was the first to describe changes to the dorsal aspect of the pubic symphysis which he considered to result from parturition. However, pubic pitting as a sexually dimorphic feature was noted as long ago as 1854 by Luschka (Ullrich 1975, 24).

Plates 3, 4 and 5 illustrate variations of what have become known colloquially as "pubic pits". Putschar attributes these changes to; "...resorption and

> remodelling of the posterior margin of the pubic facet and of the adjacent posterior pubic cortex, concomitant with the formation of layers of the transverse symphysial ligament arising more laterally. This ligamentous hyperplasia is one of the main factors contributing to the formation of a retro-pubic eminence in the female. The insertion of these hypertrophic ligaments may present as a deep bony groove on the posterior pubic cortex........Each pregnancy and delivery leaves the pelvic joints permanently loosened. This is particularly true of the symphysis pubis, exposing the osteo-cartilaginous border to increasing shearing forces of upright gait and progressive attrition of the disc cartilage. In this phase, disruption of the continuity of the osteo-cartilaginous border with herniation of cartilage into the underlying bone, formation of proliferating cartilage nodules, cyst formation, fibrous transformation of the bone marrow and reactive sometimes sclerotic, bone formation is observed" (Putschar 1976, 591 & 593).

The problem with evaluating Putschar's work is that, in translation, there are no tables or statistics to illustrate the frequency of the changes he describes in relation to parity status.

Stewart (1957, 9-18), whilst attempting to systematize age related changes to the pubic symphysis, observed that abnormalities of the female pubis must be connected with childbearing. In 1970, Nemeskeri (p.98) established a five stage scheme of birth changes at the pubic symphysis. He observed that the scheme needed verification on a control sample with known obstetric histories.

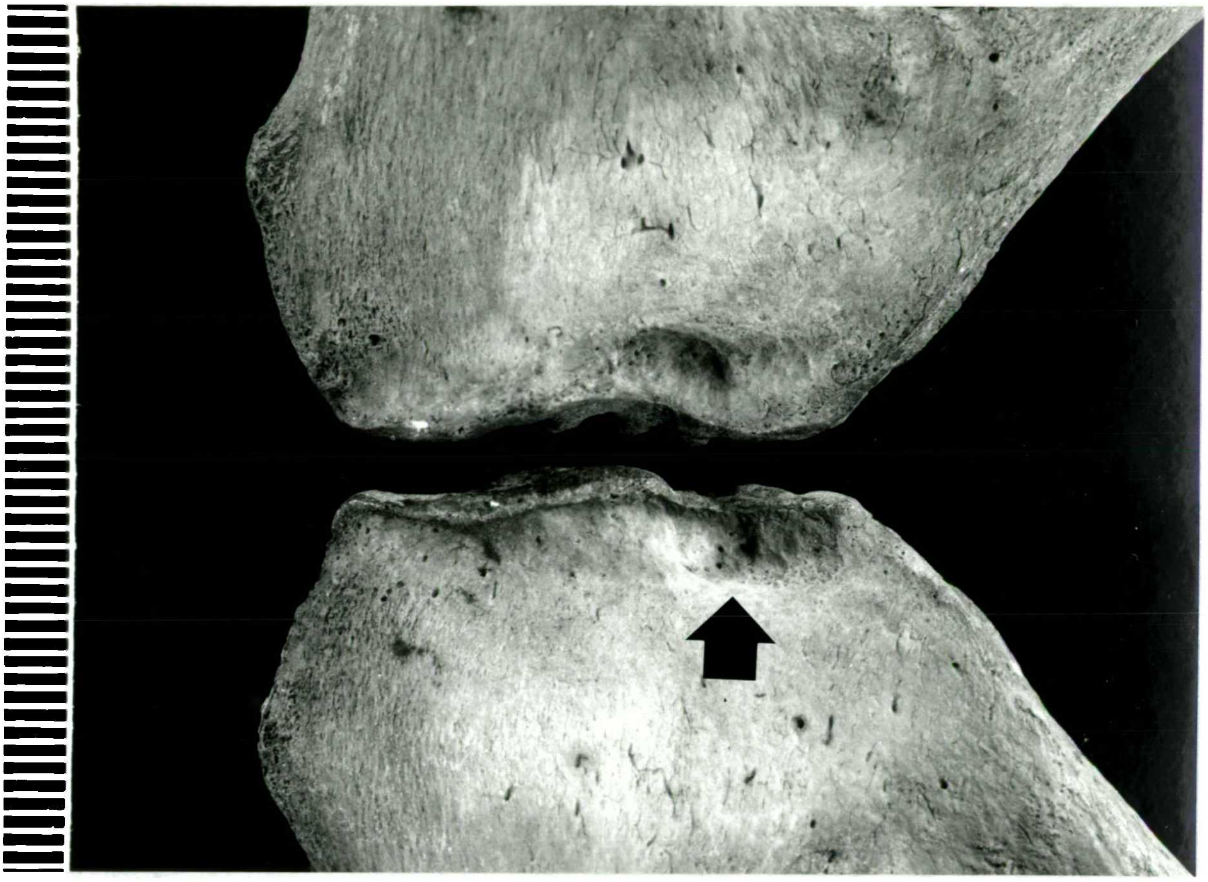
Plate 4. Pitting of the dorsal aspect of the pubic corpus. CAS 2169 - 85 year old nulliparous female.

Gilbert and McKern (1973, 31-38), examined the pubes of 140 females of known parity status (T.D. Stewart's collection) and concluded that pubic pitting was not a reliable indicator of parity. The work of Holt (1978, 91-94) on a sample of 68 females from the Hammond Todd collection, concluded that there was no correlation between symmetrical scarring and parity status or size of configuration of pits and parity status. Kelly (1979, 541-546) also using the Hammond Todd collection, concluded that pits and grooves acquired through pregnancy and parturition became obliterated through old age. Why he was convinced that such features had been present prior to increasing age is not evident. He also observed that moderate to large pubic pitting was rarely found in nulliparas.

In the same year the work of Suchey et al. (1979, 517-540), on an autopsy sample of 486 females of mixed racial groups, concluded that a statistical correlation was found between the number of full term pregnancies and the degree of dorsal pitting but that the correlation was not strong and that age at death was an independent variable. Multiple regression analysis of these data indicated that age and the number of pregnancies was important in the prediction of pitting.

Analysis of 49 pairs of pubic bones by Bergfelder and Herrmann (1980, 611-613) concluded that although there was a tendency for the size of the cavities, which occasionally occurred only on one branch of the pubis, to increase with the number of births, that there was no unequivocal relationship between pubic pitting and either pregnancy or the number of births. This sample was taken by dissection, parity status was derived from medical records.

Plate 5. Pitting on the dorsal aspect of the pubic corpus. CAS 2667 - 30 year old female of unknown parity status.



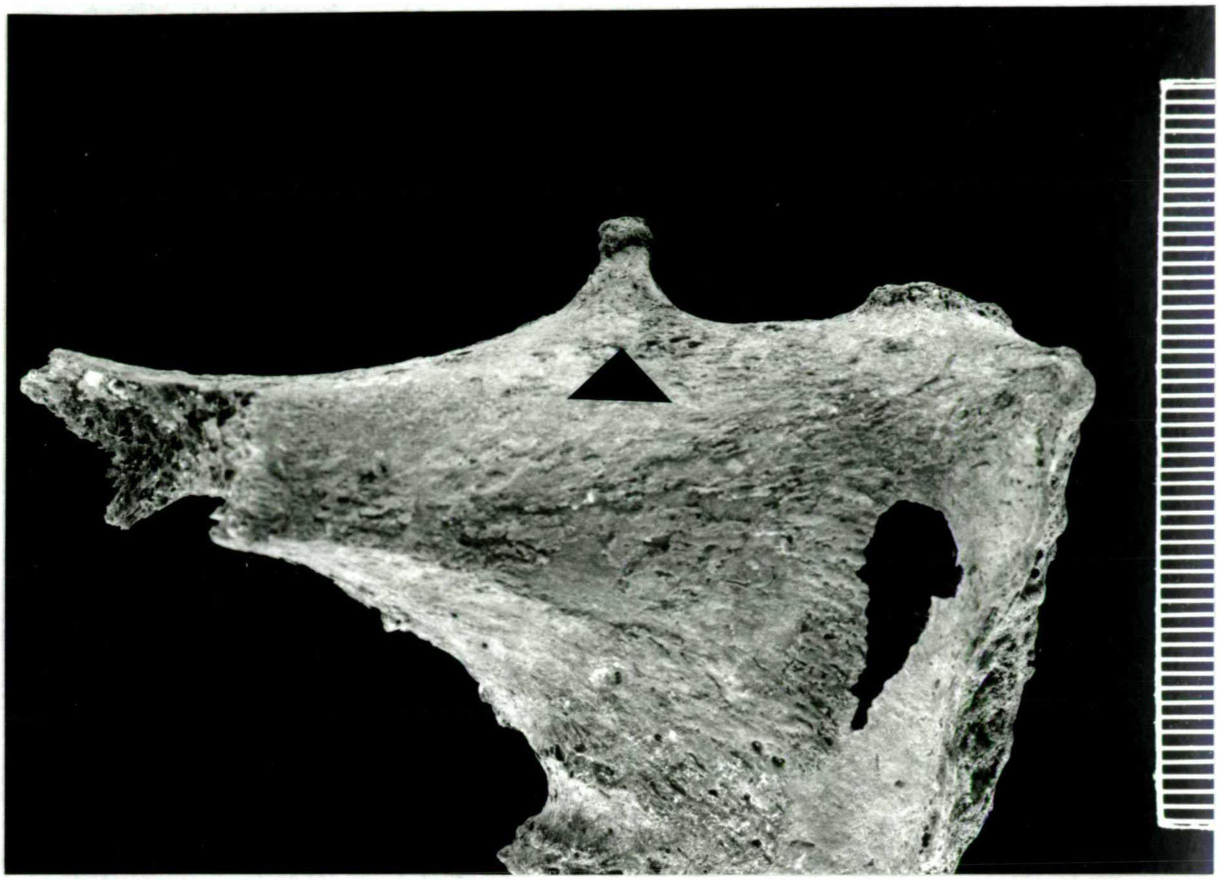
As with the results of previous work evaluating the relationship between the preauricular sulcus and parity status, those based on cortical resorption on the dorsal aspect of the pubic symphysis are also conflicting in their conclusions. In this case, even when the material is obtained from dissecting room cadavers, which are presumed to have reliable obstetric data, different workers arrive at different conclusions. The majority however, seem to agree that there is no strong association between pubic pits and parity status.

1.5 The Pubic Tubercle.

The pubic tubercle is situated on the ventral aspect of the superior border of the pubis. Attached to the pubic tubercle are the medial end of the inguinal ligament, the outer pillar of the external abdominal ring (Gray 1977, 176) and a portion of rectus abdominus. The inguinal ligament is formed by the lower border of the aponeurosis of the external oblique muscle, and extends from the anterior superior iliac spine to the pubic tubercle. There is no apparent reason for pregnancy or parturition to impose stress upon this ligament. However, pregnancy does cause distention of rectus abdominus and it is possible that this could impose stress and subsequent remodelling upon the attachment to the pubic tubercle.

Bergfelder and Herrmann's work (1980), (n = 49) is the only evaluation of the relationship between changes to the pubic tubercle and parity status. Using a dissecting room sample, whose parity status was evaluated from medical records, they concluded that a distinctly prominent pubic tubercle (see plate 6) usually indicated more than three births as did a reduction in the dorso-ventral diameter of the symphysis but, that in other respects there is no strong association between the degree of extension of the pubic tubercle and parity status. Their study did not include evaluation of the variation in the pubic tubercle in males.

Plate 6. The extended pubic tubercle. CAS - 2566, 74 year old mother of one.



It appears that further study of the pubic tubercle in relation to parity status is merited, as is examination of Bergfelder and Herrmann's observation of the reduction in width of the pubic symphysis in association with obstetric events.

1.6 Sacral Pitting.

Sacral pitting occurs on the ventral aspect of the sacrum immediately adjacent to the pre-auricular groove of the ilium. The morphology of sacral pitting is similar to that of the pre-auricular sulcus and equally as varied. This feature has been examined by Houghton (1974), Ullrich (1975) and Kelly (1979). Whilst Ullrich observed this feature in conjunction with the pre-auricular sulcus, Houghton and Kelly consider this variant to be less constant than the pre-auricular sulcus, and dismiss it as being unrepresentative of parity status.

Personal observation of sacral scarring has led to the same conclusion as that arrived at by Houghton and Kelly. It does occur only infrequently, nevertheless, examination of its distribution in relation to parity status is merited.

1.7 Endocrinology and the Pelvic Joints in Obstetrics.

It is believed (Maclennon A.H., 1983, Phillipp E.et al., 1986) that there is hormonally influenced softening of the ligaments of the pelvic joints during pregnancy. This is considered due to the effects of relaxin, a peptide hormone produced by the corpus luteum of pregnancy or decidua.

The corpus luteum is a functional unit that occurs during the menstrual cycle. After the oocyte and the surrounding cumulus cells are discharged from the mature ovarian follicle, the remaining follicle cells (membrana granulosa) and the adjacent connective tissue (theca interna) undergo changes that create the corpus luteum. These changes result from the stimulus of a luteinizing pituitary hormone. The corpus luteum in turn produces another hormone, progesterone, which affects the oestrogen primed uterus. If pregnancy occurs the corpus luteum remains functional, if the ovum is not fertilized it regresses, the cellular components being replaced by fibrous tissue, the structure is then a corpus albicans

(Reith & Ross 1977, 226).

Most of the research undertaken into the effects of relaxin during pregnancy and parturition has been carried out on animals, with particular emphasis on the pubic symphysis.

Relaxin was first discovered in 1926 by Dr.F.Hisaw who isolated a hormone that relaxed the pubic symphysis of guinea pigs prior to parturition. In several small mammals the size of the emerging foetus during parturition is so great that dramatic enlargement of the pelvis is essential. The cartilage at the pubic symphysis in the females of such species as guinea pigs and mice is replaced by fibrous tissue. During parturition, to avoid dystocia, this stretches widely, allowing the pelvis to open like a book (Stewart 1984, 614), this usually closes after delivery, stretching of the sacro-iliac joints is also implied. Relaxin in conjunction with oestrogen and other hormones is considered essential in the process of softening the ligaments.

Two types of relaxin have been recognised in human beings. It is not only produced in females, but also by the male prostrate gland. Relaxin has been detected in target tissues such as the cervix, myometrium and connective breast tissue in pregnant females.

The primary function of relaxin appears to be the facilitation of remodelling of connective target tissues. These facilitate the necessary changes in organ structure during pregnancy and parturition (MacLennon A.H., 1983, 77-95). In some species relaxin inhibits myometrial contractions until near the end of pregnancy. Human trials have shown that relaxin works in sequence with prostaglandins and oestradiol. In human beings, relaxin levels are highest around the twelth week of pregnancy and steadily decline to term (Annual Report of the Howard Florey Institute of Experimental Physiology and Medicine 1987). To date, no link has been established between relaxin and the relaxation of pelvic ligaments in humans. However, there is widespread acceptance of the idea that there is a relationship (Philipp E. et al. 1986).

Calguneri et al. (1982) examined the question of increased relaxation of the ligaments of the body as a whole in pregnant females. Using a finger hyperextensometer for the metacarpophalangeal joint of the index finger, they found a significant increase in extension during the third trimester as compared with extension recorded at several weeks postpartum. They detected an even greater extension in second pregnancies, but no subsequent increase. Whilst the authors suggest that relaxin is responsible for this, other evidence (see paragraph I) would not support this.

A recent review of bone resorption of the pubis in the nonhuman mammalian innominate (Tague R.G., 1988, 251) demonstrates that oestrogen alone can induce resorption of the mammalian pubis by stimulating the synthesis of osteoclastic enzymes.

The issue of hormonally induced, ligamentous relaxation in human beings during pregnancy is ill-understood and requires further research. It might be however, that the pelvic ligaments stretch merely in response to changes of posture and pressure during pregnancy. This remains an unclear area in obstetric science.

1.8 The Evolution of the Bony Pelvis.

"In sorrow thou shalt bring forth children."
(Genesis: 111, 16)

The question arises as to why a process as natural and essential for the survival of the species as childbearing, should necessitate such an elaborate and complex process as it does in humans beings.

Unlike most quadrupeds where the lumbosacral angle[1] is negligible, the descending human foetal head has to negotiate a deep, curved pelvic outlet. In primates the lumbosacral angle varies from 11 to 35 degrees whilst in humans beings it is approximately 60 degrees in males and 64 degrees in females (Stewart 1984, 614).

Angulation of the lumbosacrum was necessary if man was to achieve a bi-pedal gait (Davies 1956, 1018). Bi-pedality also necessitated the development of an immensely strong pelvic diaphram to support the abdomino-pelvic organs (Abitbol 1988, 53). In human beings the muscles and fascias of the pelvic diaphram are inserted on the ischial spines, which are prominent and more anteriorly located than in quadrupeds. As a consequence of their

1. The angle backwards of the sacrum from the extended vertical line of the lumbar spine.

position and their size the ischial spines are an obstacle to parturition in humans beings (Abitbol 1988, 53).

It seems that the morphology of the human pelvis represents a response to the often conflicting requirements of bi-pedality and obstetrics (Jordaan 1976, 744). Bi-pedality is considered to be the dominant function, the modifications serving the needs of parturition are seen as compensatory, and are responsible for the sexual dimorphism of the human pelvis.

It would appear that pelvic moulding in human parturition is a requirement imposed by evolution. Not only bipedality but also an increase in the size of the foetal head in-utero, may have necessitated a change in the attitude of the foetal head from extension to flexion (Stewart D.B. 1984, 611) during parturition.

Encephalization is considered to have been a progressive process in hominids occurring between approximately five million and 200,000 years ago (Martin 1983, 48). Pelvic limitation on increasing foetal brain development was reached approximately one and a half million years ago. The effect of this was that unlike other primates, human foetal brain growth rate continues for approximately one year after birth. Hence the comparatively helpless condition, and elaborate care that is required for the human infant. A large brain size requires a relatively high metabolic input from the mother, this factor when combined with the high nutritional requirements of post natal fetal brain growth suggests that brain size evolved as a response to the relative predictability of specific habitat conditions, particularly food supplies (ibid 51).

1.9 The skeletal Pelvis and Childbearing.

Pelvic Shape.

The most widely used classification for pelvic shape is that of Caldwell and Maloy (1938). Based on the shape of the pelvic inlet there are four classifications (see figure 4). The most common pelvic shape is gynecoid (50.5%), this category has an overall "round" inlet shape, but one in which the transverse diameter is greater than the antero-posterior diameter, see plate 7. The android pelvis (18.5%) has a triangular shaped inlet and is smaller than the gynecoid pelvis. The anthropoid pelvis (26.5%) has a greater antero-posterior than transverse diameter, see plate 8, whilst the platypelloid pelvis (4.5%) which is very unusual, has a reduced antero-posterior and extended transverse diameter. See plate 9.

Superior aspect

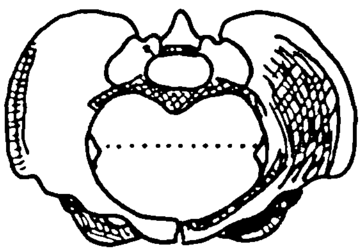
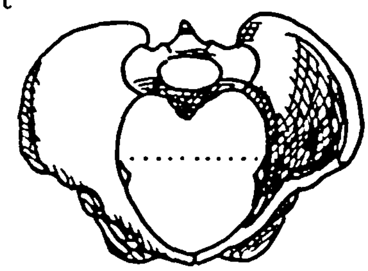


Figure 4

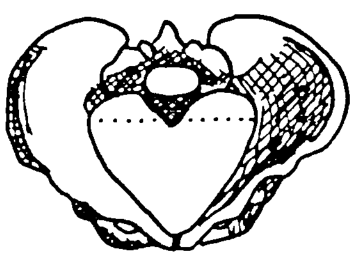


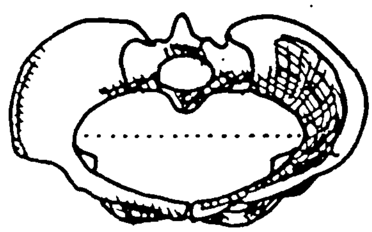
Gynecoid

Anthropoid

Android

Platypelloid





The gynecoid pelvis is obstetrically the most efficient of the four. The android pelvis can have a reduced inlet and outlet. Often the concavity of the pelvis is reduced by the "pointed" attitude of the pubes, leaving no room for the sinciput to turn into (Chassar Moir 1964, 121), this causes deep transverse arrest. If the foetal head is not too large however, head moulding can compensate allowing a normal delivery.

<u>Plate 7. Gynecoid pelvis. CAS 2070 - 35 year old mother of five.</u>

The architecture of the anthropoid pelvis causes the foetal head to rotate into the occipito-sacral position (normal delivery is with the foetal head occipito anterior), this can cause misdirection of uterine force and cause foetal and maternal stress (Chassar Moir 1964, 121).

Plate 8. Anthropoid pelvis. CAS 2300 - 53 year old of unknown parity status.

Both rickets and osteomalacia can cause platypelloid pelves. This pelvic shape causes cephalo-pelvic disproportion which results in deep transverse arrest unless the foetal head is very small.

Skeletal dimensions affecting obstetric efficiency.

The average foetal head has an occipito-frontal diameter of 115 mms. (Thomas 1961, 165). In a normal vertex presentation the head enters the pelvic girdle at an angle of approximately 45 degrees either side of the sacral promontory, it rotates within the sacral curve and is born with the vertex presenting first.

Plate 9. Platypelloid pelvis. CAS 2368 - 45 year old mother of four.

Reduction of a number of internal diameters, both inlet and outlet, can cause dystocia. These at best prolong normal labour and at worst prevent vaginal delivery. A narrow bispinous diameter is considered the most important factor causing deep pelvic arrest and impairing normal delivery (Abitbol 1988, 53). A reduction in either the ischio-diameter or the inferior antero-posterior diameter is potentially serious as are reduced transverse or conjugate diameters.

Discussion in depth of the effects of a reduction in the greatest pelvic diameter will illustrate the effects of one example of pelvic disproportion. This is caused by a "flat sacrum". In a sample of 440 females

(Posner 1955, 1021-1025) known to have this condition;

42.8% had a spontaneous delivery.

19.8% needed a low forceps delivery.

11.1% required a mid forceps delivery.

9.6% had breech deliveries.

17.7% required a caesarean section (norm = 4.9%).

Furthermore;

62.8% had cephalo-pelvic disproportion (norm = 22.3%).

15.3% presented abnormally (norm = 8.7%).

40% suffered prolonged labour.

Pelvic dimensions are a crucial determinant of the obstetric efficiency of the bony pelvis. Diminished dimensions can cause dystocia and cause both maternal and foetal stress. If the cortical changes colloquially known as "scars of parturition" are related to the stresses of pregnancy and parturition, it seems logical that in smaller pelves, there will be greater ligamentous stress than in larger pelves, consequently smaller pelves of parous females should have more evidence of cortical resorption and subsequent remodelling than larger pelves.

Skeletal conditions and diseases affecting obstetric efficiency.

Childhood rickets and its adult equivalent, osteomalacia are the result of osteoid failing to mineralise due to interference with calcification mechanisms. Osteoid is increased at the expense of mineralised bone. Dietary vitamin D deficiency and poor solar irradiation are the main causes (Parsons 1980, 41).

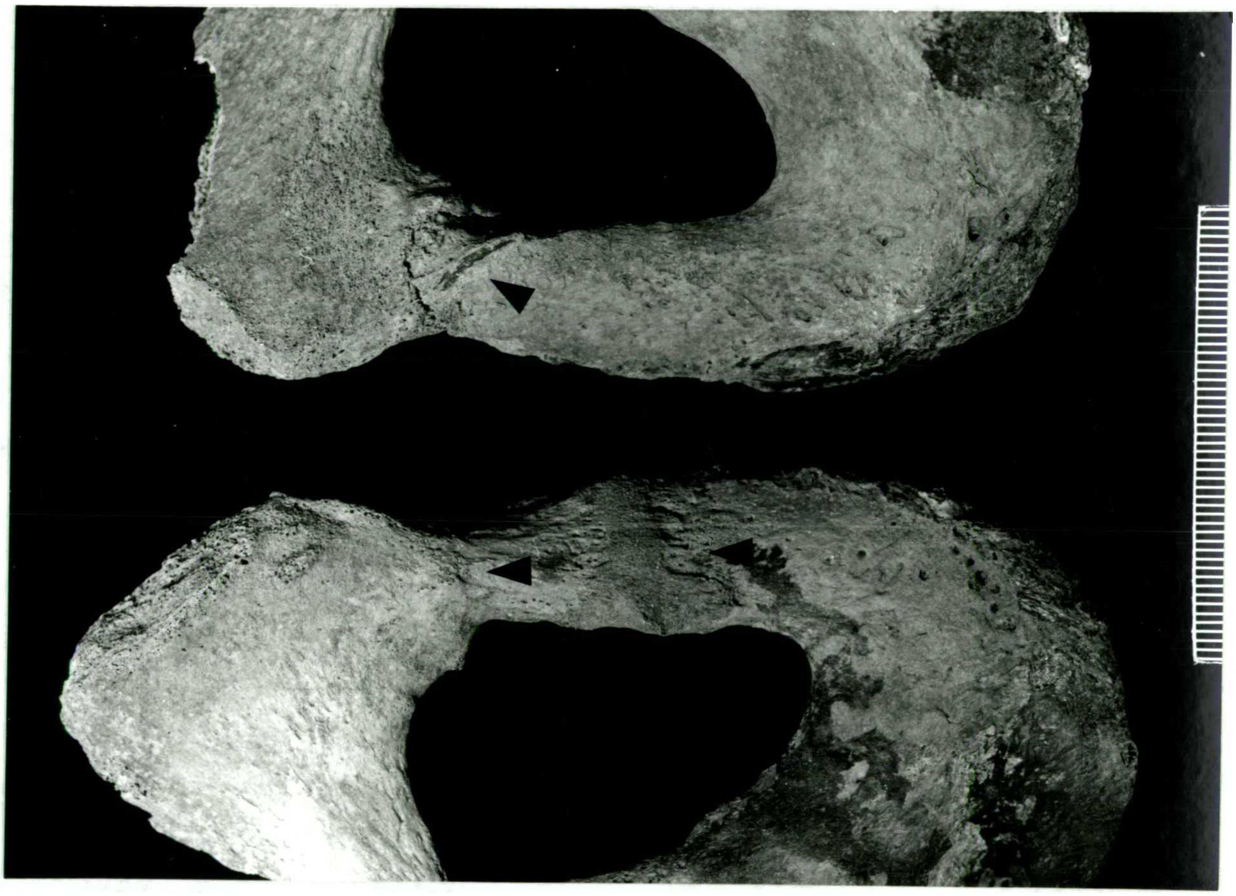
Both disorders lead to the distortion of weight supporting bones. Osteomalacia, which affects females 12 times as often as males, can lead to scoliosis, kyphosis, fractures and deformities. The pelvis can be deformed by both conditions in several ways. The antero-posterior diameter can be reduced. The promontory of the sacrum can be displaced downwards and forwards, leading to backwards tilting of the lower sacrum and coccyx causing a sharp bend in the sacrum at the 4th and 5th sacral vertebrae. The anterior walls can be flattened causing the acetabulum to present forward and the ischial tuberosities can be widened out increasing the sub-pubic angle (Chassar Moir 1964, 304). The degree to which rickets or osteomalacia can affect a woman's ability to bear children depends upon the severity of the disease and the extent of deformity.

A scolio-rachitic pelvis is created when marked lateral spinal curvature occurs, causing the sacral promontory to be pushed over to one side. Consequently, the foetal head is obstructed at the inlet, frequently to the extent that it is impassable (Chassar Moir 1964, 306).

Osteomata in the region of the pubic symphysis, sacroiliac joints and iliopectilineal eminences are rare, as are larger tumours such as enchondromata and sarcoma. Large bone growths affecting the pelvic joints, can obstruct parturition, and cause injury to the foetal head.

Pelvic fractures must be assessed individually as to whether they would impair the childbearing efficiency of the pelvis. The problem with making assumptions about fractures and the conditions described above (apart from rickets) in relation to obstetrics about archaeological material is that it is impossible to establish if the condition pre or post dated a female's fecund period. It seems unlikely that the fractured ischiopubic rami illustrated in plate 10 would impair childbearing.

Plate 10. Fractured ischio-pubic rami. CAS 2744 - 52 year old of unknown year at death and consequently unknown parity status.



The same problem arises with evaluating the obstetric significance of such conditions as kyphosis and spondylolisthesis. Both disorders can cause the lumbar vertebrae to overhang the pelvic inlet obstructing delivery. Kyphosis can also cause the sacral promontory to tilt back, this creates a "funnel" pelvis, and causes deep transverse arrest. Such conditions as poliomyelitis can cause a shortened limb. This condition has the same effect on the pelvis as a dislocated (congenital or aquired) femur, the sound leg takes the weight, pushing inwards that side of the pelvis. Where there is congenital dislocation of both femora the pelvic girdle becomes wide and flattened with an enlarged sub-pubic angle (Chassar Moir 1964, 318).

A high assimilation pelvis (6 sacral vertebrae) can accentuate the brim of the pelvis causing minor disproportion, the antero-posterior diameter often exceeding the transverse diameter (Chassar Moir 1964, 304). When the transverse diameter of the outlet is also reduced the problem is excacerbated. A low assimilation pelvis (4 sacral vertebrae) does not impair eutocia.

Other skeletal conditions affecting childbirth are a Naegele pelvis where one sacral ala is imperfectly developed and can cause inlet obstruction. In a Robert pelvis both alaeare defective. A split pelvis can also cause problems during parturition, in this condition the pubes develop imperfectly and can fail to meet by up to 100mms. A band of fibrous tissue usually connects the pubes. This condition can also be associated with deformity of the urinary and generative organs (Chassar Moir 1964, 269).

The conditions described above can all be detected in archaeologically derived skeletal material. When seeking to understand the obstetric histories of women from earlier periods, it is essential that the obstetric significance of such conditions is recognised and commented upon. In terms of the possible effects of mechanical trauma and stress upon the articular ligaments and their attachments to the periosteum, these pathologies will increase the need for resorption and remodelling. If "scars of parturition" are what their name implies, they will logically be more severe in females with pathological conditions such as those described above.

An unknown and variable commodity in childbearing is the size of the baby. A large infant, or an infant with a large head, especially the infant of a diabetic mother or an infant with hydrocephalus, is going to increase the trauma of parturition particularly where the mother has a small pelvis. A breech or shoulder presentation can also increase the mechanical stresses associated with childbirth. There is however, no way of determining these factors except in modern samples where extensive medical records exist. To date, no study has been able to consider this variable other than hypothetically.

1.10 Research Objectives.

The processes behind, and the significance of, the preauricular sulcus, pubic pitting, sacral scarring and the extension of the pubic tubercle in the female skeletal pelvis remain unclear. The aim of this thesis is to attempt to elucidate two areas of inquiry. Using an adult female sample with reconstructed obstetric histories, excavated from an East London crypt, examination of so called parturition scars will be undertaken in relation to such obstetric data as parity status, age at first birth, age at last birth, number of children born, birth spacing and the age at death. If, as has been suggested, "scars of parturition" are modifications representing osteological response to the mechanical trauma of pregnancy and parturition, it follows that in a smaller pelvic girdle or one with a reduced diameter, the stress and therefore the response will be greater, that in the capacious, obstetrically favourable pelvis the demands and equally the response will be reduced. It is because of this supposition that this study encompasses a wide range of pelvic measurements, ones that are specifically related to obstetric capability.

Furthermore, the morphology and size of scars of parturition will be examined as a component part of the skeletal pelvis. Such variants as pelvic shape, pathologies and other aspects of pelvic morphology will be considered in relationship to macroscopic changes of the cortex, particularly resorption, near areas of pelvic articulation. The age at death of the female and the presence of degenerative conditions affecting the areas of articulation will also be considered.

Before proceeding to this discussion, the results of the historical inquiry into the life styles and the life histories of the 138 females, aged 12 and over exhumed from Christ Church, whose names, age at death and date of death are known from their coffin plates, will be described. This sample will also be discussed as part of the larger skeletal sample (n = 968) from which they are derived. As a detailed discussion, it will provide the cultural and environmental basis for evaluating the question of inter-population variation should that prove desirable in the future.

Chapter 2 Christ Church, Spitalfields and the Crypt Sample.

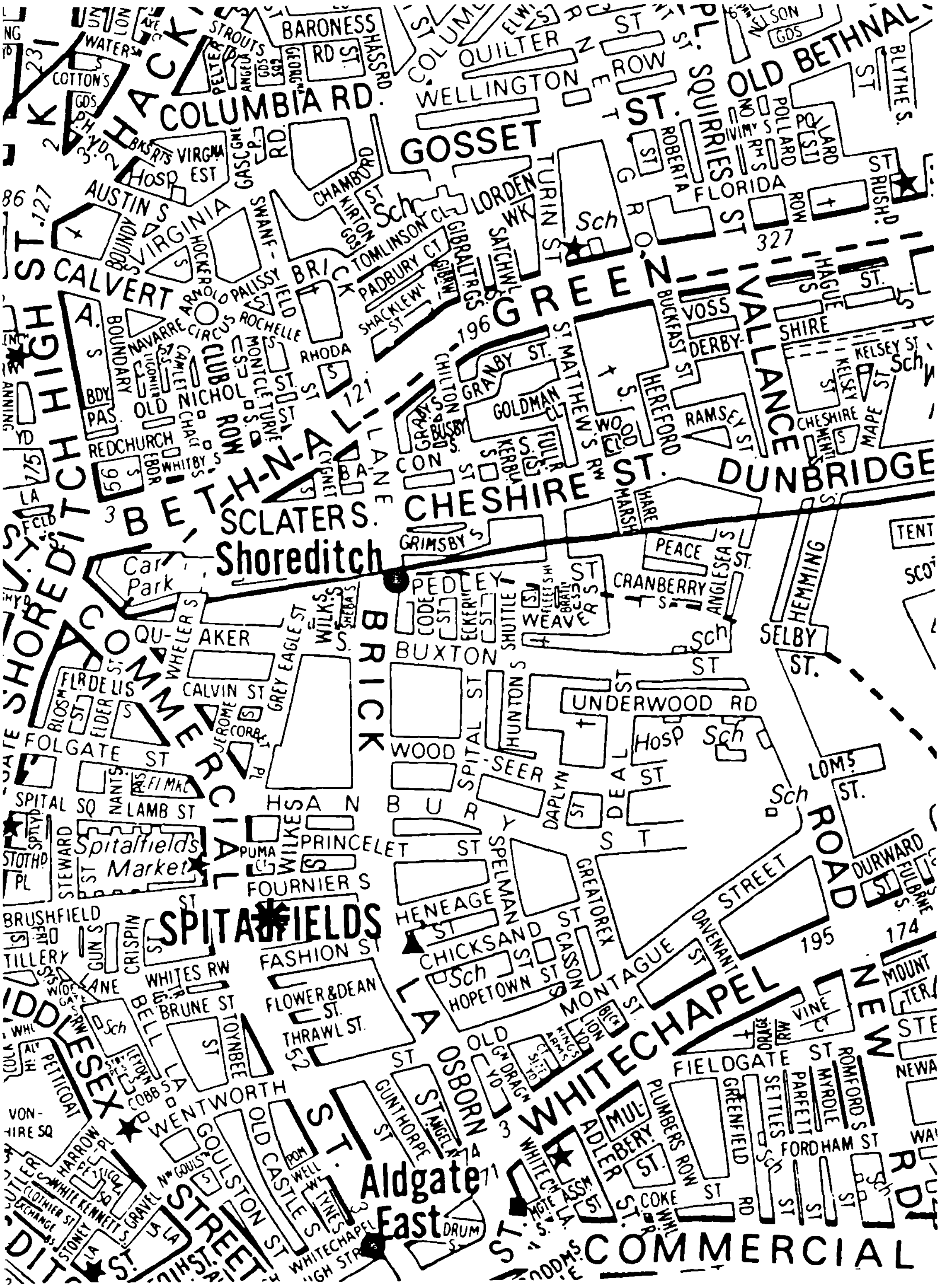
2.1 The History of the Site.

Christ Church, Spitalfields (see plate 11) is situated to the east of Bishopsgate and the city of London. The church is located at the junction of Fournier Street and Commercial Street (see figure 5). The contemporary nature of the area is coloured by the activities of one of the largest fruit and vegetable markets in England, and a multitude of Bangladeshi textile workshops.

Christ Church was designed by Nicholas Hawkesmoor (1666-1736), construction began in 1714 and was complete in 1729. The interior was modified by Ewan Christian in 1866 to bring the church into line with contemporary ecclesiastical ideologies. These alterations are today considered to be deleterious in their effect on what is considered by some to be one of the finest Baroque churches in northern Europe.

Christ Church was consecrated on 5th July 1729, the first burial took place on the 8th, just three days later and the last on 23rd February 1859. Following an order of 1813, all of the corpses were enclosed in lead, some being in triple shelled coffins. An estimated 68,000 funerals took place at Christ Church. There is however, no record of exactly how many people were interred within the crypts and how many were buried in the church yard.

The positions of the parochial vaults and the private family vaults are shown in figure 6. The coffins occupied the complete floor area within these vaults and



✱ Christ Church

Figure 5 Taken from Davies 1987, 73.

were stacked on top of one another. They were covered with a "sanitizing" layer of charcoal and sand when the vaults were sealed in 1867.

2.2 The Excavation

In 1965 restoration of the church to its original design was initiated along with essential repairs and in order to facilitate secular and religious use, the provision of ancillary facilities. Consequently, the Rector, the Churchwardens and the Parochial Church Council proposed the exhumation of the burials interred within the western half of the crypt, an area estimated at approximately 2,000 square feet.

Excavation of the vaults under the direction of Jez Reeve began in 1984 and was completed in 1986. It was the first scientific excavation of church vaults ever to be undertaken in Great Britain.

The nature of the site meant that new methodologies had to be devised as and when the need arose. There were several tunnels, a number of small family vaults and the much larger parochial vaults all of which were full of coffins. Plate 12 illustrates the task confronting the archaeologists. In the tunnels, excavation had to be carried out from the side working inwards, in the larger vaults excavation was from above. This caused problems as the archaeologists were effectively walking on top of the deposits of coffins which in some cases were already fragmented.

In order to be able to reconstruct the excavated deposits from each area on the plan and ensure that each coffin plate could be relocated with the relevant skeleton, a single matrix recording system was adopted. Each skeleton was given an identification number as was every component of the coffin, its furniture and all other deposits.

Plate 12. Unexcavated parochial vault.

Although the excavation was instigated primarily to provide anthropologists with a skeletal sample of known age at death and sex, the archaeologists aimed to retrieve information about 18th and 19th century burial practice, formation processes in a mortuary context and typologies of burial furniture, clothing and coffins.

The excavation was carried out in appalling conditions. It proved impossible to ventilate the vaults adequately and this did little to alleviate the high dust levels and unpleasant smells. Furthermore, the poor ventilation made it impossible to wear the breathing masks which were essential not only to prevent the inhalation of dust but also of lead oxide. The psychologically depressive effects of the conditions were excacerbated by the nature of the excavation. The removal of skeletons and cadavers in varying stages of decay proved a very exacting occupation. The results were a high turnover of staff and a high incidence of sick leave for minor ailments. That the excavation was completed is to the credit of the director, who had to shoulder the responsibility of the excavation without the backing or supervision of any museum or university prior to the commencement of post excavation analysis, when the university of Bradford became involved.

Preliminary post excavation analysis is almost complete and the combined archaeological and anthropological report is due to be published in 1989 by the Council for British Archaeology.

Direction of the anthropological aspect of the project was undertaken by Theya Molleson of the British Museum (Natural History). The main object was to retrieve a sample of skeletons of known age at death and sex. The possibility of retrieving further biographical data about the sample was considered a tantalising bonus. The size of the named sample was determined by the number of skeletons retrieved in securely contexed association with legible coffin plates, see plate 13. Ultimately 968 skeletons were recovered, 387 of these had legible coffin

PLATE 13

plates. Each skeleton retained the identification number allocated by the archaeologists, the abbreviation "CAS" preceeds the four digit number which always begins with the digit 2 which denotes that the "find" is a skeleton (these are used in this text when refering to individuals).

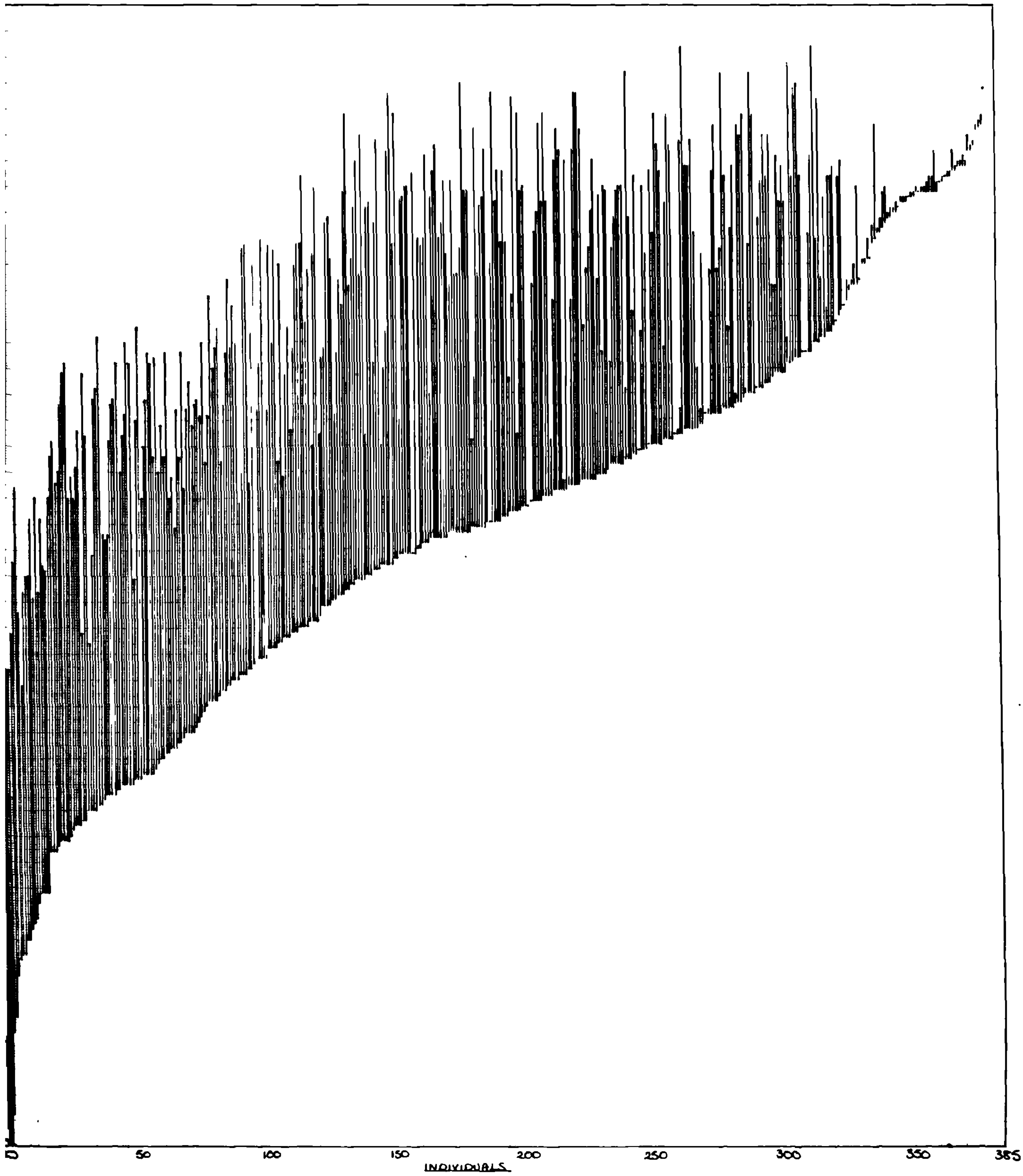
The abundance of historical data available for the period of concern has facilitated the recovery of a wealth of biographical and environmental data relating to the named sample. Consequently the following description of the sample, based largely upon historical data, is far more complete and secure than is usual when describing skeletal populations. These data were collected in 1987 and analysed in 1988. English Heritage funded this research.

2.3 The Historical Background.

The period which is of concern is determined by the date of birth of the 'first born' of the named sample and the date of death of the last known interment. Plate 14 illustrates the lifespan of the named sample within the chronological period of concern.

The earliest known birth was Susannah Hull (CAS 2169), who was baptised on 16th January 1646 at St. Dunstan's Stepney. The daughter of Richard and Christian Hull, very little is known of her life history. Unless she married isonymously, and no record has been traced, she died a spinster in January 1732, aged 85. Susannah's birth represents one boundary of the study, the other is marked by the death of William Louis Moinier Leschallas (CAS 2910), a writing paper

PLATE 14



manufacturer and exporter who died on 13th December 1852, aged 57.

The period 1646 - 1852 encompasses two hundred of the most dynamic years of British history. The world of Susannah Hull was much smaller and vastly different from that familiar to William Leschallas. Grossly over-simplified, the period saw the gradual change from the medieval, religious and teleological outlook to a more modern, scientific and mechanistic stance (Walker 1982, 6).

This period witnessed the Agrarian Revolution, which fed the rapidly increasing population, and freed them to become the necessary labour force, just one factor facilitating the Industrial Revolution. The Commercial Revolution was concomitant with the former, and fiscal development was stimulated by all three and the demands of government.

Almost continuous warfare retarded economic development and diverted revenue from more constructive usage. Wars also created hardship and hunger and social disorganisation for many.

Susannah Hull lived through such well documented events as the Great Plague of 1665, and the Fire of London in the following year. She might have been aware of the significance of the Bill of Rights and the Religious Toleration Act both of 1689. The completion of St. Paul's Cathedral in 1710 is unlikely to have gone unnoticed and she would have been well aware of the prosperity and development of the hamlet of Spitalfields.

Before the birth of William Leschallas in 1795, notable historical events included Culloden in 1746, James Cook's discovery of New South Wales in 1770, the American War of Independence in 1775 and the French Revolution of 1786.

William himself would not have been oblivious to the developments in steam transport, shipping and railways. Although only a youth, he may have been aware of the Luddite Riots of 1811 and the passing of the Corn Laws in 1815. On his own doorstep, he could not have failed to notice the decline and demise of the Spitalfields silk industry and the poverty and hardship suffered by the journeymen weavers living in the urban slum, which had just two hundred years previously, been an attractive rural hamlet. Appendix 2 is an historical fact sheet of the period 1646 to 1860. It includes data reflecting the cost of living, for example the prices of wheat and coal.

2.4 The Development of Spitalfields.

The parish of Spitalfields was created from the manor of Stepney, owned by the Lords Wentworth between 1550 and 1720. An act of George II gave the hamlet parochial status in 1729, the year which saw the consecration of Christ and All Saints Church. Thomas Hull (CAS 2186) was the 51st entry in the burial register and the first interment among the named sample. He died on 30th June 1729 aged 51.

"Spitalfields" derived its name from "land belonging to a hospital'. It was the site of St. Mary Spital, the largest medieval hospital in London

(Cartwright 1977, 25). Founded by Walter Brune in 1197 it was part of the Augustinian Priory of St. Mary. The name Spitalfields had developed by 1588 from Seintmariespital in 1394, Spitelland in 1399, and Spyttlefeildes in 1561 (Field 1980, 87).

The earliest known use of the site was as a Roman cemetery. This reflects its proximity to one of the main roads leading out of Londinium. Stow records the discovery of both interments and cremations when the fields were dug for brick earth in the late 16th century (Sheppard 1957, 1).

In the 12th century, as mentioned above, the area east of Bishopsgate became the site of a priory and hospital. The two Liberties of Norton Folgate and the Old Artillery Ground were probably coextensive with the priory, they retained their autonomy until 1900 when the borough of Stepney was created.

Residential development of the area began after the dissolution in 1532 and by 1598 Stow described the area as "covered with many fair houses" (Manchee 1913, 301). Norton Folgate came into the hands of the St. John family, the Earls of Bolingbroke. They adapted the former institutional buildings for residential use. Proximity to the city coupled with immunity from parochial or manorial authority made the area attractive to Roman Catholic recusants and other non conformists (Sheppard 1957, 2).

The southern part of the precinct was a teasel ground, cultivated by clothworkers at the time of the dissolution. Until 1682 it was used as an archery and

gunnery practice site, hence it derived its name the "Old Artillery Ground". From the 1680's the area was laid out in streets of cheaply constructed houses by Nicholas Barbon and it was granted a market franchise by the crown.

The land to the east of the precinct was undeveloped through the middle ages. Belonging to the manor of Stepney it was dug for brick earth and as late as 1669, bricks used for the development of the area were dug and fired on this site (Sheppard 1957, 3). As Brick Lane derived its name from early land use, so did the Tenter Ground. To the south of the precinct, it was used by clothworkers as an area on which cloth was stretched on "Tenter Hooks", see figure 7.

A large part of what had been the priory precinct came into the ownership of the Wheler family. The northern and southern areas were developed in the 1650's-1670's.

By 1662 the area was considered sufficiently developed to acquire its own churchwarden (Sheppard 1957, 3). The hearth tax returns indicate that there were 1,336 houses in the area. Whilst 40 of these had eight or more hearths, the majority were very humble.

Immigrants, fleeing religious intolerance in France, began to settle in England following the Massacre of St. Bartholomew in 1572 and by the mid 17th century the area outside Bishopsgate was known as "Petty France". By the early and mid 18th century the Spitalfields area had a homogeneity arising from the French immigrants and the development of the silk industry in which the French played a crucial role.

The prosperity achieved by the Huguenot master weavers and silk manufacturers stimulated the development of quality housing on the St. John estate in Norton Folgate between Blossom Street and Spital Square, and west of Brick Lane on the Wheler estate between Brown's Lane (now Hanbury Street) and Church Street (now Fournier Street). These houses were of various sizes and quality with imposing facades. Some still stand today.

By the early 18th century there were nine French churches in Spitalfields and two Anglican Chapels of Ease. A workhouse was opened in 1727, in 1746 120 individuals were maintained, inmates wound silk for local throwsters. By 1752 larger premises were needed and it was removed to Mile End New Town. In 1746, Spitalfields had four almshouses and a charity school in Corbets Court (Manchee 1913, 314). Figure 7 shows the relevant part of John Roques map of London of 1746, it illustrates the area which had been developed at this time.

The mid 18th century also saw some redevelopment of existing housing. The surviving Huguenot shop fronts at Numbers 56 and 58 Artillery Lane date from this period. Whilst there were some desirable residences in Spitalfields, most of the parish was very poor. Many houses were subdivided into lodgings from this period, and any new construction was modest in intent catering for the poor weaver and his family. By 1807, the Christ Church Vestry Minute books record that Spitalfields was "inhabited almost entirely by poor persons" (Sheppard 1957, 7).

The population of Spitalfields is considered to have fallen from 21,420 to 15,091 between 1710-11 and 1801 (George 1965, 409). However, given the increase in housing density during this period and references to the sub-division of houses, these figures lack credibility. It is likely that the former figure was based on a vague historical estimate whilst the latter was derived from the more reliable census returns. In the 19th century the population of Spitalfields began to rise, reaching 17,949 by 1831, and as conditions continued to deteriorate the value of property fell. Annual Real property was valued at £37,695 in 1815 and £29,930 by 1828 (Comparative Census Account 1801-31 1831, 161). Figure 8, Faden's map of 1813, shows that the entire area was developed by this time.

The abandonment of the Spitalfields Act in 1824 led to the decline of the Spitalfields silk industry, Cobden's Treaty of 1860 hastened the end and the occupational nature of the parish began to reflect the success and redevelopment of the market and the growth of Truman's Brewery. The influx of Jewish refugees, fleeing from the pogroms in Eastern Europe in the second half of the 19th century, led to the development of small clothier's workshops and furriers. The construction of Commercial street, the development and subsequent transformation of the Great Eastern Railway terminus into a goods station, finally destroyed the domestic nature of the area. War damage and continued 20th century

redevelopment has changed the face of Spitalfields and only the current immigrant population and their association with the textile industry serve as a reminder of the past.

2.5 The Climate

The period 1646 to 1859 was one during which the climate of Great Britain varied enormously. However, in general terms it was colder than it is today, the beginning of the period falls within the latter stages of the "little ice age" of 1550 to approximately 1700 (Lamb 1981, 301). This period ranks with the warmest postglacial period of approximately 6,000 years ago (ibid).

Fortunately, the period was one during which scientific instruments for measuring temperature and humidity were developed, consequently, accurate series of data are available. Importantly, these were collected on a regional basis and exist for the south-east of England.

The 1690's experienced the coldest winters of this period, closely followed by the years 1750-80. The springs of the 1690's and the summers of 1810-19 were also notably cold. The Thames froze over in London at least eleven times in the 17th century, again in 1709, 1716 and in 1813-14. On average the period 1670-1700 experienced between twenty and thirty days annually with snow on the ground, in the 20th century the average is between two and ten days (Manley 1974).

After 1700 the weather became much warmer though only for a short time, another warm spell occurred in the later 1740s and 1750s again in the 1780s and between 1800 and 1808. Extremes of variability recurred through the 18th and 19th centuries, an example of this is demonstrated by the mild winters of 1723-4 and the 1730's yet 1725 produced the coldest summer of the period and 1740 the coldest year on record since 1659. Average summer temperatures in the later 18th century were in fact warmer than 20th century summers.

The wettest summers on record were in 1751-60, 1763-72 and 1775-84, these resulted in harvest failures and hardship. The cool and wet summers were economically more detrimental as they affected food supplies. Climatic instability causes disease as a result of hunger and can excacerbate the effects of certain epidemics. For details of the effects of climatic change both on mortality, morbidity, metric variation and non metric skeletal traits see the forthcoming report (C.B.A. 1989).

2.6 Origins of the Sample.

The most striking aspect of the list of names derived from the coffin plates is that 41.6% (161 of 387) are French. One hundred and twenty eight (33.1%) are English and the remaining 98 (25.3%) are ambiguous or unknown. Some appear to be from the Low Countries, for example the Backer family (CAS 2440 & 2364) and Elizabeth Schleicher (CAS 2596), Moser (CAS 2406) is apparently a Swiss name. For basic biographical data of the named sample, see Appendix 3.

The underlying reason for the high incidence of French names was the religious intolerance in their homeland. Usually encouraged for political reasons, it appears to have been widespread in Europe from the Middle ages well into the 19th century. The French names reflect the fact that England granted freedom of worship to protestant refugees from Europe. Huguenot refugees settled in London from the mid 16th to the mid 18th centuries. Seven of the 206 (3.4%) individuals whose place of birth has been established were born in France, the Huguenots settling in Spitalfields came predominantly from Normandy, Picardy and Poitou.

The origin of the term "Huguenot" remains obscure, historically it has been applied to French protestant refugees fleeing from religious persecution and continues to be so. For further information about the Huguenots see Appendix 4.

2.7 Where Did They Live?

Tom Shuttle was his name, and he
In Spitalfields resided;
But wand'ring far for love of she,
At Islington he die did.

The Spitalfields Weaver or, Tom Shuttle and Blousalinda, A Dolorous Ditty. 1821, 4)

The addresses of individuals alive in 18th and early 19th century London can be traced in several ways. The obvious starting point is with the burial register of the parish of Christ Church since this would indicate where each individual lived when he or she died.

The addresses of 21 of the 387 individuals known to have been interred within the crypts could not be retrieved from the burial register. Six burials were not registered, surprisingly three of these were of fairly prominent citizens; John Rondeau (CAS 2430) a master weaver also sexton of the parish for 29 years, a master weaver of the Mesman family (CAS 2954) and John Stubbs (CAS 2811), one of the proprietors of the Norton Folgate Brewery (Sheppard 1957, 81). One address was illegible, eight were not given and six individuals could not be located in the register due to insufficient coffin plate information. Two of the missing addresses were obtained from other sources, leaving 19 "abodes at death" unknown.

Mid life addresses can be established from appropriately dated Trade Directories, Land Tax Returns, the Christ Church Vestry Minute Books and Company Records. Another useful source are marriage registers, which usually record the parish in which both parties lived, they rarely note street names. The addresses of 98 individuals have been traced from these sources.

Places of birth can be traced from baptism registers after 1750. They can also be deduced from parents' marriage certificates and appropriately dated Trade Directory, Land Tax and Guild records. One hundred and thirty one places of birth have been established, mostly from the parochial registers.

As data are most complete for the later years of the crypt sample's lives, it seemed best to concentrate on these as they provide the most complete picture. For ease of manipulation the Parishes in which individuals died have been analysed (see appendix 5). Sixty-one different parishes are represented, two liberties, and the six counties of Middlesex, Surrey, Essex, Berkshire, Hertfordshire and Hampshire.

At the time of their death 38.5% (142 of 369) of the crypt sample lived in Spitalfields and 38.7% (143 of 369) in the neighbouring parishes of Bethnal Green, Shoreditch, Whitechapel, Bishopsgate, Stepney, Mile End New Town, and the two liberties of Norton Folgate and the Old Artillery Ground; 21.7% (80 of 369) from other London parishes; and 1.3% (4 of 369) from outside London. (See table 1 below)

Very little literature exists that deals with the distribution of addresses in relation to the parish of burial, specifically of crypt interments, as it is impossible to differentiate between church yard or crypt burials from the parish registers. In order to establish whether the crypt sample is representative of the parish as a whole, the "abode at death" has been analysed from the burial register of those dying in 1730 and 1731, and from 1819 and 1820. Larger samples would have produced more reliable results and a total study the most reliable. The time difference between the two blocks provides an opportunity to examine chronological change. The only selection criterion applied was to avoid periods of unusually high mortality, such as periods of epidemic, dearth or severe weather. Equally the 1730's rioting in the parish was not considered sufficiently important in terms affecting mortality to avoid these years. The results are shown in Table 1, with those of the crypt sample.

Table 1. Addresses at Death of those Buried within Christ Church.

Abode.	P.R.1730/31.	P.R.1819/20.	Crypt Sample.
Spitalfields	94.7%	75.2%	38.5%
Nearby parishes	2.6%	18.2%	38.7%
Other Lon. pars	2.5%	6.4%	21.7%
Outside	0.2%	0.2%	1.3%
Totals	931.	645.	369.

The parish register sample was derived from 32 parishes, in contrast to the crypt sample's 61, two liberties and the five counties of Middlesex, Surrey, Kent, Yorkshire and Warwickshire.

These results are interesting in several respects. First, there seems to be a chronological change in the parish record population. In the 19th century the number of non-parishioners electing to be buried at Christ Church increases. This is surprising as burial outside the parish of residence incurred double burial fees (Gittings 1984, p.132) and high transport costs. Furthermore it is well documented that Spitalfields, and its neighbours where the change is most apparent, were in economic decline from the late 18th century.

Secondly, and of greater importance to this study, the crypt sample is atypical of the parish register sample at either end of the chronological spectrum. That the parish sample appears to behave differently in the 18th and 19th centuries respectively, suggests the possibility that the crypt sample might show a similar trend. There is a significant economic change in the status of crypt sample either side of 1800 as demonstrated in 2.7. This was seen as sufficient reason to divide the sample for analysis accordingly. The results of the chronological breakdown of the crypt addresses are shown in Table 2 alongside the parish register data.

Table 2. Addresses of those Buried at Christ Church in the 18th and 19th Centuries.

	Parish Register Sample		Crypt Sample	
Abode	1730-31	1819-20	Pre 1800	Post 1801
Spitalfields	94.7%	75.2%	44.6%	34.9%
Nearby Parishes	2.6%	8.2%	33.1%	42.4%
Other Lon.Pars.	2.5%	6.4%	20.1%	22.3%
Outside London	0.2%	0.2%	2.7%	0.4%
Totals	931.	645.	139.	230.

These results seem to suggest that although the crypt population is notably different in composition from the parish, it is following the same overall trend in that the percentage from neighbouring parishes increases in relation to those from Spitalfields itself. A possible explanation for this trend is suggested in a comment of the Reverend William Stone to Edwin Chadwick in the 1840's. He suggests that undertakers were smuggling in bodies from outside the parish in order to avoid paying the double fees which were charged in Spitalfields as they were elsewhere (Rude 1971, 55). The address data of the crypt sample suggests that they are not representative of the parish as a whole. This raises two questions. In what ways were they different and why did they choose to be buried within the vaults of Christ Church?

The answer to the first question may lie in the high social and economic status of the sample, particularly those who died during the 18th century. Most were engaged in profitable occupations and professions, and many inherited wealth both in terms of capital and land. This group of people could afford to be buried intramurally (some had family vaults), a proposition which at this time seems to have held greater appeal than interment in the horribly overcrowded burial grounds where: " the decaying bodies, constantly disturbed to make

way for others, began to pollute the air of the neighbourhood," (Stone 1979, 233). This generalisation also applies to some of the 19th century population, the majority of this group were less wealthy than the earlier group but nevertheless were among the better off living in the Spitalfields and Bethnal Green area. Another interesting factor in the later group is that a very high proportion of the infant and juvenile deaths are from the 19th century. Of this group 91.5% lived in or near the parish of Christ Church, suggesting that their place of burial could be based upon convenience. Why there are so few children from the earlier period is unclear since these families suffered equally high infant mortality rates. For detailed discussion of the housing conditions of the Christ Church sample see appendix 6.

An answer as to why so many non-parishioners chose to be buried within Christ Church may be gained from detailed examination of the life histories of individuals'. Where known, mid-life and birth addresses are shown in Table 3.

Table 3 Lifetime Addresses for the Crypt Sample.

	Abodes at Baptism.	Abodes at Marriage
Spitalfields	58.8%	76.5%
Nearby Parishes	25.2%	18.3%
Other London Parishes	9.2%	5.1%
Outside London	1.5%	
France	5.3%	
Sample Size	31.	98.

Addresses both at baptism and marriage have been established for only 28 individuals. Only four were baptised, married and died resident in the parish of Christ Church. (For details see Appendix 7.) Eleven celebrated two out of three events in the parish and five were never residents. One individual who never resided in the parish was Mrs Jane Julien (nee Ogier) who died in 1791 aged 78 (CAS 2609). She was born and baptised in Moncoutant, Poitou, France in 1713. Having fled religious persecution in France, her father Pierre Ogier II (CAS 2863), a prosperous silk merchant, settled in Spital Square, Norton Folgate. In 1751, Jane married Abraham Julien (a widower with three daughters), at St. Paul's, Covent Garden. Why she chose to be married at Covent Garden is unknown, there were many more convenient churches including Christ Church. Childless, she died at Twickenham, a popular retirement area of the time. (For further information about retirement addresses see Appendix 8.)

It seems probable that her choice of final resting place lay in the close proximity to Christ Church, of Spital Square, where she spent much of her early life.

Jane's sister Mrs Louisa Perinna Courtauld (CAS 2309), was also born in France, she married at St. Luke's, Old Street and lived and worked at Cornhill in the city. Louisa retired to Clapton, died aged 77, in 1807 and also elected to be buried within Christ Church. (Rather surprisingly, the wealthy Ogier family did not purchase a family vault.) Another sentimental link these two women had with the parish was that their brothers, notably Peter III (CAS 2863) and Thomas Abraham Ogier, like their father were successful in the silk industry. Peter Ogier (CAS 2863) was also buried in the crypt, his tie with the area seems to have been very strong. Before his death he returned from retirement at his country estate to live in the Old Artillery Ground, where he had previously owned business premises. The story of this 18th century family is typical of Huguenots who settled and prospered in the vicinity of Christ Church, if not the parish itself.

A more remarkable example of the pull of family tradition, again in a family of Huguenot ancestry, can be seen in the 19th century sample. Many of the professional people buried at Christ Church, resided and were employed in the City, Westminster and adjoining parishes. William Mills Pulley (CAS 2363), a proctor and notary who died in 1847 aged 61, lived, worked and died at No. 5 Great Garter Street, Doctors Common, Holborn (1845 Court Directory G.H.L.). He was baptised at St. Anne's, Blackfriars. No record of his marriage seems to survive, although the baptisms of his three children at St. Andrew's, Holborn are listed in the International Genealogical Index. No evidence has been traced to imply that he ever lived in or near Christ Church. However, references to "Pulleys" living and working in the 18th century parish of Christ Church abound in the parochial records, land tax returns and in the records of the Weavers Company. In fact William's father lived in Booth Street in 1760, where he was liable for nine shillings land tax (G.H.M.S.6008/12).

Another member of the family among the crypt sample is Mrs Frances Pulley (CAS 2267), William's sister in law, she died in 1843 aged 82. Born in Shoreditch, her husband Joseph was a member of the Stock Exchange. They retired to Hackney and are a further example of family tradition overriding convenience and determining the place of burial. No evidence has yet come to light suggesting the same strength of tradition among the non-Huguenot sample.

2.8 Status.

> The great, who live profusely.
> The rich, who live plentifully.
> The middling sort, who live well.
> The working trades, who labour hard but feel no want.
> The country people, who fare indifferently.
> The poor, that fare hard.
> The miserable, that really pinch and suffer want.

(Daniel Defoe, The Review, 25 June 1709. Cited in London Life, p 368)

An indication of the socio-economic status of the named sample has been established. This is based largely on their occupation and their position within their particular occupational structure. These data have been supplemented by information derived from wills, insurance policies, Land Tax Returns and Company membership. There are considerable problems and limitations inherent in basing status on such criteria, and at the end of the day, all that can be said with certainty is that the results reflect modern historiography.

Status has been divided into the following categories:

<u>Artisans</u>, includes shopkeepers, journeymen, labourers and those in the building and heavy metal industries.

<u>Master Craftsmen</u>, mainly weavers but including such as cabinet makers and goldsmiths.

<u>Professionals</u>, includes those employed in finance, law, the church, medicine and public servants.

<u>Merchants</u>, are specifically titled and do not include food retailers and "shopkeepers".

<u>Wholesalers</u>, are specifically so. It is assumed that their economic status would be higher than retailers.

<u>Independently Wealthy</u>, includes "gentlemen", and those of means for whom no specific occupation is evident. Many of those in all categories other than "artisans" are known to have inherited capital and, or land.

For details of the socio-economic status of the named sample, see table 4. This illustrates both the sample as a whole and split into two chronological groups, representing the 18th and 19th century samples separately.

Table 4. Status of the named sample (%)

Category	* 1729-1800	*1801-1852	Total
Artisan(%)	17.0 %	68.3 %	47.9%
Master Craftsmen	61.7	12.0	31.8
Professionals	11.7	10.6	11.0
Merchants	6.4	2.8	4.2
Wholesalers	0	4.2	2.5
Independently Wealthy	2.2	2.1	2.1
Sample Sizes (n)	94	142	236

* Year of death.

These results are informative, particularly the chronological perspective. The ratios of master craftsmen to artisan are almost reversed either side of 1800. This reflects the changing character and occupational identity of Spitalfields.

The status of the named sample seems to be a mix of Defoe's "middling sort", and his "working trades". Two groups who "live well" and "labour hard but feel no want" respectively. For discussion of the educational attainment of the crypt sample refer to appendix 9.

An indication of the wealth acquired by the named sample can be gleaned from their estates and their insurance policies. The estate of Mr Edward Peck who laid the foundation stone of Christ Church in 1715 was valued at over forty thousand pounds (Spitalfields Parish Church Magazine July 1916). John Brown (CAS 2939), who married Edward's daughter Frances, inherited this fortune and from him it went to John Peck and his wife Deborah (CAS 2930). Their niece Elizabeth married Sir Robert Ladbroke (CAS 2936) and they inherited the ever increasing "Peck" fortune. From them it eventually found its way to Henry Ladbroke (CAS 2936), a nephew. A fortune founded on the success of Spitalfields' silk was eventually invested in Banking and country estates. This trend is typical among the descendants of the successful silk merchants.

Daniel Mesman (CAS 2444), who died in 1765, left his eldest daughter Jane (unmarried) three thousand five hundred pounds capital bank stock, the lease of his house at Southgate and the furniture from his house in Spital Square. Warehouse furnishings and stock he left to his sons in trade, and to his daughter Lucy and her husband Daniel Giles he left two thousand five hundred pounds capital bank stock (Will pcc Rushworth folio 192 Middlesex May 1965. Rothstein personal communication). This will illustrates that the Huguenots, unlike the majority of the wealthy English, did not practice primogeniture (in order to keep their estates intact). Furthermore sons do not seem to have received preferential treatment.

Illustrating the diverse fortunes of the named sample a broker, Peter Dupuy (CAS 2898), who died in 1804 left one shilling each to his sons Peter and Daniel (Huguenot Research File)!

A sense of responsibility for dependents can be seen in some wills. Peter Ogier II, the father of Louisa Courtauld (CAS 2309), Jane Julien (CAS 2609), Frances Merzeau (CAS 2789) and Peter Ogier III (CAS 2863), left 2,560 pounds to each of his children and 500 pounds and his household effects to his widow. He directed that the remainder of his vast estate should be invested, the interest going to his widow for her lifetime, their children inheriting the residue of the capital upon her death (Sander 1986, 26). A reflection of the preoccupations of the wealthy "middling sort" can be seen by bequests of Peter's widow, Catherine (nee Rabaud): "To

> my five sons...and to my four daughters...to each of them the sum of fifteen pounds sterling for mourning...Item I give and bequeath to my said daughter Louisa Perinna all my cloaths linnen and other things belonging to my wearing apparell by reason that they fitt her better than any other of my said daughters..". (sic) (Sander 1986, 45). Both of these

bequests reflect that in the mid 18th century, even comfortably off individuals bought only limited quantities of clothing.

Insurance policies also serve to indicate the materialistic level of wealth acquired by individuals. Edward Mason (CAS 2608) a weaver and factor of Steward Street, the Old Artillery Ground, insured his house contents in 1746. These are described as "Household goods...and wearing apparel, plate, china, glass, books, utensils and stock...for one thousand pounds" (Sun Ins 11936 Vol. 76 p.205 105329 24/06/1746). Peter Isaac Galhie (CAS 2727) and his brother Paul, weavers also insured property in Steward Street. Household goods were insured for one thousand nine hundred and fifty pounds and weaving apparel for fifty pounds (Sun Ins 11933 Vol. 137 p.23 180615 10/12/1761).

Few of the named sample owned the property in which they lived freehold, although many held leases as Daniel Mesman above. Several of the master craftsmen and the professionals owned country estates. Charles Shaw

LeFevre (CAS 2221) was Lord of the Manor of Burnley, and he owned estates at Old Ford and Heckfield Place near Southampton. Peter Ogier III (CAS 2863) owned an estate between Sydenham and Lewisham in Kent and the Ladbrokes (CAS 2926 & 2936) held property at Frenches, Surrey. By contrast, William Harwood (CAS 2613) owned several houses in Brick Lane (Land Tax Returns).

It appears that many families interred within the vaults of Christ Church were wealthy by the standards of the day. However, fortunes could fall as well as rise, and the father of Master Robert John Blachford (CAS 2730) suffered this fate. Richard Blachford was a successful Gold Lacemaker with business premises in Lombard Street. He was a member of the Goldsmiths Company and a citizen of the city of London. By 1824 his business was failing and he resigned from the Goldsmiths Company and gave up his rights as a freeman of the city (Field personal communication). For details of the philanthropic activities of many of the crypt sample and their roles in public life refer to Appendix 10.

Chapter 3 The Crypt Sample: their Life Styles.

3.1 Occupations.

Historical Background

In 18th century London trade and occupation fell into categories which reflected the political, marketing and geographical characteristics of the capital. London was the main port of England and the headquarters of coastal shipping. Such trades as shipbuilding and supply, cooperages, breweries, distilleries and sugar refineries were all dependent upon this for exports and distribution for home consumption. London was the centre of production of such high class goods as clocks, watches, optical and mathematical instruments, jewellery, furniture and coach building. As the seat of government and the court London was the centre of conspicuous consumption. Trades serving the needs of the rich and prosperous thrived, both in terms of material goods and professional services. These varied from peruke makers and milliners to lawyers, stockbrokers and bankers.

As industrialisation progressed and changed the economic face of the country London's role as a port and manufacturer declined. Industries developed in other areas gaining access to the London markets as a result of improved transport systems.

Eighteenth century London was "...an age of minute social distinction." (George 1965, 165). Within specific occupational groups lines were drawn between the master craftsman and the journeyman, and the artisan the labourer. Ancient differences between the latter were eroded by the growth of new industries which employed workmen under a skilled foreman, instead of journeymen who had served an apprenticeship. Brewers, distillers, tobacconists, sugar refiners and soapboilers were considered as labourers but, they could be as highly paid as journeymen in the lower paid trades such as silk (ibid.). Older trades of similar character such as tallow chandlers and tanners, employed journeymen at labourers wages. Artisans in the building trades and Smiths employed labourers to perform the heavy and menial aspects of their trade. In many professions it is not possible to deduce economic status from profession alone, particularly when the exact "grade" of an individual within a complex occupational structure is obscure. A master craftsman might employ a large number of journeymen and own a well stocked retail outlet, or he might work alone and own only the tools of his trade.

London trades and professions tended to cluster in particular areas, hence each locality would develop its own particular manufacturing and business identity as well as provide locally required supplies and services. Many crafts and industries developed outside of the city and in extra parochial precincts to avoid guild and parochial restrictions and dues.

The Occupations of the Crypt Sample

The occupational status of 61.2% of the named sample (237 of 387) has been established. In the case of adult males the occupation is their own, for the majority of adult females the occupation is their husband's or their father's if they were single. For children, their father's occupation has been used.

Occupations have been established from a variety of sources. Of the relevant parochial registers most baptism, and a small number of the earlier marriage records, give the occupation of the father or husband. The baptism records in particular have proved an extremely valuable source. The Christ Church Vestry Minute Books list the addresses and occupations of those standing for office. Data havealso been obtained from the London Trade Directories. This proved comparatively straight forward for those with unusual French names who were in business, their addresses were already known from the burial register, and this served as a cross check. Those whose occupations have not been traced are those whose marriages and baptisms do not give occupation, who are employees, and those with common English surnames such as Smith and Curtis.

For details of the occupations of the named sample see Table 5. In order to evaluate the possibility of chronological change the data have been divided into two groups, pre, and post, 1800. The totals are given for each occupational group.

Table 5 . Occupations of the named sample.

Occupation.	Pre 1800.	Post 1800.	Total.
Master Silk Weaver/Merchant.	55	7	62
Journeyman Weaver.	1	16	17
Silk Dyer.	4	10	14
Victualler/Grocer.	4	10	14
Carpenter.	1	11	12
Butcher.	5	5	10
Tallow Chandler.(incls.soap)	1	6	7
Bricklayer.	0	6	6
Cordwainer/Shoe Maker.	0	6	6
Cabinet Maker/Undertaker.	0	5	5
Tailor.	1	4	5

Occupation.	Pre 1800.	Post 1800.	Total.
Surgeon.	2	3	5
Rector.	5	0	5
Builders Merchant.	0	3	3
Cheesesmonger.	1	2	3
Merchant.(not silk)	2	1	3
Goldsmith.	1	2	3
Apothecary.	2	1	3
Bank Clerk.	0	3	3
Glazier.	0	3	3
Silk Broker.	1	2	3
Brewer.(1 proprietor)	2	0	2
Upholsterer.	2	0	2
Member of Parliament.	1	1	2
Haberdasher/Hosier.	2	0	2
Silk Throwster.	1	1	2
Stationer.(1 wholesale)	1	1	2
Pawn Broker.	0	2	2
Cooper.	0	2	2
Baker.	0	2	2
Painter/Plumber.	0	2	2
Smith.	0	2	2
Corn Chandler.	0	2	2
Sugar Refiner.	0	2	2
Tobacco Pipe Maker.	0	2	2
Brush Maker.	0	2	2
Tin Plate Worker.	0	2	2
Distiller.	1	0	1
Bookseller.	1	0	1
Gentleman.	0	1	1
Stockbroker.	0	1	1
Consul.	0	1	1
Coroner. J.P.	0	1	1
Pewterer.	0	1	1
Staffordshire Pottery Warehouseman.	0	1	1
Calico & Muslin Warehouseman.	0	1	1
Exciseman.	0	1	1
Cook.	0	1	1
Labourer.	0	1	1
Enamel Painter/Artist.	0	1	1
Author/Novelist.	0	1	1
Bird Dealer.	0	1	1
Soldier.	0	1	1
Barrister.	0	1	1
Salesman.	0	1	1
Publican.	0	1	1
Leatherfellow.	0	1	1
Potatoe Merchant.	0	1	1
Milliner.	0	1	1
Slaymaker.	0	1	1
Drysalter.	0	1	1
Proctor & Notary.	0	1	1
Bank Proprietor.	0	1	1
Totals.	97	153	250

Note. Where an individual is known to have had more than one occupation, each one is listed.

39.6% of the 250 known occupations are in the silk industry. 14% are in food retail and manufacture, this ranges from cheesemongers to sausage makers, bakers to potatoe merchants. 15.6% were involved in the building industries such as plumbing and bricklaying. Tallow chandlers are represented providing candles (among other items) a crucial provision through this period.

One of the more unusual professions represented by this sample was that of William Louis Moinier Leschallas (CAS 2910). On his death certificate he is described as a stationer and rag merchant, in the 1851 trade directory he is listed as a wholesale and export stationer and manufacturer of "Moinier's Linen Writing Paper". It is possible his business venture was unsuccessful, as in December 1852 he shot himself and died. A salutary lesson for human skeletal biologists is that none of the observers who examined this skull, including a forensic pathologist, identified the cause of death!

The remaining occupations range from a consul, two M.P.s, surgeons, and those involved in the legal profession, going down the social scale to brushmakers, bricklayers and a bird dealer. There are three Goldsmiths in the sample, Susannah Vine's (CAS 2507) husband is listed in the 1820 trade directory as a wedding and mourning ring manufacturer. Table 5 illustrates that the trades and professions became considerably more varied after 1800. It seems that by the third generation, many of the children of the prosperous Huguenots in the silk industry, withdrew from silk and entered the professions.

(Rothstein 1961, 216). For discussion of the organisation and decline of the silk industry in Spitalfields and of women in business see appendices 11 and 12.

Evidence from both successive baptism registers and trade directories illustrates that some individuals changed their occupations during the course of their lives. This does not seem to have occurred among master craftsmen, although an individual might be called a silk merchant in one source and a silk weaver in another. Similar variations in job descriptions occurred among the lower classes. Sarah Brookman's (CAS 2470) husband is described alternatively as a pork butcher and as a German Sausage Maker! Among the artisan class, some men changed their occupation. John Whisker (CAS 2442) (died 1822) was employed as a soldier, and later as a weaver. Samuel Dawson (CAS 2173) was a labourer, weaver and undertaker in that order (died 1816). More puzzling is the change in trade of Susannah Thommasson's (CAS 2166) husband (died 1750). He was described as a wax chandler when they married and a Goldsmith at the baptism of their children. It is possible that he may have taken over his father in law's business, but there is no evidence to support this.

Many of those involved in the professions seem to have also been public servants. Sir Robert Ladbroke (CAS 2926), who inherited wealth from the Peck family, was a distiller and grocer by trade. He became Lord Mayor of London in 1747, was president of Christs Hospital, a Member of Parliament and Alderman of Bridge Ward. Charles Shaw Lefevre (CAS 2221), a barrister, was the member of

Parliament for Reading for 18 years. Joseph Moser (CAS 2406) was Deputy Lieutenant for Middlesex and a magistrate for Westminster.

Joseph Moser's career is unusual among this sample. The son of a Swiss artist, he was born in Greek Street, Soho. Instructed by an uncle in enamel painting, he exhibited in the Royal Academy from 1774-1782 and in 1787. After marrying the daughter of the surgeon Peter Liege he abandoned his profession and retired into the country. Three years later he returned to London living in Romney Terrace, Westminster and devoted himself to literary pursuits. A novelist of little merit, he enjoyed only temporary popularity (Dictionary of National Biography 1894, 178). His association with Spitalfields remains obscure.

Analysis of the known occupations in conjunction with address data, land tax values, and sundry information, such as that derived from wills, suggests that the economic and social status of the crypt population changed around the turn of the century. Before 1800, 81.44% of those whose occupations are known were either master craftsmen, merchants or in the professions. After 1801, 73.18% were journeymen weavers, artisans or shopkeepers.

3.2 Nutrition.

Dietary Background

The diet of a population is a fundamental indicator of many elements of its society. It reflects technological status, resources and land to population ratios. Distribution reflects political, economic and social structures. Food intake affects metabolic rate, body growth and maintenance, susceptibility to certain infectious diseases and to metabolic disorders. Nutritional status is a determinant of stature, physical capacity, work productivity, demographic behaviour, morbidity and mortality (Rotberg and Rabb1983, p.303).

Unlike so many areas of this study, historical evidence relating directly to the diet of the crypt sample does not seem to survive. There are no extant descriptions of their daily menus or of recipe books describing meals frequently eaten by these individuals. Even if there were they would be unlikely to give quantities or the quality of foods consumed and such information is crucial to understanding this sample's nutritional status. The problem is compounded by the apparent decline in the economic status of the 19th century crypt sample which could explain the slight reduction apparent in the stature of the population as the period progressed.

For the 18th century sample in particular it is assumed that their relative wealth would have cushioned them against food shortages and high prices. However, their socio-economic status suggests that they would have followed fashions affecting diet. These range from the influence of immigrants on menus to the use of artificial feeds and wet nurses for infant feeding. They may have been susceptible to intestinal parasites which were prevalent in Britain until the 20th century, however, the few gut samples that were taken did not produce any evidence of such. They would have been exposed to the food adulteration so widely commented upon in contemporary sources (e.g. Jackson 1758, Punch 1851).

Developments in internal transport (turnpike roads and canals), improved agricultural technology (fodder crops, improved breeds, drainage and water meadows), the effect on food markets of imperialism and progress in commercial organisation all increased the range of foodstuffs available. These factors also improved the freshness and quality of the food that could be purchased during this period, for those who could afford them.

Stated simply, the diets of the wealthier classes, during this period were high in animal proteins and in animal fats. In fact English middle and upper class eating habits amazed foreign visitors. An account of the 1690's states: "I always heard thet they were great flesh

> eaters, and I found it to be true. I have known people in England that never eat any bread, and universally they eat very little; they nibble a few crumbs while they chew meat by whole mouthfuls...Among the middling sort of people they had ten or twelve sorts of common meats which infallibly take their turns at their tables..." (Stead 1985, 20).

A wide range of fruits and vegetables was available (see Table 6 below) and various types of cereal carbohydrates were consumed as bread and pastries. However, as the comment above exemplifies, it is widely believed that the wealthier classes ate only very small quantities of fibre, particularly in the 18th century. All classes are believed to have imbibed large quantities of alcohol.

An idea of what may have been a familiar day's fare to the comfortably off crypt population, especially those of Huguenot descent, may be gleaned from the Diary of William Tayler, Footman 1837 (Wise 1987). Mr Tayler was footman to the widowed Mrs Princeps, nee Auriol of Huguenot descent. She lived at No. 6, Great Cumberland Street. As her husband had been an M.P., an Alderman and High Bailiff this puts the Princeps family in the same social class as some members of the crypt population, for example, Sir Robert Ladbroke (CAS 2926), who died in 1773 and Charles Shaw Lefevre Esq. M.A. F.R.S. (CAS 2221).

Having described food below stairs several times William Tayler begins his entry for 14th May 1837 with;

> "I said some time ago I would give an account of the way the people live in the parlour....For parlour breakfast they have hot rolls, dry toast, a loaf of fancy bread and a loaf of common and a slice of butter. They have hot water come up in a hurn....they make their tea themselves. They have chocalate ...Lunch at one, they generally have.. some cold meat and vegitables. Dinner...two soles fryed with saws, a leg of mutton, a dish of ox, pullets, potatos, brocolo, rice and a rhubarb tart, a tabiaca pudding, cheese and butter...tea at eight with bread and butter and dry toast; never any supper-its not fashionable." (sic) (ibid 34).

On May 18th, Mrs Princeps entertained two gentlemen to dinner, it comprised; " ... fish, soop,

> saddle of mutton, piece of veal stewed, spinnach, two sorts of potatoes and a bowl of sallad. For second course, a roast duck, stewd coliflour, goosberry tart, orang jelly, custard pudding, two dishes of oranges, one of apples, one of sponge cakes, one of cracknells, one of prueins, one of raisons and almonds, wine &c. &c." (sic) (ibid 36).

There were incidentally, only two members comprising Mrs Princeps' household, herself and her daughter, the latter described as " an old maid" (ibid 9). Interestingly, this diet does seem to contain a reasonable amount of vegetable fibre. It seems unlikely however that this diet would have been familiar to those of those of the 19th century sample who seem to represent a lower social class, for example James Dickens (CAS 2580) who died aged 26, he lived in Rose Lane and was a tobacco pipe maker. On the basis of cost alone it seems likely that the less well off ate more bread and root vegetables, which were far less expensive than the animal fats and proteins favoured by the more affluent. Not necessarily an unhealthy diet depending on the quantities consumed.

The only direct evidence of the diet of the journeymen weaver and his family, comes from the end of the period, circa 1850-60. A woman weaver whilst describing her childhood mentioned that: "On Sundays...we

> had a cooked dinner, but on other days we had only bread and perhaps a red herring, or a piece of cheese."

(P.H.S.L. 1947-52, 288) How typical such a diet was is impossible to judge, it must be remembered that at this time the Spitalfields silk industry was in decline, and the hardship of the journeymen and their families the subject of contemporary comment. Nevertheless, eighteen members of the crypt population are known to have been dependent upon the income a journeyman, his wife and children, were capable of earning in the 19th century.

Diet and Health

Adulteration of foodstuffs may be detected by skeletal analysis. Microscopic trace elements analysis has yet to be undertaken. Evidence of lead poisoning has not been observed radiographically in the limbs of juveniles and it cannot easily be detected radiographically in adults. The issue of lead poisoning is one that may prove difficult to analyse in the Christ Church sample. Post mortem uptake of lead by skeletal tissue will mask ante mortem levels. This problem results from burial within lead coffins. After 1813 the Christ church vestry minutes recorded that subsequent interments should be in "enclosed in lead", consequently almost sixteen tons of lead were excavated.

It seems unlikely that the adult crypt population suffered dietary iron deficiency given the large quantities of meats they are reputed to have consumed. Vitamin C is necessary for efficient absorption of non-haem iron, this is mainly derived from certain fruits and vegetables. Per capita consumption of fruit and vegetables for the year 1851 are listed in Table 6. For comparative purposes, the figures for 1978 are also shown. Those foods high in Vitamin C are marked *.

Table 6. Fruit and vegetables consumed in London in 1851 & 1978.

Fruit	1851		1978
Apples	15.48lbs.		26.78lbs.
Pears	7.96		3.12
Oranges	7.34	*	12.97
Stone Fruit	5.68		3.64
Grapes	0.50		1.66
Soft fruits other than grapes.	8.22		2.37
Rhubarb	1.74		1.76
Nuts	4.22		1.76
Dried fruit	17.99		3.51
Vegetables			
Potatoes	148.64lbs	*	130.39
Cabbages	68.33	*	21.03
Broccoli and Cauliflowers	27.29	*	8.71
Turnips and Swedes	40.84		2.31
Carrots	6.87		11.28
Peas	3.34		15.67
Beans	2.28		18.56
Lettuce	1.71	*	5.53
Onions	31.82		13.20

Sources: Mayhew (1851) and Ministry of Agriculture (1980, 45-7) from Oddy 1985.

It seems unlikely that many of these items would have been consumed in their raw state and cooking destroys most but not all Vitamin C. Apart from fruits eaten raw, only salad would have provided substantial quantities of this vitamin. These figures are derived from data regarding the large fruit markets in London; obviously per capita consumption conceals those consuming more than average and the deprived poor.

During this period, it seems that many houses in the Spitalfields area had gardens and that some householders used these to supplement their diets. As always the overall benefit of "growing your own" is impossible to quantify, but evidence survives suggesting that some people did in fact grow salad vegetables as the following extract written in the early 19th century illustrates: "I well remember your little garden, Mother often talkes of the sallad you used to bring her out of it." (sic.) (The Benson letters.)

The iron needs of the less affluent would have been more critical and may have been supplemented to a limited extent by the use of iron cooking vessels. The presence of cribra orbitalia, a skeletal condition considered representative of childhood iron deficiency anaemia (Stuart-MacAdam 1985, 391-398), was noted during the non-metric analysis of the skeletons. The results are presented in Table 7.

<u>Table 7. Frequency of Cribra Orbitalia in the total crypt sample.</u>

	Frequency	Percent	Valid Percent
Absent	273	28.20	65.94
Present	141	14.57	34.06
Missing value	554	57.23	
Total	968	100.00	100.00

In light of present research, 34.06% of those whose crania survived well enough for cribra orbitalia to be assessed, seem to have suffered childhood anaemia. There are several possible explanations for this. Certain intestinal parasites can contribute to anaemia, and "worms" were a subject much discussed by doctors at this time. Dr William Cadogan writing in 1748 believed that intestinal worms along with fever at teething time, were the most common causes of infant mortality (Stone. 1979, 62), it is however highly unlikely that he was correct in his assumption.

"Worms" are listed in the Bills of Mortality as a cause of death, though in real terms this almost certainly means that they were the only recognisable symptom presented by the deceased person. Those which cause anaemia, for example Ancyclostomatidae and Cestoidea, were unlikely to be widespread. The common worms, Ascaridoidea are almost invariably harmless unless present in massive infestations. As stated above no evidence for infestation has been recovered from Christ Church however, the method of sampling was unsatisfactory.

Another possible explanation for childhood anaemia is weaning practices and childhood feeding. Until the late 18th century, most middle class women employed wet nurses rather than breast feed their own babies (Fildes 1986, 121). Wet nursed infants rarely received the colostrum provided by a newly delivered mother. Colostrum liberates protective proteins and engulfs infective organisms in an infant's gut, it also provides concentrated amounts of nutrients, notably zinc (ibid 81). If wet nursed infants survived the deprivation of colostrum and their wet nurses were well fed, healthy and only feeding one or two babies, there is no real reason why wet nursed infants should be nutritionally deprived. However, an increasing number of mothers practised handfeeding artificial foods by the and of the 18th century.

Interestingly, only 15.38% of a 17th century London collection, excavated from Spitalfields, Liverpool Street and Moorfield, was affected by cribra orbitalia (Brothwell 1981, 92). If these two samples are comparable, and cribra does represent anaemia, a change in dietary or health status is suggested.

If the anaemia was purely dietary in origin, artificial feeding denied the infant breast milk, it comprised spoon feeding pap or panada from a dish. The risk of infection from implements and contaminated foods was high, and potentially fatal. Pap was flour or breadcrumbs cooked in milk or water, Panada consisted of bread, broth or milk, occasionally eggs were added (Fildes 1986, 213) and some kind of flavouring such as sugar or spices. Analysis of the nutrient components of the various recipes (ibid. 215) suggests that some protein, calcium and iron would have been obtained however, this reflects the assumption that the cereal components were not highly processed. If the crypt infants were in fact artificially fed, the high incidence of cribra orbitalia may indicate that this was not the case. Fashion in food at this time was in favour of the consumption of "white" bread and highly processed cereals amongst all classes, and it is possible that this extended to infant feeding.

Stuart Macadam's current research into the significance of cribra-orbitalia (1988, 286) suggests that the presence and incidence of cribra might in fact reflect iron deficiency that is part of an adaptive response to increase immunity to pathogens. That rather than reflect nutritional stress it reflects environmental factors. If this thesis is correct and if Brothwell's 17th century sample is comparable with the 18th & 19th century sample from Christ Church, the increase from 15% in the 17th century to 34% in the 18th and 19th centuries might well reflect the deteriorating environment that was concomitant with the growth of London. There is no doubt that the increase in population density and industrialisation caused horrendous environmental and health problems, for example, sewerage disposal and water born diseases, which took many decades of human misery to resolve.

The fat soluble vitamins A and D would not have been present in artificial infant foods, and unless the infant feeds were supplemented by breast milk it is highly probable that artificially fed infants would have been vitamin A and D deficient. Of relevance to this area of inquiry is the fact that in 1870, almost 100% of artificially fed children in the Clyde district were rachitic (Drummond & Wilbraham 1958, 310). Artificial feeding may have been compounded in effect by the practice of swaddling, although the practice was in decline by this period. Swaddling effectively denied the child vitamin D from sunlight, and contributed to metabolic disease. Rickets is present among the infants buried in Christ Church. It is caused by a lack of vitamin D which is derived mainly from ultra violet rays absorbed through the skin and from a balanced diet (McLaren & Meguid 1988, 132). Rickets is well attested historically in all classes of society from the late 18th century. William Farrar observed in 1773; "the unhappy

> progress rickets has lately made amongst us...tun bellies, swelled wrists and ankles, and crooked limbs"

(Drummond & Wilbraham 1958, 272). As always there is a market response to misery, in this case it serves to illustrate that rickets was a classless disease. The General Advertiser, February 11th, 1748 draws attention to the wares of Mrs Parsons, Stay Maker at The Golden Acorn, James Street, Covent Garden ;"...supports for misses that

> are crooked, or inclined to be so either by falls, rickets, sickness..." (ibid 274).

Poverty and ignorance was the cause of Rickets amongst the poor, fashion and ignorance its counterpart amongst the more affluent.

Calcium intake is crucial to health and of particular interest here as it plays a major role, with other nutrients in skeletal mineralisation. Historical evidence suggests that dairy foods, an important source of calcium were available to city dwellers. As always the quality and quantity available to individuals was dependent upon income. It seems likely that the majority of the crypt sample could afford to purchase dairy foods, which became increasingly available as the period progressed. Cheese was the dairy food with the longest life, and regional varieties became available with improved transport and centralised marketing. William Hedges (CAS 2185), who died in 1812, aged 32 was a Cheesemonger, as was the father of William Brooks (CAS 2735), a two year old who died in 1785. Mr Thomas Hills of Spitalfields Market specialised in Cheshire Cheese (1846 Post Office London Directory). It is impossible to estimate per capita consumption for this population, however Mr Tayler's diary notes it as a feature of the diet in the household he served.

Butter was available although much of what was sold in the 18th century was rancid (Drummond & Wilbraham 1958, 301) and washed to remove the unpleasant taste. Good quality butter was twice as expensive as beef, this factor would have determined the class of the consumer. It played a major part in the many sauces popularised by French influence on diet, and considering the Huguenot component of this population is likely to have been an important part of their diet.

Milk supplies in 18th century London were notorious. Unless milk fresh from the lactarium in St. James Park or that supplied by cattle driven around the streets was consumed, the product was likely to have been watered and nearly sour (ibid., 193). Most milk was from cattle kept in London, many animals were reputedly housed in dark sheds or cellars, which were ill ventilated. The animals stood ankle deep in their own excrement. They were fed on hay and brewers' grounds. Apparently the situation had not improved by the early 19th century, when analysis showed that it was difficult to find a milk sample in the capital that did not contain blood or pus (ibid., 300). The Trade Directories list only two milk suppliers in Spitalfields. Mr Rees Lewis, "Cowkeeper and Dairyman" who traded from 19 Browns Lane in 1846, and Jo Hurley, "Cowkeeper", at 38 Crispin Street. (1846 Post Office London Directory).

An article in the Lancet in 1847, condemned Londons milk supply as responsible for scrofula (Drummond & Wilbraham 1958, 300). The milk would have been a contributory cause of tuberculosis, of which scrofula was a glandular form. Both the bovine and human forms of tuberculosis would have been present at this time and both may caused infection. Tubercular lesions in the skeleton are relatively characteristic and a small number of cases are present among the Christ Church population.

Sugar was regarded by contemporaries as one of the causal factors in the increased prevalence of dental caries, through this period. Sugar imports increased dramatically from circa 1700 as a result of the colonization of sugar producing countries. A further increase in quantities available, and reduction in price later in the century, resulted from settlement and slavery in North America. It seems likely that whilst sugar was an expensive luxury in the earlier part of this period, the wealthier classes were more likely to have suffered from caries, than the poorer people. Sugar consumption per capita ranged from 11.74lbs to 30.45lbs between 1793 and 1856 (Mitchell & Deane 1962, 355-6), a fluctuating but generally increasing trend through time. However, it must be remembered that in 1960, per capita consumption was 112lbs. This illustrates that the appalling oral health of this sample (see forthcoming report) results as much from the lack of dental hygiene as the consumption of sugar.

In the 1840's approximately 30,000 of London's inhabitants were without piped water, even from communal street taps (Wohl 1983, 62). During the 18th century the situation was even worse. Apart from consumption, water was crucial to personal and environmental hygiene. It is possible, however that the some of the crypt population may have had piped water in their homes. The water was conveyed through lead pipes and may have been installed during the construction of the better quality housing, built in Spitalfields during the early 18th century. (The use of lead pipes does not contribute to plumbism in hard water areas such as East London.) What must be remembered is that this water could be drawn from contaminated sources and unless it was boiled, it could and did act as a conveyer of disease. The contamination of drinking water by excrement was a contributory factor to the horrendous cholera and typhoid epidemics of the mid 19th century.

3.3 Marriage and fertility.

> "In a word, the married state, with and
> without the affection suitable to it is
> the completest image of heaven and hell
> we are capable of receiving in this life."

(The Spectator, 9th September 1712)

Marital Status

Marriage register data have been retrieved for 116 of the crypt sample. 44.8% of their marriages took place at Christ Church, Spitalfields the remainder were located by reference to the International Genealogoical Index (Guildhall). For the remaining 198, the data are incomplete or are unknown. That the majority of the adult females were titled "Mrs" on their coffin plates does not signify that they were necessarily married. The terms "Mrs" and "Miss" are both contracted from "Mistress" and it is not clear when their use to distinguish married from unmarried women crystallised (Landers personal communication). Mrs Catherine Galhie (CAS 2747), for example was the unmarried daughter of Etienne and Marie Galhie. This is determined by her baptism record, no record of an isonymous marriage exists for her. Catherine died aged 28 in 1777.

Details of marital partners, and a terminus ante quem have been derived for many of the remaining 198 from the baptism records of their children. In total marital status has been established for 259 of the 304 individuals aged twelve and over (85.2%). See Table 8.

Table 8. Marital Status of the Spitalfields Crypt Sample.

Status	Percentage	N
Married, but details obscure:	44.8	116
Married once:	41.3	107
Married twice or more:	5.4	14
Unmarried:	8.5	22

Of those known to have been unmarried at death (22), twelve were aged below 25 and might have married had they lived.

Age of Marriage

Before Hardwicke's Marriage Act of 1753, marriages from seven to thirteen were directed by law to have parental consent. After 1753, parental consent was deemed necessary for boys and girls aged below twelve and fourteen respectively. These ages were were considered to relate to puberty. This law provides the the only clue to the age of those marrying in the parish churches as their parents were required to sign the register. However, none of the crypt sample married with their parents consent although one female is known to have been aged 11 or 12 when she married. These remained the minimum ages, without consent until the Age of Marriage Act 1929 (Bromley 1981, 32).

For comparative purposes, the age at first marriage for the crypt sample has been assessed separately for males and females and has been divided into three chronological divisions, according to the year of marriage. These have been compared to a "British" sample, derived from ten parishes, all outside London (Floud et Al 1981, 27), see Table 9 . The age of each individual at marriage has been estimated by reference to their date of birth. There is a decline in the age of marriage of the comparative sample through the period. Interestingly, the crypt sample does not to follow this trend, however, this may be a result of the small sample sizes.

Table 9. Age at First Marriage of the Spitalfields Crypt Sample.

	Females					Males				
Date	No	Mean	S.D.	Range	+	No	Mean	S.D.	Range	+
-1750	18	*27.8	5.6	20-38	27.0	13	26.1	4.2	19-35	28.1
1751-1800	32	23.4	6.7	12-39	25.4	25	26.2	6.2	16-39	27.1
1801-1855	7	*26.0	6.3	18-37	24.3	12	*27.7	5.7	21-38	26.5
Total	57	25.2	6.5	12-39		50	26.5	5.6	16-39	

(*See Table 11 below) (+ British sample from Floud et Al 1981, 27)

It seems that the women all entered into their first marriage during their fecund period, (fecundity is delineated by puberty and menopause). Ages of second and subsequent marriages differ in this respect. For details see table 10.

Table 10 Age at Second and Subsequent Marriages.

Sex	Number	Mean	S.D.	Range
Female.	5	46.2	8.0	32-51 years
Male.	9	40.7	12.6	29-66 years

It seems that procreation was a less important criterion for many women entering into a second marriage. This could reflect that women sought either companionship and / or economic benefits from later marriages. Mr John Chevalier and his wife, Magdelene (CAS 2129 & 2137) were both married for the the second time in May 1740, at the ages of 55 and 50 respectively. Both had children from their first marriages.

The seasonality of marriage among the crypt sample has been examined for the 109 individuals whose exact date of marriage is known. The most popular month was May, when seventeen marriages occurred and the least popular, January when only four took place. Twenty-one were married in the winter, thirty-four in the spring, twenty-nine in the summer and twenty-five in the autumn.

In a population where sexual activity appears to be within the confines of marriage (syphilitic skeletal involvement has only been identified in 2 of 967 individuals), the level of nuptuality or age of first marriage is a crucial determinant of fertility (fertility is the number of births achieved by a woman during her fecund period). No historical evidence of illegitimacy or bastardy has been found relating to the crypt sample.

Age at First Birth

The age at first birth has been ascertained for 140 individuals. This is derived from reference to parochial baptism registers. These provide a variety of types of information, ranging from age of the child at baptism, mother's maiden name, father's occupation, address and godparents' names. The nature and quantity of data varies within the same parish chronologically, and between parishes. The dates of the baptisms and, where possible, births of the children of each individual are then compared with their own date of birth in order to establish their age at first birth.

The results have been analysed separately for both sexes, and in three chronological groups.

Table 11. Age at First Birth

	Females				Males			
Date	Number	Mean	S.D.	Range	Number	Mean	S.D.	Range
Pre 1750	21	*26.7	5.3	19-36	20	29.3	5.1	19-42
1751-1800	41	27.0	8.0	12-45	38	28.0	6.4	18-43
1801-1855	9	*25.0	4.6	19-33	11	*26.7	5.2	19-35
Total	71	26.7	6.9	12-45	69	28.2	5.9	18-43

*See comments below, and table 9 above.

Comparison of the data derived from tables 9 & 11 illustrates inconsistencies caused by the fact that the two samples are not identical. The starred figures denote where the average age at marriage is later than the age at first birth. This error is removed by analysis of the sample as a whole. The age of parenthood for men appears to fall through this period although it is not statistically significant, averaging at 28.2 years, for women the average is 26.7.

In populations where it is normal for girls to marry at puberty, the age at first birth can serve as an indication of the age of puberty. With this sample, however, the average age of marriage is in the mid-twenties for women and very little can be gleaned from birth data about the age of puberty. Despite this there are three very young mothers in the crypt sample. Mary Margas married Alexander Sigourney (CAS 2487 & 2564), a journeyman weaver, on 20th May 1766. She was aged eleven or twelve (parents consent was not however given in the marriage register). Their first child Alexander was baptised on 24th May 1767, the second James on 27th August 1769. Two other young women baptised their first children at the age of fourteen. If adolescent sterility operated (during the first year or two after menarche, menstrual periods are annovulatory), Mary Sigourney experienced menarche (first menstruation) at around the age of ten.

Currently the average age of menarche is thirteen years, however it can vary from as early as nine to as late as sixteen (Phillipp 1986, 195). It is generally considered that the age of puberty was about seventeen (Young 1971, 249) in 18th century England. This assumption needs careful review as there seems to be some evidence from the Parochial Records (gained by tracing individuals from their their own baptism, to marriage and the baptism of their children) that it may have been nearer today's figure. The age of puberty as suggested by the marriage laws also supports this. All that can be said for certain is that for the small percentage of individuals who married early, menarche seems to have occurred at a similar age as it does today.

Pre-nuptual conception was considered a common feature of early modern England, particularly in rural areas among the lower classes (Stone 1979, 388). In the 17th century the level of recorded pre-nuptual pregnancies in England was below twenty percent. In the first half of the 18th century it rose to over 40%.(ibid.) Francis Place remarked that in the late 18th century: "...want of chastity in girls was common" up to the class of respectable small property owners, tradesmen and master craftsmen. By the 1820's the practices were considered confined to the lower classes (ibid).

The interval between marriage and first birth has been established for 65 members of the crypt sample. The average is 19.3 months. The variation ranges from over seven years, to baptism and marriage on the same day for Mrs Mary Cadman (CAS 2407), who was 22 years old at the time. It must be remembered that these data only represent those who survived to be baptised and, where the date of birth or age of the child being baptised are not given extends the true interval. Some infants were never baptised for various reasons. Stillbirths were not baptised by the church. Midwives were allowed to perform in-utero and postnatal baptisms at their discretion (Towler & Bramall 1986, 53-4) but none are entered in the Christ Church register. Furthermore, at least 15-20% of all conceptions are aborted in the first trimester of pregnancy (Phillipp 1986, 60) and this further increases the incidence of under registration of conceptions. For these reasons the mean of 19.3 months is in fact an over estimation of the marriage - conception interval. Since many of the crypt population are of the classes described by Francis Place as promiscuous (see above), it is rather surprising that only 6% (4 of 65) of first births seem to have occurred less than eight months after marriage. Analysis of 16 English parishes (outside London) between 1750 and 1849 demonstrates that 25% of all first births occurred less than eight months after marriage (Smith 1986, 89). These results indicate that the crypt sample is atypical in this respect.

Childbirth in the 18th and early 19th Centuries

During the period 1650-1850, pregnancy and childbirth became the subject of increasing concern and inquiry by doctors and scientists. Despite this, it remained for many a subject shrouded in superstition and folklore. Whilst women seem to have accepted that childbearing was a desirable consequence of marriage, it was an event viewed by many with trepidation. Childbirth was more dangerous than it is today and it is likely that all women would have lost friends or relatives in childbirth (Carter & Duriez 1986, 31). Furthermore, some women never recovered from injuries and damage incurred during parturition. These ranged from fistulae, perineal lacerations which could extend to the anus causing faecal incontinence and prolapse of the uterus, which at its most severe resulted in procidentia (Shorter 1982, 268-75).

The majority of women gave birth at home, usually in overheated rooms devoid of fresh air. Very little evidence exists regarding the place where the crypt females were delivered. It seems probable that the wife of Isaac Lefevre (CAS 2216) had her twelve babies at home.

Their baptism records, from the Register of the Church of the Artillery, Spitalfields (P.H.S.L. Minet 1948), note "bap. a la maison" in most cases and "bap. en la maison par maladie" regarding Jean "Ne 21st. Octobre, 1722", Jean was baptised on October 28th. Of the ill-fated infants (six) of Jean and Henrietta Lemaistre (CAS 2162 & 2184), one of which is believed to have suffered from osteopetrosis (see forthcoming report), all but the first, Susanne (CAS 2249) were also noted as being baptised at home (La Patente, Spitalfields. P.H.S.L. Minet & Walker 1898). Only one woman from this population is known to have had a hospital delivery. Mrs Sarah Hurlin (CAS 2521), gave birth to her first child Sarah, circa December 1786, in the Lying-in Hospital, City Road (personnal communication Eileen Freyne, descendent). In London, the Middlesex hospital opened a lying in ward in 1747 (Carter & Duriez 1986, 75) and a small number of Lying-in hospitals opened in the 18th century. An example is the Jerymn Street Hospital in 1752 (ibid). Generally though, such facilities were not readily available, even if they were desired.

Pain during childbirth was dealt with by recourse to herbal remedies and age-old rituals few of which had value other than as a placebo. Examination of advertisements for "remedies" in contemporary newspapers and magazines fails to find specific painkillers for use during childbirth.

Birth took place in whichever position the woman found most comfortable. This could be sitting on a birthing stool, squatting, kneeling or standing. The growth of the profession of male midwives and intervention of doctors in obstetrics led to the adoption by their patients of the lithotomy position on a bed. Such doctors as Charles White believed (Carter & Duriez 1986, 28) that the horizontal position reduced the possibility of the complications mentioned above and; "retention of the

> secundine (placenta), flooding (haemorrhage)...even death".

Contemporary constraints of modesty meant that examination and delivery by a male, were performed under clothing or a sheet (ibid 107).

Puerperal fever (post partum sepsis) was a cause of maternal mortality. It increased in prevalence through this period, particularly in towns and with the increase in hospital confinements. A description from 1874-5 depicts the horror of this condition (Carter & Duriez 1986, 42); "...there is nothing more sudden than the

> changes in the condition of these women...In the morning they are cheerful and smiling, and seem to be well, yet they are consumed by fever, pulse rapid, features pale and shrunken, and death is written on their foreheads. They sink and die without a struggle."

The cause of puerperal sepsis was not appreciated until 1847. Ignaz Semmelweiss, a Hungarian doctor proved that:

> " Puerperal fever is caused by the conveyance to pregnant women of putrid articles derived from living organisms, through the agency of examining fingers."

(ibid.p.114). Even then, little regard was paid to his advice regarding cleanliness and hygiene.

Maternal Mortality

It is impossible to detect the real incidence of maternal mortality during this period. The Bills of Mortality lists deaths in "childbed" but puerperal fever can develop either hours or up to ten days after delivery. Consequently, it is possible that some deaths from this cause might have been classified as "fevers". Furthermore, it is not certain whether deaths referred to as "abortive" are the mother's or the child's. Five women from the crypt sample are known to have died within days of childbirth. This has been deduced from their date of death and the date of birth of their infants. It is of course possible that they may have died from other causes. It is also possible that some of the 25 other women who died during their childbearing years, for whom no contemporary infant birth was registered, did in fact die as the result of childbirth.

The maternal death rate per 1000 deliveries has been estimated for London from the Bills of Mortality and outside of London from 13 Parish Registers (Schofield 1986, 233 & 248). See table 12 for a comparison of this with the possible rate for the crypt population. For comparative purposes the figure for England in 1980 was 0.1:1000, and 4.5:1000 in 1930 (ibid 231).

Table 12 Maternal Deaths per 1000 Deliveries.

Date	London No per 1000	Outside London
1700-1749	14.5	11.3
1750-1799	11.4	7.7
1800-1849	9.2	5.5
Christ Church	8	

(621 births have been established for the Christ Church

females.)

These data suggest that the crypt sample has a lower maternal mortality rate than London as a whole, though a slightly higher rate than the rural parishes in the later period. The generally declining rate is considered to reflect improvements in obstetric practices (ibid 254). Interestingly, the five possible maternal mortalities were all aged below 29. Four had survived previous births. This suggests that they may have died from such causes as haemorrhage, eclampsia or puerperal sepsis rather than an obstructed pelvis.

The most common cause of pelvic obstruction at this time was rickets. A rachitic pelvis can be generally contracted, both antero-posterior and transverse diameters can be reduced and the pelvic outlet can be so narrow as to create a funnel effect. In severe cases an infant cannot be delivered vaginally. Caesarean sections were rarely performed and were normally fatal because of either infection, haemorrhage or shock. There are no instances of contracted rachitic pelves in either the coffin plate or the unnamed samples. This is interesting as there are twenty cases of rickets among the infants and thirteen healed cases amongst the adults, perhaps those with severe rickets did not survive to adulthood.

Embryotomy, dismembering the infant in order to remove it or craniotomy, piercing the skull, inserting a hook and pulling the infant out, could save the mother. However, she frequently succumbed to infection, internal injury or haemorrhage. Such methods were employed by midwives and barber surgeons before and throughout this period.

Obstetric forceps were invented in 16th century France and introduced into England by the Huguenot immigrant, Doctor William Chamberlain, later in the century (Towler & Bramall 1986, 77). During the 17th and 18th centuries their use became accepted and commonplace amongst doctors and male midwives. Female midwives resisted them partly because they came to symbolise male interference in what they considered to be female territory, and also because, whilst they could save lives, their application by some, as a matter of course, crippled and killed. Lisbeth Berger, a midwife described an occasion she witnessed in 1813 (Carter & Duriez 1986, 39). She and the patient's husband held down a woman undergoing a forceps delivery; "...the groaning and

> whimpering of the mother dominated everything in the room, the jerking and shaking of her tortured body....After all that pulling and levering, holding and bleeding, the child finally emerged from the mother's lap. Torn and haemorrhaging, exhausted to death, the poor mother lay back against the cushions."

Lisbeth Berger does not discuss the ultimate fate of the mother and child.

Pubiotomy and symphysiotomy were occasionally attempted. Symphysiotomy was first proposed to the Royal Academy in France, in 1740 by Jean Renee Sigoult. Whilst it could save lives it frequently maimed the woman for life. She could be left incontinent or unable to walk, not suprisingly the fear of such complications made it unpopular.

Malpresentation was another potential problem during parturition. Skills in "version" or turning the foetus in utero improved during this period. Increased male interest in obstetrics and the growth of the sciences, led to a greater understanding of the anatomy and mechanics of parturition. There was, consequently, a slow improvement in this fundamentally important area of womens' lives.

Family Size

Family size reflects many social and environmental factors. The relatively late age of marriage of this sample reduces their maximum fertility by the number of births women could expect to have achieved in the period from puberty to marriage. Inadequate nutritional standards can cause amenorrhoea, preventing conception, and can influence prematurity rates increasing the incidence by as much as 41% (Phillipp 1986, 419).

Deliberate family restriction and social taboos restricting sexual activity reduce fertility as does prolonged lactation. Before discussing these factors the family size of the crypt population will be examined. Again, it must be remembered that only those who were baptised are recognised, and births are clearly underepresented by this, the only method of estimating family size for this population. For details see table 13.

Table 13. Family Size

Date	Number	Mean	S.D.	Range	Childless
Pre 1750	51	4.2	3.8	0-15	5
1751-1800	105	3.2	2.6	0-11	10
1801-1855	27	2.6	2.0	0-10	1
Total	183	3.4	2.9	0-15	16

(Note. Family size has been estimated for each individual. There are 27 husbands and wives among the crypt population, where data exist for couples, each is represented as an individual. Second marriages are considered as separate entities.)

As always the mean masks human variation, sixteen married individuals seem to have been childless, five of these are post menopausal women in second marriages. Discounting these five individuals, six percent of the crypt sample appear to have been childless. The fertility of the sample seems to decline through this period. The declining fertility might reflect increased parental failure to baptise their infants, due perhaps to the growth of nonconformity; increased birth spacing resulting from changing infant feeding patterns; or as a consequence of reduced nutritional intake. There is no clear indication which, if any of these forces were operative.

Birth Spacing

Birth spacing has been estimated from the baptism records of those children known to have been born to the adult coffin plate sample. This is an important area of inquiry as it might give an insight into such issues as infant mortality and duration of lactation. Data has been established for 93 individuals. Birth spacing ranges from 7 months (!) to 128 (10 years 8 months), with a mean of

29 months (2 years 5 months), and standard deviation of 21.54. The seven month birth interval is presumed to be a clerical error at the time of registration and was excluded from the calculation.

Birth Control

The birth spacing data for this sample (mean=29 months) is within the average range of 24 - 30 months in upper class England (Stone 1979, 52). How was this achieved? Survey of the literature concerned with family size, contraception and abortion suggests that those who married during their fecund period expected parenthood. However, whilst it is explicit that within marriage some children were welcome, it is equally clear that not all were. The literature exemplifies concern for the well-being of the mother, existing children and the family as a whole above and beyond further births (McClaren 1984, 65).

By and large, birth control during this period seems to have placed emphasis on spacing births from marriage through to menopause. This seems to have been achieved by a variety of means, some unconscious and others deliberate. Frequency of coitus is a crucial determinant of fertility and this can be affected by nutritional status and environmental factors, postpartum and menstrual taboos. Historical evidence (Mclaren 1984, 66-67) suggests that extended lactation discouraged sexual activity for cultural reasons and suppressed ovulation. Quantification of the latter is difficult. Studies have shown that it varies in different females in similar circumstances, and in the same individual from one post partum period to another (Phillipp 1986, 297). Low nutritional status is considered to be a significant factor, prolonging lactational amenorrhoea.

It is believed that amongst those fortunate enough to have a companionate marriage, the desire for effective contraception spread from the wife to the husband, who was aware of the danger and discomfort which could accompany pregnancy and childbirth. In this environment, contraception as a distinct entity became desirable within marriage. Coitus interruptus is attested historically, as are barrier methods, herbal potions and magical charms. If conception occurred and abortion was recoursed to, this could be achieved by the use of pessaries, abortifacient drugs administered orally, or mechanical procedures. It is however, impossible to quantify the use and effectiveness of contraception and abortion. Such evidence as that contained in the letters of Isabella Tomkins of Hackney Road to her brother in New South Wales, is indicative of the desire for family limitation but imprecise as to the means: "...

> I have as yet but one [child], but expect, long before you get this [letter], to be plagued with another - but I suppose I must not grumble as I have been now married six years...." (The Benson Letters, 1849).

The average birth spacing for the crypt population gives no indication of the underlying causal factors. Examination of two families from differing social and economic classes may offer some indications, even if only on an individual level.

Louisa Perinna Ogier (CAS 2309) see plate 15, was born in Moncoutant, Poitou, France in 1729. She was the youngest daughter of a wealthy silk merchant. The Ogier family settled in Spitalfields and became one of the most important and successful silk manufacturing dynasties in the area.

In August 1749, Louisa married Samuel Courtauld, a Goldsmith also of Huguenot descent. Their first son Augustine was born on 26th August 1750. His prompt arrival attests to the fertility of his parents and their desire for an heir. (Louisa was wealthy in her own right as was her husband.)

Unfortunately however, Augustine died aged only five days. Their second son Samuel was born in October 1752, 26 months after Augustine. Why the delay? Was it deliberate or perhaps created by a succession of miscarriages. It is certain that it was not a consequence of lactational amenhorroea and unlikely to have been the result dietary deficiency.

Louisa junior was born 17 months after Samuel, who managed to survive the perils of infancy. It is possible that if Louisa was breastfeeding Samuel, she may have weaned him at eight months and conceived. Equally she may have employed a wet nurse, or artificially fed her son, it is impossible to tell which. Louisa junior died in July 1756 aged two years and four months, Esther was born eight months later. This birth interval could suggest that Louisa breast fed her first daughter until she died, this seems unlikely though in view of her earlier history.

PLATE IF

This was in fact the longest birth interval in Louisa's obstetric history and it seems likely that unless she experienced miscarriages or unbaptised stillbirths, some form of conscious contraception was being practised. Esther died as an infant, age unknown and eighteen months after her birth, Louis was born in August 1758. He too died. Louisa had lost four of her five children as infants. Almost two years later Catherine was born, she was followed seventeen months later by George and he after two years by Sophia. These babies and Samuel survived to adulthood.

Infant mortality at this time could result from an enormous range of illnesses and diseases. Venereal disease can cause high infant mortality, particularly gonorrhea. Although contemporary doctors were aware that there were several types of venereal disease, there appears to have been a great deal of confusion as to who had what. However, only syphylis and non specific urethritis (Reiter's syndrome) can affect the skeleton and Louisa appears to have been affected by neither. Venereal disease can also cause sterility.

There is no apparent pattern to Louisa Courtauld's birth intervals. If she had kept a detailed diary, and it had survived, an understanding of causal forces might have been achieved. As the evidence stands it can only be speculated as to whether she fed her own children and if so, for how long. The death of an infant does not seem to shorten the apparent interval before the next birth. Was she miscarrying, were they sexually active or were they deliberately preventing conceptions by some means? The necessary evidence to understand this aspect of family life does not seem to exist.

Louisa's fertile period was fifteen years, it began with her marriage at the age of twenty and ended when she was widowed at the age of thirty-six. That she successfully reared only four of eight infants was not unusual, some couples lost all of their children during infancy.

Sarah Marchand (CAS 2521), the granddaughter of Nicholas Marchand of Normandy, was born in England in 1765. She came from a comfortably off background, spoke and wrote French and English. In 1786, when she was 21, Sarah clandestinely married Martin Hurlin, an illiterate journeyman weaver, at St. Anne's church, Limehouse. She was five months pregnant at the time. Only the years of birth of Sarah's infants are known, nevertheless they provide a guide to her birth intervals.

Despite living an economically less privileged life than Louisa Courtauld, and indeed the majority of the crypt population, 9 of the 10 children born to Sarah and Martin Hurlin managed to survive infancy. Only the second born, James (born 1788) died as an infant. Sarah's namesake was born in the year of her marriage 1786, James 2 years later in 1788 and William in 1791. In 1794 George was born, 2 years later Charles and in 1799 Mary Ann. 1803 saw the arrival of Catherine, James was born in 1805, John in 1807 and 3 years later, in 1810, Samuel.

Sarah's birth intervals of 2 or 3 years average 32 months. This could be the result of lactational amenhorroea, it is unlikely that a journeyman weavers wife could afford a wet nurse, or that she would have the time to feed her infants artificially. Furthermore, her nutritional status could have been low enough to depress her fertility if she was lactating. The three year intervals could possibly obscure the occasional miscarriage, it is impossible to tell. The interesting interval is that following James' death. Sarah was obviously not lactating and it is interesting to speculate whether or not conscious contraception was being practised or, if Sarah miscarried at all during this interval. In this case, lower economic status, narrows the possibilities but once again the type of evidence really needed to understand what determined these birth intervals is not available.

Sarah's fertile period was from her marriage at 21 until Martin's death, shortly before Samuel was born when she was 45. It is probable that Sarah was approaching the menopause at this time, had Martin lived there could be more certainty. It remains a source of wonder, how someone living on a restricted income managed to rear 9 children as a widow. It might be however, that Sarah received financial help from the Marchand family, either before and/or after her widowhood. If they did significantly subsidise her income whilst Martin was alive, this interpretation of her childbirth intervals is probably misplaced.

Age of Last Birth.

It is not possible to deduce the age of menopause from skeletal remains. The subsequent onset of osteoporosis whilst being associated with post-menopausal females today, is both too gradual and variable to be of use.

The age of menopause of the named sample might be indicated by their age at last birth. However, this is not easy to apply, as with many women, for example Sarah Hurlin and Louisa Courtauld, their last confinement was determined by their husband's death. In Sarah's case in particular, had the date of her husband's death not been known, it would have been assumed that she had ceased bearing children because of her age. There are at least two other women whose husbands are known to have died leaving posthumous issue. Sterility, through infection contracted during childbirth can also restrict a womans fertility, as their failure to baptise infants restricts understanding of that fertility. Furthermore, female fertility declines from their mid-thirties. This method is far from perfect, but it is the only means of estimating the age of menopause, at our disposal. Table 14 lists the data as known.

Table 14. Number of Last Births at Specific Ages. (Females only.)

Age	Number	Age	Number
35	6	42	2
36	4	43	3
37	2	44	3
38	4	45	3
39	8	46	1
40	2	47	2
41	3	48+	0

Median is 39.7 years.

This data suggests that for some women the menopause was in their mid - late forties, more than that cannot be deduced.

The age at last birth for the coffin plate sample is illustrated in table 15. This is perhaps in real terms more important than the data presented in table 14, as it indicates (failure to baptise and stillbirths aside) the end of individuals' reproductive lives for the host of reasons which could could be effective in this respect, including the menopause, widowhood or death.

Table 15 Age at Last Birth for Males and Females

	Females				Males			
Date	N	Mean	STDev	Range	N	Mean	STDev	Range
Pre 1750	17	37.5	5.5	26-47	20	39.0	5.9	33-49
1751-1800	40	34.4	8.7	14-47	37	37.5	7.2	21-50
1801-1855	10	34.4	4.7	26-41	9	37.4	8.7	26-54
Total	67	35.2	7.6	14-47	66	37.9	7.0	21-54

Despite the internal variation, there is a slight chronological reduction in age for both sexes.

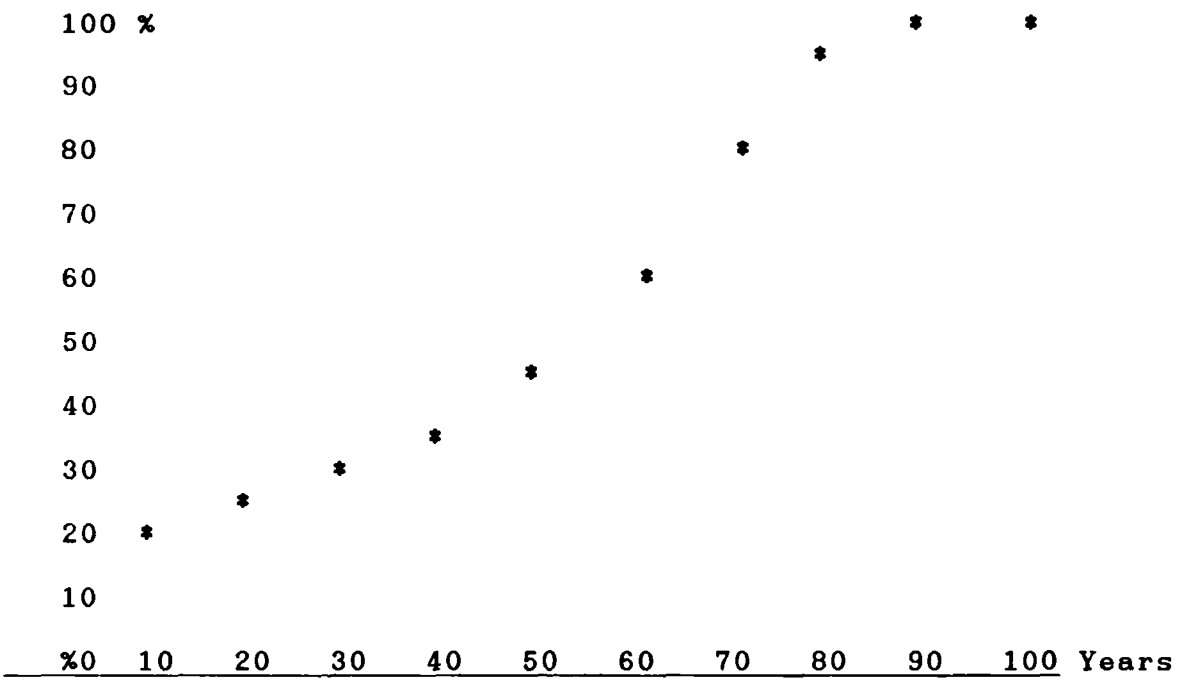
Perhaps the most poignant piece of historical data pertaining to the subject of marriage and fertility in Spitalfields is the last; " My wife has had another

> little son born on the 22 of March last...He is a very pretty little fellow-his name is Edward Ernest, he makes our tenth child, eight living. I do not know when Mrs Benson means to stop as she looks so blooming, although we have been married twenty years. She says it is my fault and I must put up with the consequences." (The Benson letters, 21st July 1861)

3.4 Mortality.

The average age at death of the named sample, deduced historically was 58.0 +/-17.9 years for females and 56.3 +/-15.9 years for males. The mortality curve for the named and aged sample is illustrated below in figure 9. 9.3% (36) died before their first birthday N = 387.

Figure 9. Age at death of the named sample; mortality curve.

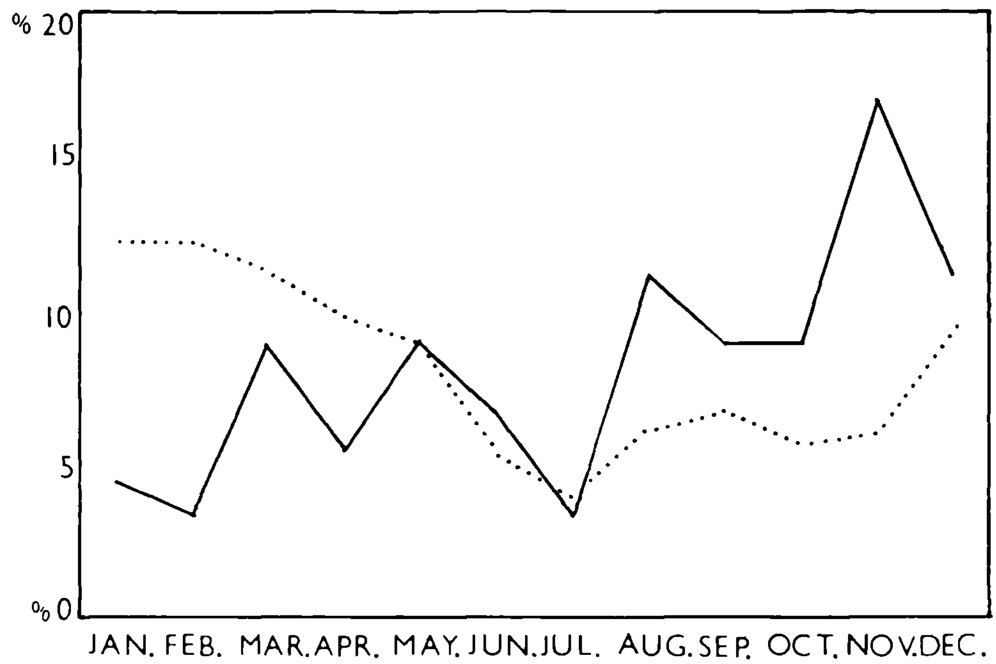


The mean average ages at death described above, when compared to data about population of the parish and of London, suggests that the crypt sample was atypically long-lived and that they had an unusually low rate of infant mortality (see forthcoming report). However, as only rarely have the mortality data for complete families been available, it cannot be stated whether this apparent longevity reflects the effect of class on mortality or if it is an artefact of selective burial within the crypts.

The seasonality of death.

The Seasonality of death could be assessed for 378 of the named crypt sample. Of the remaining 9, the date of death was unknown. Figure 10 illustrates the seasonality of mortality of the adults and children from the crypt sample.

Figure 10. The seasonality of mortality;the crypt sample.



Children = ———— N = 88. Adults = ...N = 287.

Interestingly the two groups are behaving differently. The adult deaths peak in January, February and March whilst the children (aged 18 years and below) are peaking in August and November. The different trends reflect that adults were susceptible to fatalities from the respiratory disorders so prevalent in the colder months, whilst children, particularly infants were most vulnerable to gastric infections. Furthermore, mortality seasonality is considered to reflect the seasonality of certain infectious diseases and the age groups most effected by them.

The cause of death.

The cause of death of individuals can ocasionally be assessed skeletally. Civil registration began on July 1st 1837 and the death certificate states the cause of death. Twenty-eight members of the crypt sample died after this date and copies of the death certificates of all but two, who could not be located in the indexes, have been obtained the details are listed in table 16.

Table 16. The cause of death and seasonality.

ID No	Month	Age	Sex	Cause of death.
2569	January.	79	F	Decay of nature.
2267	"	82	F	Natural decay.
2205	"	57	F*	Found dead in bed without marks of violence.
2340	February.	55	M	Chronic disease of the lungs.
2335	"	73	F	Debility.
2368	March.	45	F	Diseased heart.
2363	April.	61	M	Disease of the spine, 5 years paraplegia certified.
2521	May.	73	F	Mortification in the feet.
2498	"	54	F	Dropsy. (Oedema)
2464	June.	92	M	Decay of nature.
2419	July.	63	M	Dropsy.
2152	August.	86	F	Natural decay.
2519	"	53	M	Dropsy.
2272	September.	87	F	Old age.
2782	October.	53	M	Pneumonia, 4 days certified.
2461	"	74	M	Congestion of the liver 7 days, with bronchitis, cerebral effusion 24 hours certified.
2520	"	2y9m.	F	Scarlet fever.
2936	"	75	M	Epilepsia since youth, hydropericardium for 6 or 8 months.
2548	November	22dys.	F	Debility and convulsions.
2544	"	52	F	Paralytic seizures.
2910	December.	57	M*	Shooting himself in the head with a pistol bullet, died in a few minutes, temporary insanity.
2505	"	1y8m.	M	Inflammation on the lungs.
2476	"	63	M	Asthma.
2916	"	70	M*	Found dead in bed without marks of violence.
2490	"	86	F	Decay of nature.
2493	"	77	F	General decay.

* Those marked with an asterisk were subject to a coroners inquiry.

The only other surviving evidence relating to cause of death is an extract from a letter written by

George Courtauld in 1817. George is describing the last illness of his uncle Peter Ogier (CAS 2863), 42 years after he died in December 1775, aged 63;

> "My Uncle Peter Ogier was a pattern of patient suffering for some years before his death. After lying on his couch in agony for quarter of an hour at a time -the drops of sweat running down his face from extreme pain - a few minutes relief would induce expressions of pious gratitude for the ease he experienced, and he would speak with his wife and family about their several concerns; then when another paroxysm was approaching he would resignedly lie himself down and mildly say God's will be done." (sic) (Personal

communication Mr G. Courtauld, Essex).

Whilst many of the attributed causes of death (see table 16 above) defy acceptable modern diagnosis, it does seem that those relating to bronchial disorders occurred in the cold, damp months between October and February (inclusive). The only known instance of death through infectious disease, scarlet fever, an acute exanthematous disease caused by streptococcal erythrogenic toxin, usually spread by droplets, was also an October fatality. It is interesting that the three cases of Dropsy were all summer deaths. Oedema, is symptomatic of many diseases and disorders and real understanding of the causes of these deaths is impossible. A factor which might be contributory was that two of these individuals were a licensed victualler and his wife, the third was a mariner, perhaps cirrhosis of the liver was the consequence of alcohol consumption! Interestingly several of the causes of death described might be expected to cause skeletal pathologies, none did however (suicide apart, see above 3.1).

<u>The interval between death and burial.</u>

The interval between death and burial has been assessed for 356 individuals from the named sample. Of the remaining 31, either the date of death and, or burial were not known. The interval varies from 1 day to 21 days.

During the period 1729 to 1852, most funerals took place from the home or "abode at death" of the deceased. Considered with modern and western sensibilities, it seems likely that the month of death would influence the death-burial interval. Analysis suggests (see figure 11a) that the months of June and July were unlikely to encourage an interval of more than 6 days. August and September seem to have been witness to few funerals more than 7 days after death and April, May and October after 8 days. The smaller numbers of individuals dying in the warmer months (see figure 11a) enhance the appearance of this trend and must be allowed for.

Although the occasional summer funeral took place after a longer interval (one individual who died in August was not buried for 15 days), the majority of extended intervals seem to have occurred in the cooler, winter months. It seems logical to presume that these trends reflect the unpleasant effects of summer temperatures upon dead bodies.

The relationship between the death/burial interval and age at death has been examined. See figure 11b, below.

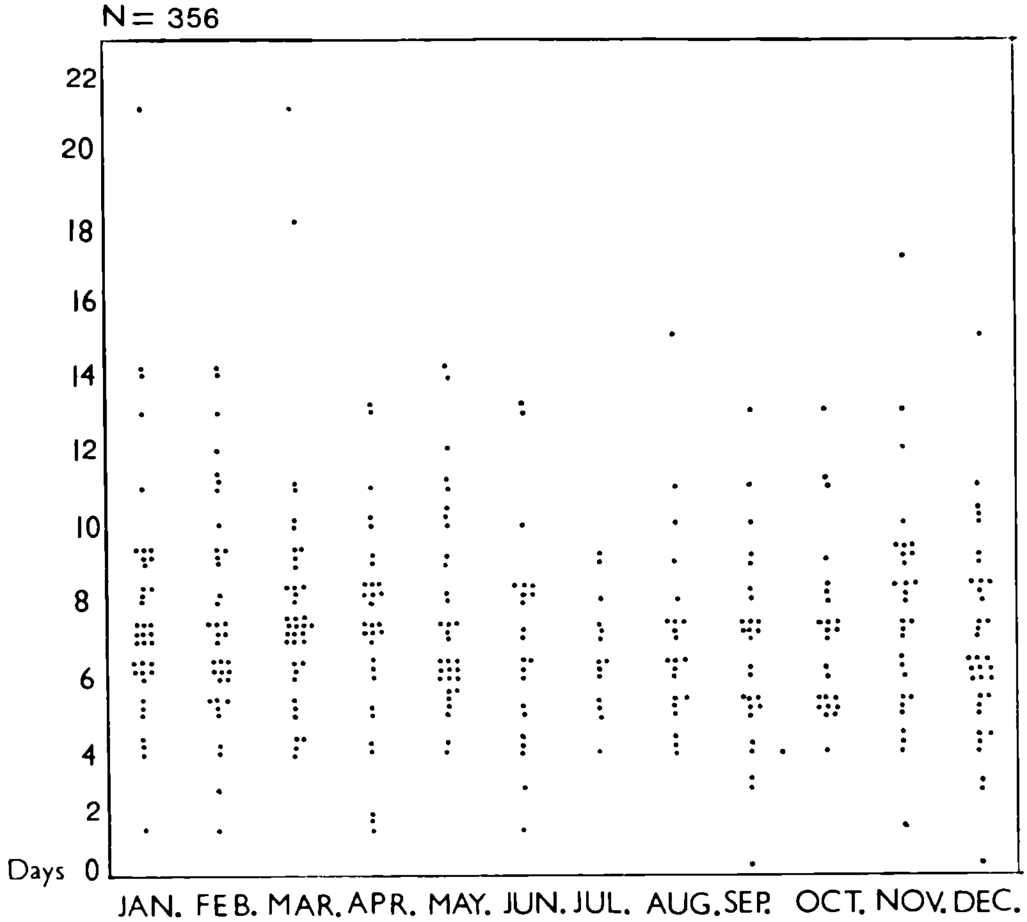


Figure 11a Interval between death and burial with month of death

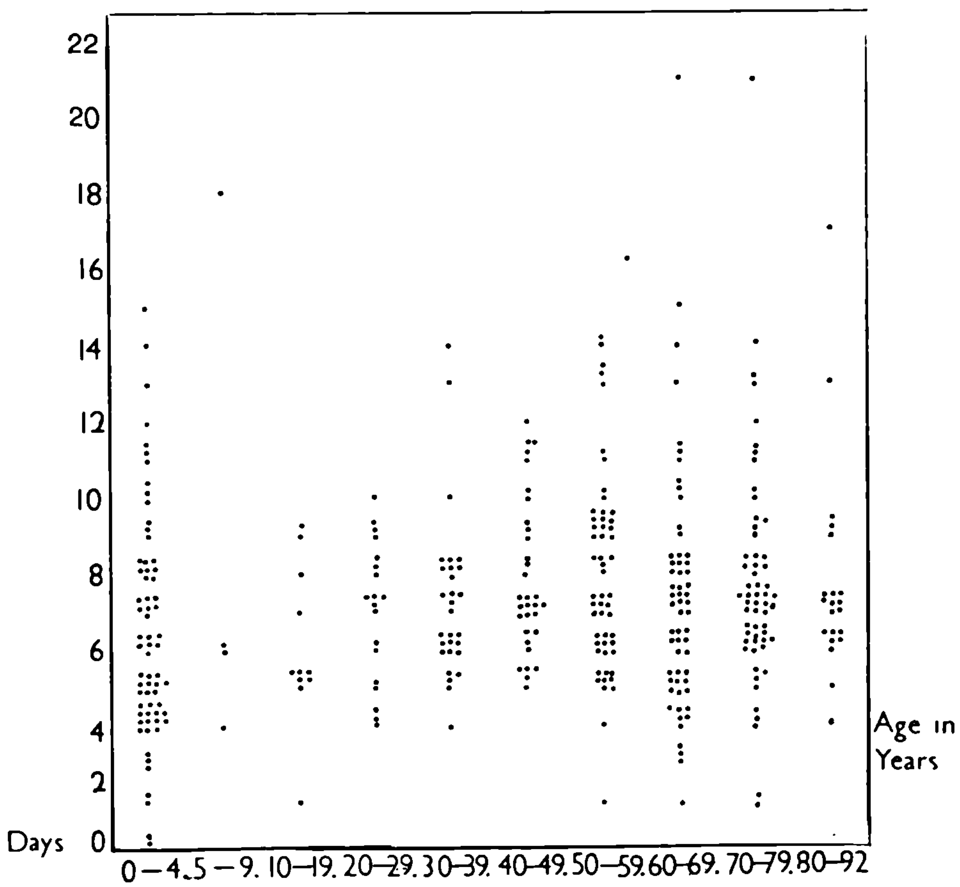


Figure 11b Interval between death and burial with age at death.

N= 356

The small number of children in the sample tends to overemphasise the difference in interval between infants and, in particular, mature adults. Nevertheless, there does seem to be a positive correlation between increased interval and increased age. This is probably explained by the fact that a child's funeral was easier to arrange. It is, and presumably was, usual for only close members of the family to attend an infant's funeral, whilst that of a mature adult might well attract people from far and wide. It is also probable that an adult's funeral was "grander" than an infant's and consequently required greater preparation and organisation.

Interestingly, the one outlier among the children was Master Jeremiah Mercer (CAS 2334) who was buried eighteen days after his death. He was the son of Jeremiah Mercer "Undertaker and Cabinet Maker", perhaps this is a 19th century example of a craftsman who was far too busy attending the needs of others, to attend the needs of his own family. An alternative explanation is that this child was given a lengthy embalming procedure.

Another variant worthy of consideration is the possibility of a relationship between the distance between abode at death and Christchurch itself. Both death/burial interval and 'distance' are known for 346 individuals. See table 17 for an overview of the results.

Table 17 The relationship between the death/burial interval and the distance from Christchurch.

Parish	Number	Mean	Range
Christchurch.	129	7.0	1-18
Nearby Parishes.			
Bethnal Green.	41	7.8	3-15
Bishopsgate.	11	7.1	5-11
Mile End New Town	4	12.5	2-21
Norton Folgate.	19	6.6	3-11
Old Artillery Ground	19	7.2	4-13
Shoreditch	12	8.2	5-14
Other London Parishes.			
Hackney.	11	6.5	3-11
St. Lukes, Old St.	5	7	4-09
City parishes.	8	10.7	5-21
Outside of London.			
Greenwich.	2	6	3-9
Leatherhead.	1	7	7
Reading.	1	9	9
Horsley Down.	2	15.5	14-17

There is no clear relationship between the distance from the church and the death/burial interval among this sample. There are, generally speaking, both short and long intervals regardless of distance involved.

3.5 ...and so to the weaknesses of human nature.

For reasons best known to himself, Peter Isaac Galhie (CAS 2727) refused to acknowledge his marriage to anyone except his brother Robert and his sister Judith (Huguenot Research File). Possibly out of concern not to contract such a disastrous marriage, Samuel Courtauld having obtained a licence to marry Elizabeth Chase on 18th January 1749, obtained another just seven months later, on 28th August, and married Louisa Perinna Ogier (CAS 2309).

Guilty of creating havoc whilst earning a living, John Stubbs (CAS 2811) was one of the proprietors of the

White Lion Brewery against whom presentations were made at the manorial court of Norton Folgate, in 1756. Their crime - obstructing Elder Street and Blossom Street, with their drays (Sheppard 1957, 81) !

Chapter 4. Method

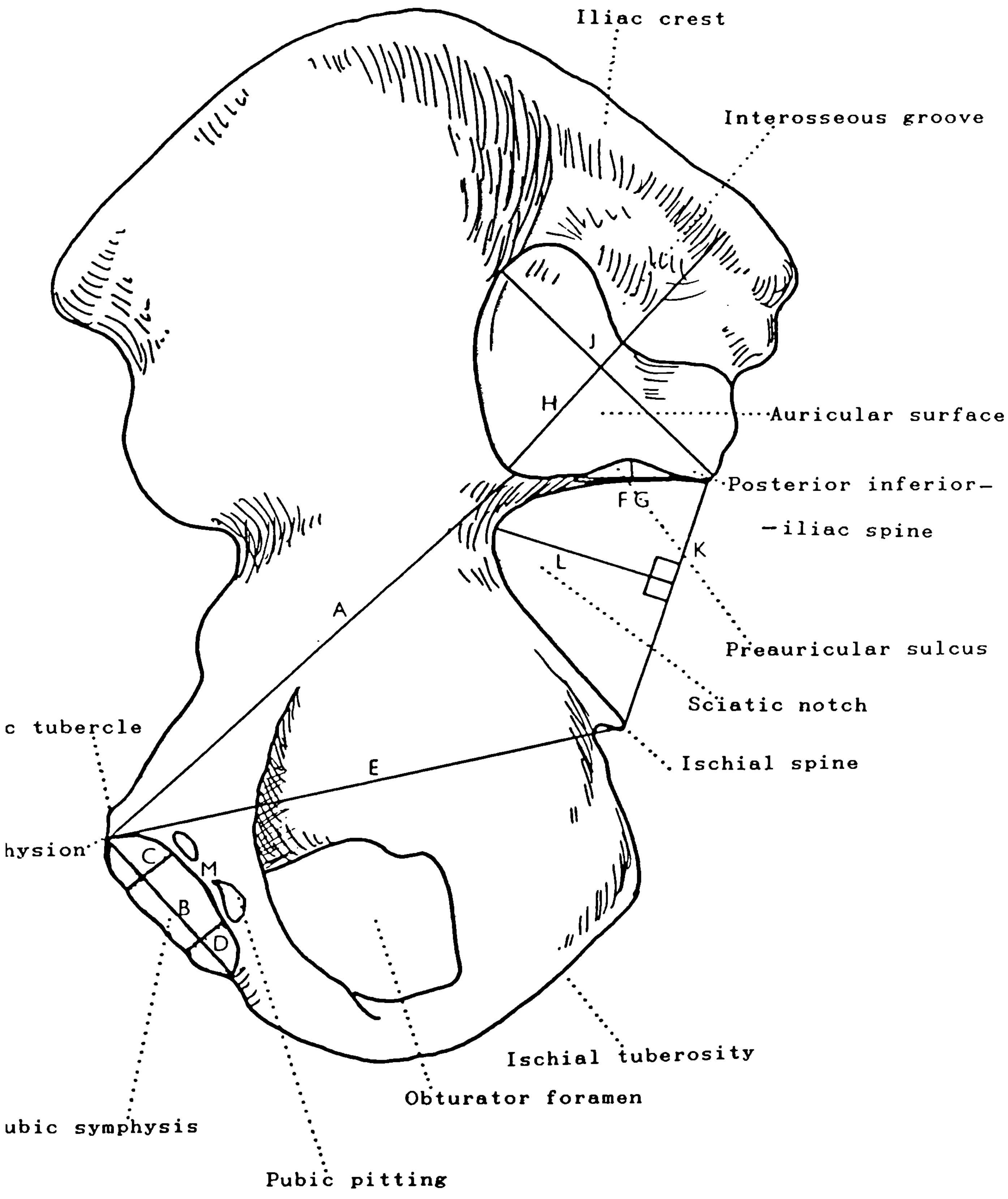
4.1. Macroscopic Skeletal Examination of the Female Sample.

> "...My working bench. A wice. Tools. Bones, warious. Skulls, warious...Bottled preparations, warious. Everything within reach of your hand, in good preservation. The mouldy ones atop. What's in them hampers over them again, I don't quite remember. Say, human warious. Oh, dear me! That's the general panoramic view." (sic. Mr Venus's deşcription of his shop in Our Mutual Friend, C. Dickens, 1864-5)

A wide range of metric and non-metric data was collected on each of the 138 female skeletons of known identity. For the reasons described in Chapter 1, the metrical analysis is specifically to provide a description of the pelvis in terms of obstetric efficiency and capaciousness. Standard pelvic measurements such as ilium height and ischium length, which measure robustness, are not considered of importance to this project. Other features which might affect pelvic stability, such as the extent of sacral articulation, have also been scored. As have degenerative changes, which can relate either to ageing or to wear and tear on the joint in question. Analysis of the pelvis took place in the following order for each individual.

1. Left innominate.
2. Right innominate.
3. Sacrum.
4. Articulated pelvis.

Figure 12



Right innominate, medial surface.

The latter was achieved by holding the innominates and the sacrum together in their correct anatomical positions with the sacroiliac joints articulated. If there was a gap of more than 2mms. between the left and right symphyseal faces, "blue tack" of the appropriate thickness was inserted between the two. Strong elastic bands, usually two, were then stretched around the pelvic girdle, these held the component parts together with surprising success. This method of reconstruction was used as it was considered less harmful to the bones than the use of adhesives, furthermore, permanent reconstruction could also inhibit future research.

<u>Plate 16. Absence of a preauricular sulcus. CAS 2605 - 19 years old, no children.</u>

The following data were collected on complete bones. Where post-mortem damage and erosion had occurred the amount of surviving bone dictated which data could be collected. Reconstruction was only occasionally undertaken as this material, when fragmented, was often eroded.

Non-metric observations.

Left and right innominates: see figure 12.

Preauricular sulcus, absent or present.

0 = Absent.

1 = Present.

Preauricular sulcus type: scored as 0-4, see description below.

0 = absent. See plate 16.

1 = groove of pregnancy (Houghton). See plate 1.

2 = groove of ligament (Houghton). See plate 2.

3 = see notes below. See plate 17.

4 = male sulcus, see below. See plate 18.

A wider range of sulci were scored than has previously been noted by other authors. Four sulcus types have been identified during the examination of the preauricular area of Romano-Celtic adults from Poundbury Camp, near Dorchester, Dorset (n= approximately 900), a Moorish sample of 49 females from 11th-13th century Murcia, in south-east Spain and the total adult sample from Christ Church, Spitalfields (n=716). Approximately 1,650 adults in total.

The four types of sulcus classifications are as follows: Type 1, Houghton's (1974, 381) "groove of pregnancy" see plate 1. This is is characterised by its

Plate 17. Type 3 sulcus. CAS 2956 - 45 year old mother of three.

"scooped" floor and irregular inferior margin. Type 2, Houghton's (ibid) "groove of ligament" see plate 2, this type is characterised by its smooth floor and where an inferior margin is present, its smoothness. The third sulcus fits neither of Houghton's categories it has distinct characteristics and is rarely observed in males. This sulcus (see plate 17) is comparatively very wide, lacks a clearly demarcated margin and usually has a grainy textured floor. The fourth type of "sulcus" is actually misnamed. A comparatively short and narrow feature, rather than being a true sulcus i.e. groove created by cortical resorption, its effect is created by the presence of an accentuated tubercle piriformis near the posterior inferior iliac spine (see plate 18). In this text it will be referred to as a sulcus for comparative purposes. It is usually found in males and only occasionally seen in females.

Plate 18. Type 4 sulcus "male type". CAS 2602 - 51 year old father of two.

Where a sulcus did not entirely fulfill the criteria of one the four sulci described above, it was categorised according to which it most resembled.

Preauricular sulcus severity: scored 0-4. 0 being the absence of a sulcus, 4 representing a large and deep sulcus with clear definition.

Preauricular sulcus, number of "scoops": the number of clearly defined "scoops" within the margin of sulcus, in the case of type 1. This variant is considered to test Ullrich's (1975) assumption that each scoop represents an obstetric event.

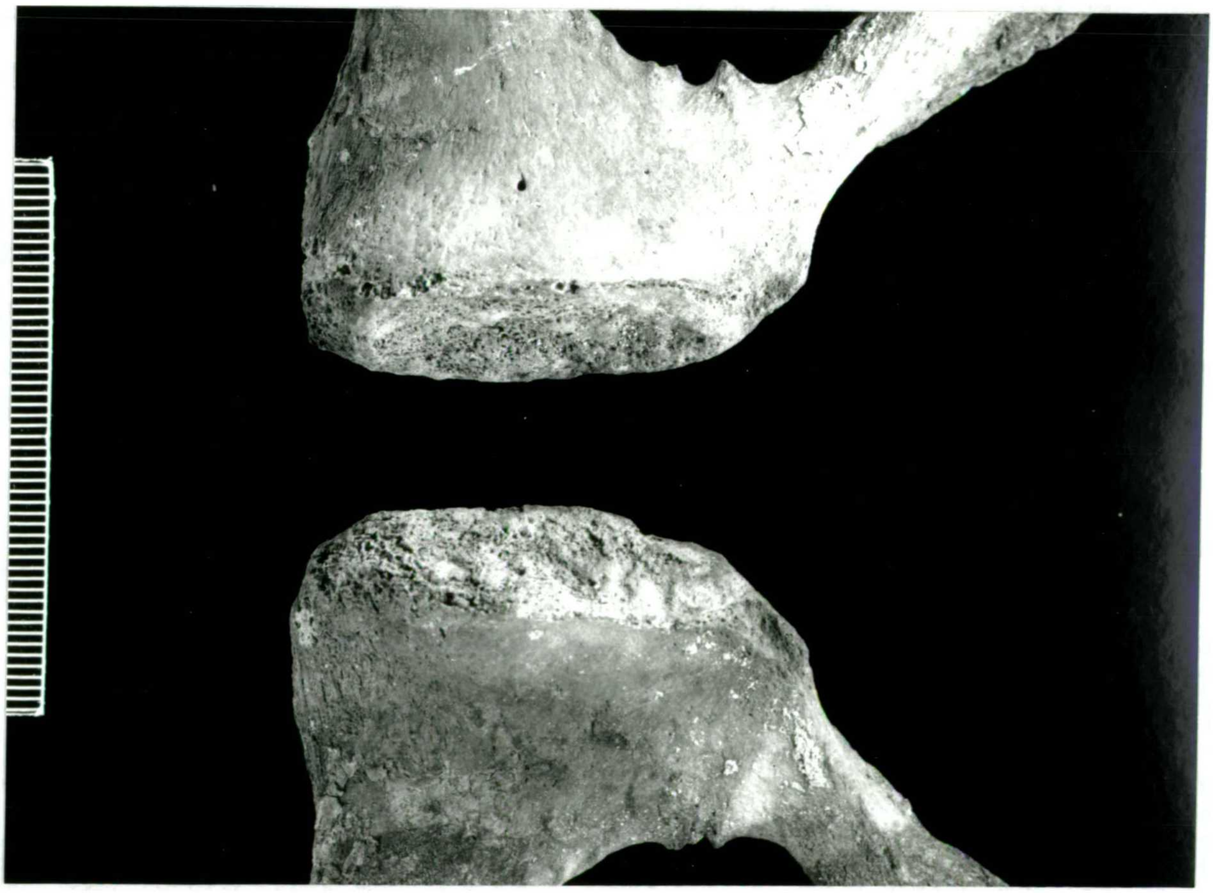
<u>Pubic pits, absent or present:</u>

0 = Absent, see plate 19.

1 = Present, see plates 3, 4 and 5.

<u>Pubic pits, number of:</u> 0 = absent, 1 + as relevant. See plate 3 for an example of pitting, or resorption, of the dorsal aspect of the pubis. The number of defined pits is scored to test Ullrich's (1975) theory that each pit represents an obstetric event.

<u>Plate 19. Absence of pitting on the dorsal aspect of the pubic corpus. CAS 2438 - 56 year old female of unknown parity status.</u>



Pubic tubercle: its discernible presence and degree of extension as seen from the dorsal aspect of the innominate with the innominate held on its anatomical plane.

0 = undeveloped.

1 = discernible.

2 = extended.

3 = an elongated conical tubercle. See plate 6.

Sciatic notch shape: visual assessment.

1 = very wide and shallow.

2 = wide and shallow.

3 = V shaped, moderately deep.

4 = U shaped.

5 = U shaped and deep.

Ischial spine shape:

1 = flat and blunt.

2 = pointed.

Degenerative conditions.

Porosity and osteophytosis are scored separately to allow for a greater internal variation than that described by Sager 1969 (Brothwell 1981, 150). Four grades of increasing severity have been applied, again to allow for more accurate description of skeletal involvement than that advocated by Sager (ibid.). No attempt to describe causality or diagnose underlying disease has been attempted and, for the sake of brevity, osteophytosis and porosity are referred to as "degenerative changes" in the text. This terminology is intended to be purely descriptive. For a more detailed description see below.

Porosity of the pubic symphysis face: using a range of scores 0-4. The grading of porosity on all areas of articulation are based on the following description:

0 = no changes.

1 = intermittent areas of porosity around the margins of the joint concerned.

2 = porosity around the entire articular margin.

3 = porosity over much, but not all, of the articular surface.

4 = porosity of the entire articular surface.

Sacroiliac joint, porosity: scored 0-4 as above.

Sacroiliac joint, osteophytosis: scored 0-4 the scoring indicating the range of changes as described below:

0 = no changes evident.

1 = intermittent osteophytes.

2 = intermittent, but larger osteophytes.

3 = continuous osteophytes.

4 = continuous, but more extreme, osteophytic changes.

Symphyseal lipping: score 0-4.

0 = absent

1 = slight lipping along part of the dorsal margin.

2 = slight lipping along the entire dorsal margin.

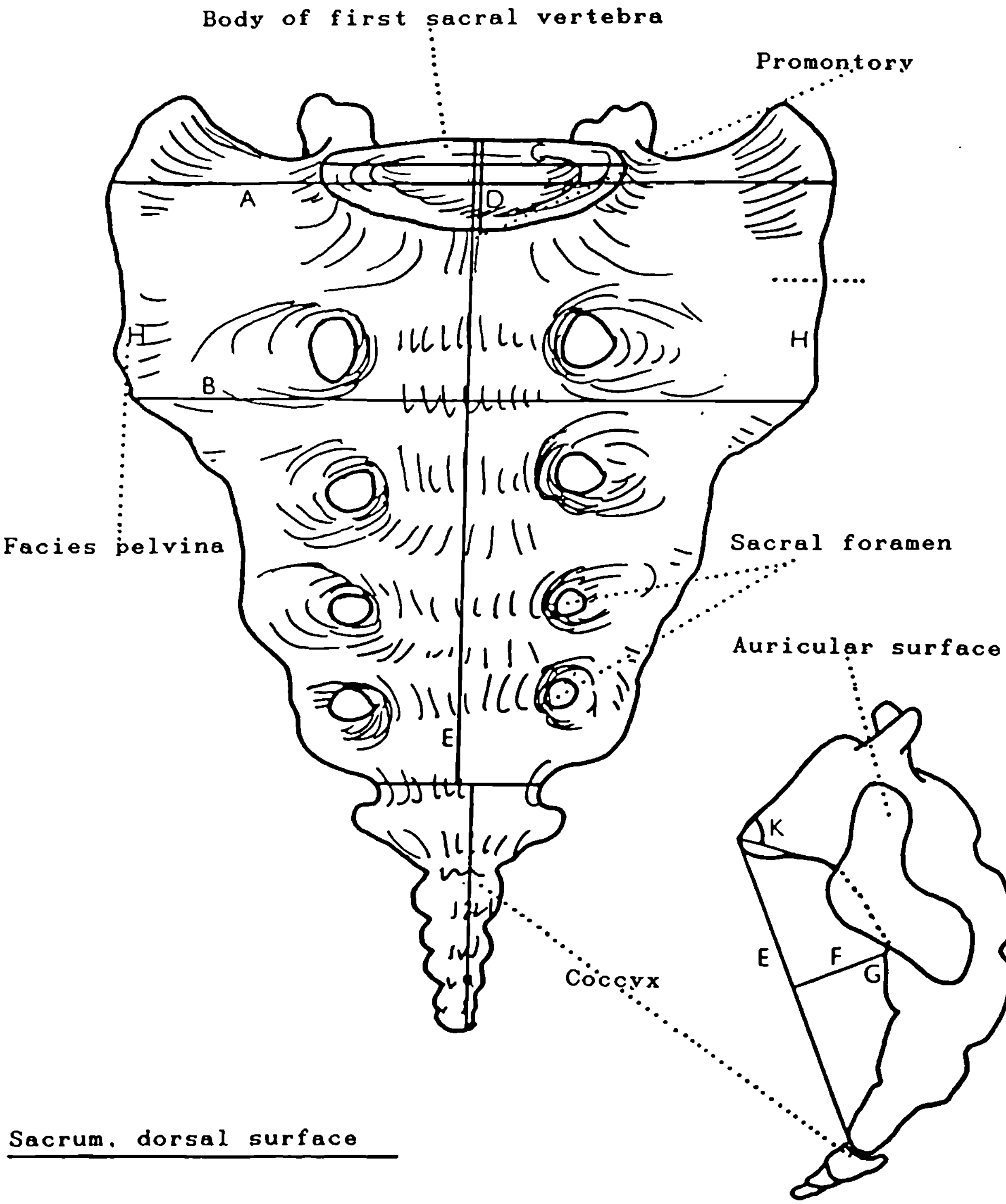
3 = moderate lipping.

4 = severe exostosis of the dorsal aspect of the symphyseal margin. See plate 20.

The Sacrum: see figure 13.

Point of maximum depth: the vertebral number at which the maximum depth was measured. See figure 13.G.

Figure 13



Sacrum, dorsal surface

Fusion of sacral vertebrae 1 & 2:

1 = completely fused, line obliterated.

2 = fusion in process.

3 = bodies still separate on the ventral surface.

Plate 20. Exostosis of the pubic symphysis. CAS 2166 - 70 year old mother of three.

Sacralization:

0 = absent.

1 = unilateral.

2 = bilateral.

Number of sacral vertebrae:

The actual number from 4 to 6.

Extent of sacroiliac articular surface: the number of the most inferior sacral vertebra included in the auricular surface. Usually 2 or 3.

Scarring of the facies pelvina:

(see figure 13.H.)

0 = absent.

1 = unilateral.

2 = bilateral.

"Spitalfields Sacrum": the presence or absence of an unusually sharp angled sacral curve occurring in the Spitalfields sample but rarely seen in English archaeological samples. The normal sacral curve is accentuated and in some cases forms a right angled bend. This usually occurs at sacral vertebra 3 or 4. This condition probably results from rickets (Chassar Moir 1964, 81) but curiously there are no other rachitic, pelvic deformities in these cases although some have healed rickets affecting their long bones. See figure 13M for a range of the sacral curve found in this sample.

Degenerative changes.

Porosity of the bodies of sacral vertebra 1 and lumbar vertebra 5: scored 0-4 as described above.

Osteophytosis of the bodies of sacral vertebra 1 and lumbar vertebra 5: scored 0-4 as above.

Porosity of the left auricular surface: scored 0-4 as above.

Porosity of the right auricular surface: scored as above.

Osteophytosis of the left auricular margin: scored as above.

Osteophytosis of the right auricular margin: scored as above.

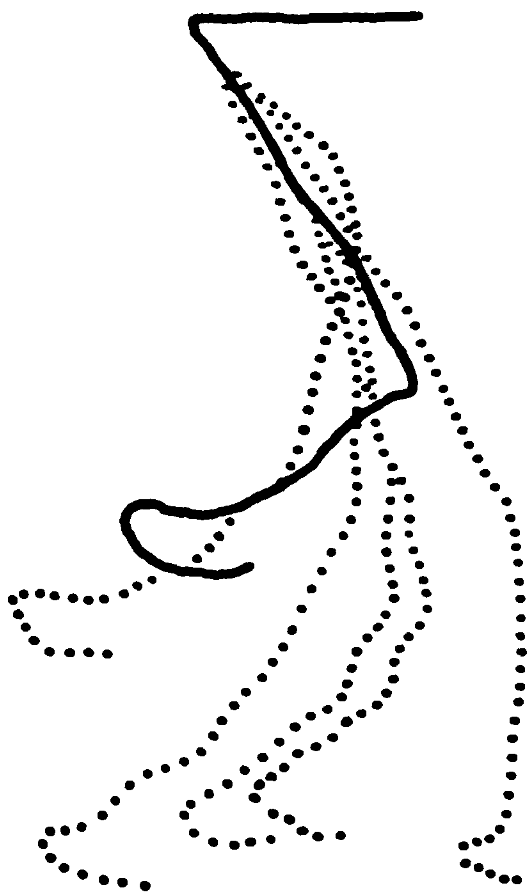


Figure 13M.

Example of a probably rachitic sacrum, "Spitalfields Sacrum" CAS 2046, compared to examples of the range of sacral curve in the Christ Church sample. The discal surface of sacral vertebra 1 is on the horizontal plane.

Fusion of the sacrum to the left innominate: this occurs in this sample and can be the result of such conditions as diffuse idiopathic skeletal hyperostosis (DISH), Reiter's syndrome or anklyosing spondylitis. Scored as either absent or present.

Fusion of the sacrum to the right innominate: as above.

The rearticulated pelvis: see figure 14.

Pubic symphyseal alignment: an abbreviated record of the alignment and proximity of the two symphyseal faces when the sacroiliac joints are correctly articulated.

1 = correctly aligned with a space between of not more than 4 mm.

2 = correctly aligned but with a space between of 4 mm or more.

3 = misaligned, i.e. one pubic branch was higher/lower than the other.

Pelvic shape: was assessed by eye using the Caldwell and Moloy (1938) classification. This method has been widely criticized for relying too heavily upon inlet shape and not considering the pelvis as a whole, however, for the purposes of this excercise, it proved adequate as the majority of pelves could be assigned into a category. See figure 4.

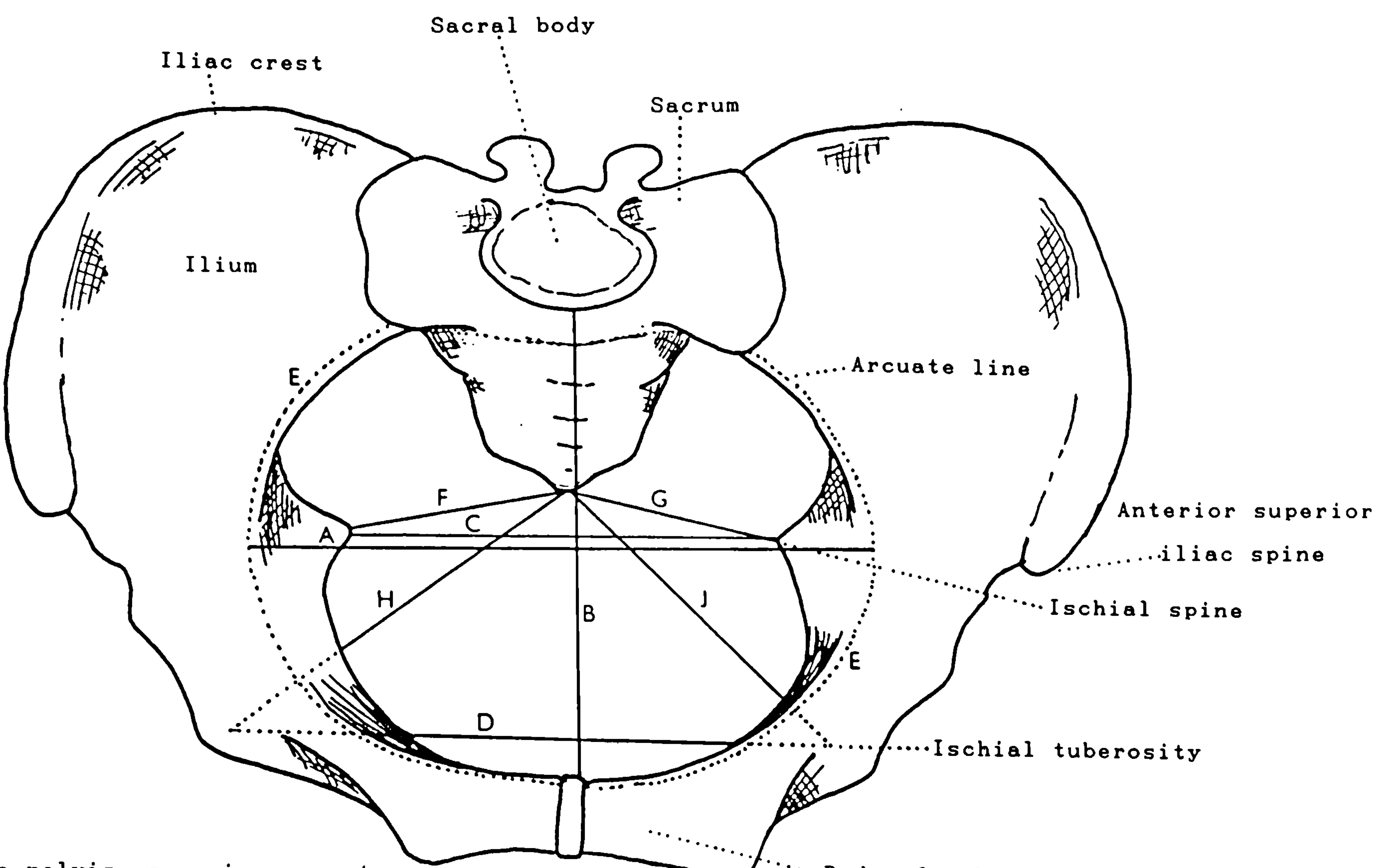
1 = Gynacoid.

2 = Anthropoid.

3 = Android.

4 = Platypelloid.

Figure 14



Female pelvis, superior aspect.

Pathology: of the lower vertebrae, pelvis and lower limbs were scored as described below. A full description is included in Appendix 1.

0 = Absent.

1 = Degenerative changes to the vertebrae.

2 = Degenerative changes to the lower limbs.

3 = Degenerative changes to both vertebrae and limbs.

4 = Fracture to pelvis or lower limbs.

5 = Other, see notes (appendix 1).

6 = Degenerative changes and fracture(s).

4.2 Macroscopic Skeletal Examination of the Female Sample: Metrics.

The following metric data was collected on complete bones. Where post-mortem damage and erosion had occurred the amount of surviving bone dictated which data could be collected. Reconstruction was only occasionally undertaken as this material, when fragmented, was often eroded. All measurements were taken in millimetres. Unless otherwise indicated a digital sliding calliper was used to take the measurements, this measured to two decimal places. However, the majority of the dimensions were such that they were only scored to the nearest millimetre.

The left and right innominates.

Pubo-sacroiliac diameter: from the symphysion to the point where the anterior auricular point of the arcuate line intersects the anterior border of the auricular surface. For an illustration of the points referred to see figure 12.A. As described (A-S) in Segebarth - Orban 1980, 602.

Pubic symphysis depth: from the symphysion to the inferior extremity of the symphyseal face. See figure 12.B. As described (M) in Day 1975, 145.

Pubic symphysis width, superior: the width of the symphyseal face at the level of the first quartile descending from the symphysion. See figure 12.C.

Pubic symphysis width, inferior: the width of the symphyseal face at the level of the third quartile descending from the symphysion. See figure 12.D.

Ischial spine to the pubic symphysis: from the medial point of the ischial spine to the symphysion. See figure 12.E.

Preauricular sulcus length: the maximum length of the sulcus from the posterior inferior iliac spine to the auricular point where the arcuate line intersects with the anterior border of the auricular surface. If the sulcus extended beyond, or was present only beyond the auricular point on the antero-superior portion of the ilium as illustrated in plate 21, this was omitted from the measurement. See figure 12.F.

Preauricular sulcus width: the maximum outer width of the sulcus, at right angles to the length. See figure 12.G.

Sacroiliac joint, maximum length: from the point where the arcuate line dissects the auricular surface to the point on the anterior margin of the iliac crest which the arcuate line would dissect if it continued.. See figure 12.H.

Sacroiliac joint, maximum width: from the posterior inferior iliac spine to the opposite extremity of the auricular surface. See figure 12.J. As described (Q) in

Day 1975, 145

Plate 21. Preauricular sulcus extending superior of the arcuate line. CAS 2654 - 61 year old female of unknown parity status.

Sciatic notch width: from the posterior inferior iliac spine to the posterior extremity of the ischial spine. See figure 12.K. As described (I) in Day 1975, 145.

Sciatic notch depth: using a co-ordinate calliper (not Aichel type) with the moving arm set at the measurement of the sciatic notch width, the points were placed on the posterior inferior iliac spine and the ischial spine and the depth of the notch was measured with the perpendicular arm. See figure 12.L.

Pubic pits, maximum diameter: the diameter of the largest "pit", or of the sulcus, at right angles to the symphyseal margin, if one has formed.

Pubic pits, minimum diameter: as above but the minimum dimension.

The Sacrum.

Maximum sacral width (superior): (maximum anterior breadth. Bass 1971, 89). See figure 13.A. Also described by Segebarth-Orban (A_1-A_2) 1980, 603.

Sacral width Inferior: the diameter of the ventral sacrum at a level determined by the inferior extremity of the auricular surface. See figure 13.B.

Sacral body width: the maximum width of the body of the first sacral vertebra. See figure 13.C.

Sacral body depth: the maximum depth of the body of the first sacral vertebra, measured from the sacral promontory to the sacral canal. See figure 13.D.

Sacral length: from the sacral promontory to the apex of sacral vertebra 5/6. as described in Bass 1971, 89 (sacral anterior height). See figure 13.E.

Sacral depth: using a co-ordinate calliper placed on the sacral promontory and the apex of vertebra 4, measure the maximum depth of the sacral curve. See figure 13.F.

Coccygeal length: the maximum coccygeal length, where the coccyx survives completely. See figure 13.J.

Lacro-Sacral angle: the angle between the superior surface of the body of sacral vertebra 1 and the anterior sacral surface. This was measured by duplication of the superior and ventral profile of the sacrum using a "shape tracer". This was then traced off onto paper and the angle was measured. A set of tracings of the sacra of this sample has consequently been compiled. See figure 13.K.

<u>The Articulated Pelvis.</u>

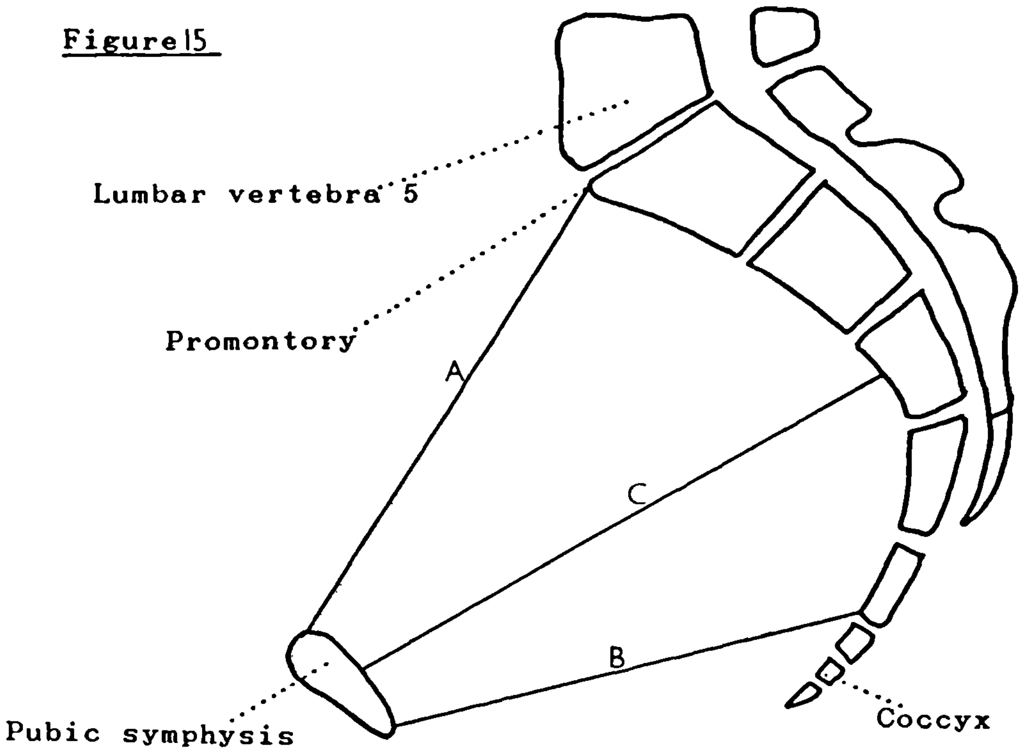
<u>Transverse diameter:</u> the maximum transverse diameter at the level of the arcuate line. See figure 14.A. As described in Segebarth-Orban, 1980 after Martin no 24, 1957.

<u>Conjugate diameter (antero-posterior superior):</u> between the dorsal margin of the pubic symphysis at the level of the arcuate line and the medial sacral promontory. See figure 14.B and 15.A. As described in Gray's Anatomy (1973, 351).

<u>Inferior antero-posterior diameter:</u> between the inferior dorsal extremity of the pubic symphysis and the ventral apex of sacral vertebra 5. See figure 15.B.

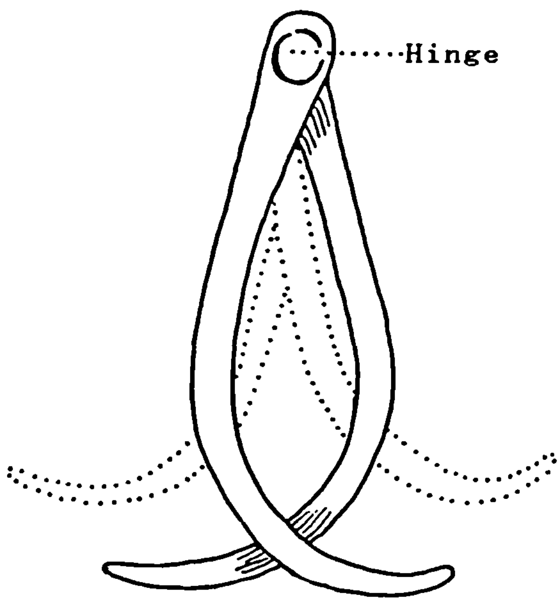
<u>Greatest pelvic diameter:</u> from the medial point of the dorsal pubic symphysis to the point of maximum depth of the sacrum, usually sacral vertebra 3. See figure 15.C. (As described in Gray's Anatomy 1973, 31.) The instrument used to measure this (see figure 16) was hinged with two curved blades. This could be inserted into the pelvic cavity and adjusted to fit the greatest pelvic diameter. Careful removal of the instrument was then required so that the dimension recorded could be measured with a sliding calliper. Trial and error illustrated that the tighter the hinge, the less chance there was of accidentally altering the dimension during removal of the instrument from the pelvic cavity.

Figure 15



Medial Sagittal Section through the Female Pelvis

Figure 16



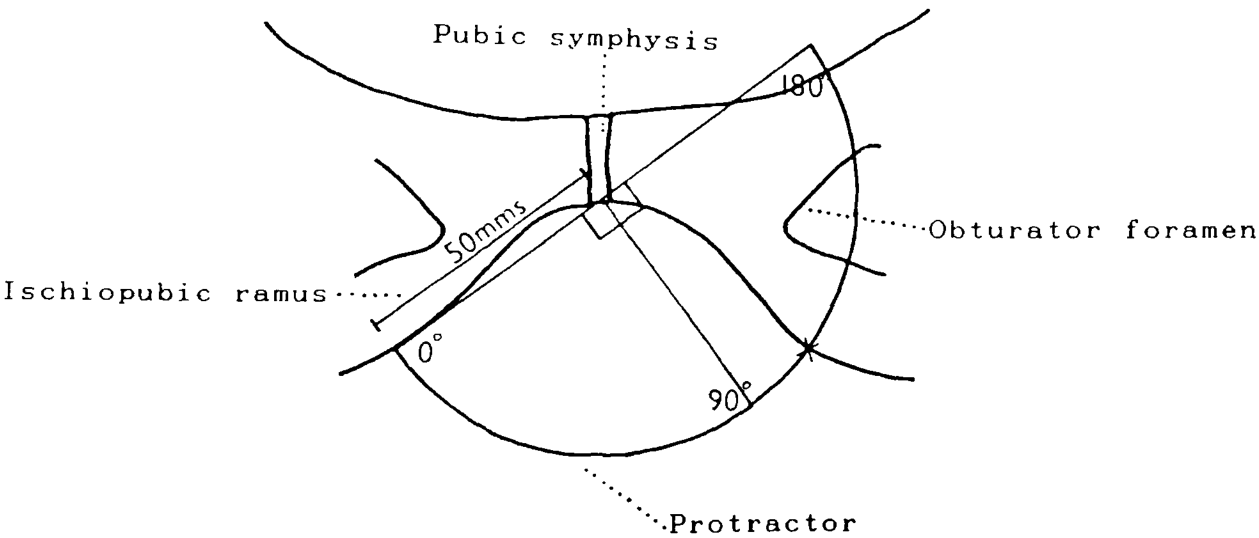
Instrument for Measuring Internal Dimensions

Bispinous diameter: measured from the inferior pelvic outlet at the midpoint of each ischial spine. See figure 14.C.

Bi-tuberous diameter: measured from the inferior pelvic aspect between the transverse ridges of the ischial tuberosities. See figure 14.D. This proved to be the only clearly recognisable point on the ischial tuberosity consequently it was utilised to ensure repeatability.

Sub-pubic angle: using the same protractor throughout, the central point of the horizontal edge was placed at the inferior aspect of the ventral pubic symphysis. The nought degrees mark was placed level with the left ischiopubic ramus, the angle was measured where the curved edge of the protractor dissected the right ischiopubic ramus. Consequently, the sub-pubic angle was measured at 50 mms. along the ischiopubic rami. See figure 17.

Figure 17



Method for Measuring the Sub-pubic Angle

Inlet circumference: using a curvemeter (often used to measure routes on maps) the arcuate line was followed around the superior pelvic inlet from the right symphyseal margin to the left. This was always repeated at least twice as it was difficult to perform and repeatability was a requirement of this data collection. See figure 14.E.

Left ischial spine to the sacral apex: from the medial point of the spine to the medial apex of sacral vertebra 5. See figure 14.G.

Right ischial spine to the sacral apex: as above. See figure 14.F.

Left ischium to the sacral apex: from the transverse ridge of the ischial tuberosity to the medial apex of sacral vertebra 5. See figure 14.J.

Right ischium to the sacral apex: as above. See figure 14.H.

Three pelvic indices were derived from the data set:

Pelvic Inlet Index: the conjugate diameter as a percentage of the transverse diameter.

Pelvic Outlet Index: the inferior antero-posterior diameter as a percentage of the bispinous diameter.

Obstetric Pelvis Index: the inlet index as a percentage of the outlet index.

Stature: was added to this data set. It was assessed from long bone lengths using Trotter and Gleser's formula (1952) (courtesy of S. Gauthier).

4.3 Data collection.

The data listed above was entered onto a portable microcomputer, an Epson PX 8. This was transferred, at regular intervals, to a personal computer, an Apricot XI with a larger memory. In order to establish repeatability of measurements and non-metric observations, and to establish a knowledge of intra population variability, the first 50 pelves (male and female) from the total adult sample were examined twice.

Further to the data listed above, a written description was made of each individual, see Appendix 1. This was undertaken because the Spitalfields material is due to be cremated and reinterred in the church. Consequently, it was considered worthwhile to enhance the continuous and discrete data collection.

The description noted skeleton identification number, name, age at and date of death. This was derived from the coffin plates and verified by reference to the Christ Church burial register available on microfiche at the Greater London Records Office. The condition of each skeleton was noted with specific reference to the vertebrae, pelvis and lower limbs. The morphological variation of the cortex observed near the areas of pelvic articulation was described fully. Pelvic anomalies and pathologies were noted and described. Similarly, such features were also noted in connection with the vertebrae and lower limbs so that the question of pelvic instability and "scars of parturition" could be addressed.

After the skeletal data collection was complete the following historical data were collected and added to the text. These data comprised the marital status of the female, her husband's name and occupation if she had married. The number of infants baptised by each couple and the intervals between births were noted, as were the age of the female at her first and last confinements.

4.4 The Male Pelvis.

Although this study is primarily concerned to evaluate the significance of so called "scars of parturition" in the female pelvis, consideration was paid to the incidence and types of morphological changes to the cortex in the male pelvis. Consequently, as part of the basic data base the following information was scored on the 82 named males for whom one or more of the areas of pelvic articulation survived. All were scored using the same criteria and scoring as was applied to the female skeleton; preauricular sulcus type and severity, pubic pitting and the pubic tubercle. Where any anomalies or pathologies were evident affecting the vertebrae, pelvis or lower limbs these were scored as they might contribute to pelvic instability. It seemed logical to suppose that the male pelvis would respond to this condition in a similar way to the female, although the question of whether any response would leave skeletal markers has yet to be resolved.

Following statistical analysis of the female data (see chapter 6) it seemed worthwhile to take a series of metric and non-metric data on the male pelvis. Only those pelves where all of the articular areas survived were examined because the measurements required were mostly from the rearticulated pelvis. Unfortunately, this determined a sample size of only 21. The following data were collected from the male pelves using the same criteria as for females (see above):

Left and right innominates.

Sciatic notch width.

Sciatic notch length.

Sacrum.

Sacral length.

Sacral width superior.

Rearticulated pelvic girdle.

Transverse diameter.

Conjugate diameter.

Antero-posterior diameter superior.

Antero-posterior diameter inferior.

Greatest pelvic diameter.

Bispinous diameter.

Inlet circumference.

Pelvic shape.

Stature was also estimated using the appropriate Trotter and Gleser (1952) formulae. (Courtesy of S. Gauthier.)

4.5 Historical Techniques Used to Retrieve the Obstetric Histories of the Named Sample: Potential and Limitations.

Historical reconstruction of the parity status of the named females was undertaken after the skeletal analysis. It was considered that if the parity status of the females was known prior to the skeletal data collection, it might subconciously bias the results.

The obstetric histories of the named sample were determined largely by reference to a range of primary source material and occasionally from secondary sources.

Undertaken as a component part of one year's historical research into the life styles and life histories of the named sample (n=387) (see chapters 2 & 3), it was funded by English Heritage as part of the Christ Church, Spitalfields Project.

It was essential that at all times the basic tenets of historical inquiry were adhered to. These comprised: That all records and other documents were authentic or authenticated copies. That the person or people responsible for creating the document had direct access to the subject upon which they were commenting or recording. That the possibility of bias was considered. That the purpose of the document was considered in relation to its content. That the document was understood as contempories would have understood it. That the problems of deciphering types of handwriting and incomplete documents were considered. Finally, that both witting and unwitting information was extracted and that all allusions, references and obscurities were understood. Historical inquiry is an art requiring skills that should not be underestimated. Both the potential, but more importantly the limitations, of all primary and secondary source material were established. Where possible, a range of sources was used.

The processes involved in acquiring these data were complex and involved working from, and building upon, the initial data base, the coffin plates (see plate 13). These were inscribed with the individual's name, age at and date of, death). Occasionally, other types of data were inscribed such as "the son of William and Mary Leese", "Lord Mayor of London in 1757" and "of the Queen's Head, Fashion Street". Starting from the primary data, information was collected and collated piece by piece until, where possible, an understanding of each individual's life history and environment had been achieved.

The first procedure was to establish if the females were married, when and to whom. In order to illustrate the complexity of the inquiry, two individual cases will be described.

Mrs Grace Wells (CAS 2666) died aged 62 on June 8th, 1811. Reference to the Christ Church burial registers was made to verify the details and to collect the additional information listed. Grace was buried on June 16th, 1811 and her "abode at death" was Dorset Street. Dorset Street is situated east of Christ Church, running from Crispin Street in the west to Red Lyon Street (now Commercial Road) in the east (see figure 11).

Grace's year of birth would have been 1749, therefore her fecund period would have extended from approximately 1760 - 1795. Any marriage she entered into after this date would be irrelevant to this project as there would have been no issue. Reference to the International Genealogical Index for London (Guildhall Library) only revealed one marriage within the period of concern, in which a male with the correct surname married a female with the christian name Grace. Christopher Wells of the parish of Christ Church, Spitalfields married Grace Duxbury on the 19th May 1767, at St. Leonard's Church, Shoreditch. The place of marriage suggested that Shoreditch had been the bride's place of residence. That the groom's parish of residence was Christ Church indicated that this could be the correct marriage.

The International Geneaogical Index also lists the baptisms at Christ Church of several children born to this couple. The next step was to refer to the original baptism registers in order to see if they contained any information which would confirm that the mother was CAS 2666. The data derived from the registers relating to the children of Grace and Christopher is listed in table 18.

Table 18. Baptism data relating to the children of Grace and Christopher Wells.

Child's name	Date of birth	Date of baptism	Father's occupation	Parents' address
Christopher	--	19/06/1768	Painter	Pater Noster Row
William	25/07/1769	13/08/1769	"	"
Christopher	14/08/1772	06/09/1772	"	"
George	05/03/1775	09/04/1775	"	Brown's Lane
Ann	24/06/1777	20/07/1777	"	"
Robert	09/08/1778	06/09/1778	"	"
Grace Ann	02/05/1781	30/05/1781	"	"
Charlotte	26/04/1782	19/05/1782	"	"
Elizabeth	07/04/1784	07/05/1784	"	"
John	28/08/1785	16/09/1785	"	"
Mary	23/06/1788	16/07/1788	"	"
Richard	01/07/1790	11/07/1790	"	Dorset Street

The address given at the baptism of Richard was the same as that on the registration of Grace's death. Reference to the Land Tax Returns (Guildhall library) for the appropriate years indicated that there was no other householder with the same surname living in Dorset Street. With this number of positive indicators it was considered that the above data did relate to the female in question.

At the beginning of the historical research the council of the Huguenot Society of Great Britain were approached with a request for permission to mail those fellows of the society claiming descent from families with surnames found among the crypt sample. This request was approved and the subsequent response from members of the society was overwhelming. Consequently, a number of genealogies were submitted for study. Where these were relevant, as much of the data as possible was checked with the original records. This type of secondary source material was occasionally useful, for example, the Courtauld genealogy, lent by Mr George Courtauld of Essex.

Louisa Perinna Ogier (CAS 2309), see plate 15, was the youngest daughter of Pierre and Catherine Ogier. She was born in 1729 in Poitou and was smuggled out of France with her siblings in the early 1730's. The Ogier family became successful silk weavers and merchants living in Spital Square, in Norton Folgate, an extra parochial precinct, adjacent to the parish of Spitalfields. On August 31st, 1749 Samuel Courtauld, also a Huguenot, married Louisa Ogier at St. Luke's Church, Old Street. The children of this marriage are as listed in table 19, these data can be verified by reference to the baptism register of the French Church in Threadneedle Street (Colyer-Ferguson 1916).

Table 19. Baptism data of the infants of Samuel and Louisa Courtauld.

Child's name	Date of birth	Date of baptism
Augustine	26/08/1750	31/08/1750
Samuel	20/10/1752	25/10/1752
Louisa	09/03/1754	17/03/1754
Esther	16/02/1757	24/02/1757
Louis	05/08/1758	15/08/1758
Catherine	07/04/1760	22/04/1760
George	19/09/1761	08/10/1761
Sophia	04/07/1763	11/07/1763

Louisa and Samuel lived at 21 Cornhill opposite the Royal Exchange in the city of London where Samuel had business premises. Louisa was widowed at the age of 36 and she successfully practised as a goldsmith until she retired at the age of 51.

It is perhaps fortunate that the Huguenots inspire research by their descendants as the French church records are, in many ways, less informative than the parochial church records. Louisa's infants were baptised in Threadneedle Street French Church (Augustine excepted) and the register does not list occupations or addresses for most of the 18th century. However, the useful thing about the Huguenot names is that many were very unusual at that time in London and they are easy to identify in other records such as the Trade Directories and the Land Tax Returns. There is only one Louisa Courtauld in the London records for the appropriate period, and only one Samuel. Consequently, they can be identified with certainty and the obstetric data used with confidence.

For those individuals dying after July 1837, the beginning of civil registration, their death certificates were useful in the quest to determine their marital and obstetric histories. For example, the death certificate of Martha Smith (CAS 2544), who died aged 52, states that she was the widow of Thomas Smith, a plumber and that her daughter Matilda reported her death (see figure 18). The death certificate of Hannah Brown (CAS 2335) states that she was a single woman (see figure 19). Prior to the receipt of this document Hannah's marital status had been assigned as unknown. Brown was a very common name in 19th century Spitalfields and, although there were many entries with the correct name, none had the correct address or any definitive supporting data.

One problem with this inquiry was that it was extremely difficult to identify with confidence those women with common surnames, such as Smith and Williams, particularly because it was not unusual for several families with these names to live in the same streets and to practise the same occupations. Consequently, the parity status of several females could not be assigned.

The major limitation of the results of this research lies in the fact that if an infant was not baptised, there is no way of knowing that it was ever born. A consequence of this is the possibility that the number of children each woman baptised under-represents the number she actually bore. If an infant died prior to baptism its birth is almost impossible to detect. Among the crypt sample is (CAS 2133) a stillbirth, Master Chauvet, who was buried on August 5th 1754. If he was

CERTIFIED COPY OF AN ENTRY OF DEATH (544)

GIVEN AT THE GENERAL REGISTER OFFICE, LONDON

Application Number B10100 9

REGISTRATION DISTRICT WHITECHAPEL

1844 DEATH in the sub-district of THE ARTILLERY in the COUNTY OF MIDDLESEX

Columns:—	1	2	3	4	5	6	7	8	9
No.	When and Where died	Name and surname	Sex	Age	Occupation	Cause of death	Signature, description and residence of informant	When registered	Signature of registrar
93	Twenty eighth of November 1844 No 1 Artillery Street Old Artillery Ground	Martha Smith	Female	52 years	Widow of Thomas Smith Plumber	Paralytic Seizures	Matilda Moore Smith Daughter in law Present at the Death No 1 Artillery Street	Thirtieth of November 1844	Thomas Madams Registrar

CERTIFIED to be a true copy of an entry in the certified copy of a Register of Deaths in the District above mentioned.
Given at the GENERAL REGISTER OFFICE, LONDON, under the Seal of the said Office, the 7th day of March 1988

This certificate is issued in pursuance of the Births and Deaths Registration Act 1953. Section 34 provides that any certified copy of an entry purporting to be sealed or stamped with the seal of the General Register Office shall be received as evidence of the birth or death to which it relates without any further or other proof of the entry, and no certified copy purporting to have been given in the said Office shall be of any force or effect unless it is sealed or stamped as aforesaid.

DX 403925

CAUTION:—It is an offence to falsify a certificate or to make or knowingly use a false certificate or a copy of a false certificate intending it to be accepted as genuine to the prejudice of any person, or to possess a certificate knowing it to be false without lawful authority.

Form A504M Dd 8098253 7640180 20M 8/87 Mcr(734596)

Figure 18

CERTIFIED COPY OF AN ENTRY OF DEATH (335)

GIVEN AT THE GENERAL REGISTER OFFICE, LONDON

Application Number B/0/009

REGISTRATION DISTRICT EDMONTON

1843 DEATH in the sub-district of EDMONTON in the COUNTY OF MIDDLESEX

Columns:—	1	2	3	4	5	6	7	8	9
No.	When and Where died	Name and surname	Sex	Age	Occupation	Cause of death	Signature, description and residence of informant	When registered	Signature of registrar
177	Twenty second of February 1843 at 4 Silver Street	Hannah Brown	Female	73 years	Single Woman	Debility	Mary Skinner Present at the Death Silver Street	Twenty fifth of February 1843	Daniel Jewell Registrar

CERTIFIED to be a true copy of an entry in the certified copy of a Register of Deaths in the District above mentioned.
Given at the GENERAL REGISTER OFFICE, LONDON, under the Seal of the said Office, the 7th day of March 1988

This certificate is issued in pursuance of the Births and Deaths Registration Act 1953. Section 34 provides that any certified copy of an entry purporting to be sealed or stamped with the seal of the General Register Office shall be received as evidence of the birth or death to which it relates without any further or other proof of the entry, and no certified copy purporting to have been given in the said Office shall be of any force or effect unless it is sealed or stamped as aforesaid.

DX 403923

CAUTION:—It is an offence to falsify a certificate or to make or knowingly use a false certificate or a copy of a false certificate intending it to be accepted as genuine to the prejudice of any person, or to possess a certificate knowing it to be false without lawful authority.

Form A504M Dd 8098253 7640180 20M 8/87 Mcr(734596)

Figure 19

baptised in utero, as some stillbirths were (Towler & Bramall 1986, 53-55), his baptism was never entered in the register. The record of his burial as the stillborn son of Louis Chauvet is the only historical reference to his birth. Midwives had the power to baptise non-viable infants at birth but none such have been identified in the Christ Church baptism register. (In theory the unbaptised are only allowed to be buried within a specific area of the church yard, one also reserved for suicides and criminals.) It is to be hoped that none of the females in this study failed to baptise their only child, as the consequence will be that they will appear historically to be nulliparious.

A further problem arises with parents who were lackadaisical about baptism. Fortunately only one family among the named sample seems to have been so inclined. Richard and Jane Wilkinson (CAS 2554 & 2569) lived in Queen Street, Richard was a silk dyer. The Wilkinson's baptised five children but it is possible that others were born who did not survive to baptism. Table 20 illustrates the baptism data of the Wilkinson children.

Table 20. Baptism data of the children of Richard and Jane Wilkinson.

Child's name	Date of birth	Date of baptism
Elizabeth	07/11/1794	13/10/1795
Robert	02/05/1797	23/02/1803
Mary	15/05/1800	"
Edwin	26/01/1803	"
Harriet	14/06/1809	07/08/1816

Had the date of birth of these children not been required for registration purposes it would have been supposed that they were all baptised shortly after birth (median for the named sample = 24.8 days) and that Robert, Mary and Edwin were triplets!

The most serious limitation of the obstetric data is that it is never possible to be certain that a female who appears or claims to be nulliparious never bore a child. The question of the incidence of apparently childless females actually having born one or more children is one that cannot be resolved whatever the period of concern or the method of inquiry. Social norms always have, and still do, render the birth of a child in certain circumstances unacceptable, the consequence often being concealment and denial. This problem cannot be resolved but it need not reduce the value of this research if it is considered when discussing the results and conclusions.

The obstetric data relating to the Christ Church sample was collected, sorted and evaluated by hand. It was entered onto a computerised database as and when it was considered to relate securely to the female in question. Initially the data was stored in "Cardbox" files, a simple storage system which facilitated sorting and selecting, and could have extra fields added as and when required. The fields of data used in the subsequent analysis were as follows.

Parity status: 0 = nulliparious.
1 = multiparious.

Number of births: actual number.

Age at first birth: in years.

Age at last birth: in years.

Birth spacing: mean in months.

Died within a few days of child birth: 0 = no.
1 =yes.

Was delivered of twins: 0 = no.
1 = yes.

4.6 Statistical Analysis.

The database as described above comprised numeric data and text. The numerical data comprised two types. Firstly, continuous data measured on a scale of constant intervals, for example, measurements of size or age and; secondly, discrete data measured on a nominal scale where no arithmetic relationship existed between different classifications, for example, parity status or pathology.

Statistical analysis has been applied to this data for two reasons. Firstly, to summarise and describe variables within the sample and secondly to test hypotheses about the relationships between specific variants using the sample as a database. Statistical methods were utilised to put numeric data into a context by which their meaning could be reliably judged for significance.

The sample being analysed was not selected randomly but was determined by four extraneous forces. Firstly, by the presence of each skeleton on the site, a factor biased by social and economic status and religion in terms of the original deposition. Secondly, by skeletal survival, which reflected such a criterion as position of burial within the crypts. Thirdly, by the preservation and association of a legible coffin plate, which was also determined by such criteria as position in the crypt and by the choice of metal type used for the inscription. The final determinant was the retrieval of each female's obstetric history.

After discussion of the aims of this project with a mathematician, Mr N. Goldman of the British Museum (Natural History), it was decided to analyse the data on a personal computer (Amstrad 1640HD20) using MINITAB a general purpose statistical program. The one complication of using the available version of MINITAB was that although it had no limit to the number of "lines" it would analyse, it could only store, and analyse from 50 "columns" at one time. To overcome this limitation, 4 "female" data files were constructed with a total of 101 columns and one male file with 21 columns. In order to analyse variants from different files, columns from different files were added to other files as and when necessary.

The female files were basically as described in 4.1 and 4.2, with the obstetric data and pathologies coded nominally and entered on file 3. Additional columns on files one and two comprised the absence or presence of pubic pitting and absence or presence of a preauricular sulcus.

Descriptive Statistics.

Descriptive statistics were used to summarise the data collected on each variable in a way that describes the sample. Histograms were used to illustrate frequency distributions. Where the variant follows a normal distribution its location and variability can be described by two parameters, the mean and the standard deviation. The standard error can be used to quantify the precision of the sample mean. When a variant does not follow a normal distribution it is more informative to describe it with the median and other percentiles. Only those statistics which are considered necessary and / or important are described in the text.

Tests of Significance.

The type of test used to evaluate the question of relationships between different variables was largely determined by the nature of the data in question. Null hypothesis tests quantify the difference between the actual observations and those that would expected if the null hypothesis were true. If the test statistic is larger than a value which would occur in 5% of cases were the null hypothesis true, then the null hypothesis is considered to be false. What must be remembered is that if a result is such that the null hypothesis cannot be rejected, all that can be said is that no significant result has been demonstrated, it could be that a small sample size and a statistical test that lacks the power to demonstrate an effect have led to a result that is not statistically significant.

The t-test was used to test the null hypothesis that there was no difference between the means of two samples. Where two samples are of different sizes a pooled estimate of variance is calculated (Glantz 1987, 78). The t-test was used to assess the significance of the differences between such variants as, for example, the transverse diameter in the male and the female samples. (Results are described as t values.)

Analysis of Variance (one way ANOVA) was used to estimate the significance of within group variance (normal distribution only). The variance of each group within the sample was computed with respect to the mean of the sample as a whole. If F is a large number, the variability between the sample means is larger than expected from the variability within the samples, thus refuting the null hypothesis that there is no difference between the samples. Variance analysis was used to look at such relationships as preauricular sulcus type (nominal data) and the greatest pelvic diameter (continuous data). (Results are given as F values.)

Mann Whitney rank sum test and Kruskal Wallis statistic (non-parametric tests) were used to estimate analysis of variance when the variable being examined was not normally distributed. Mann Whitney tests were applied when two groups within the sample were examined in relation to a variable. The test statistics are reported as 'W' following Minitab. Kruskal Wallis tests were used to examine three or more groups in relation to a variable. The test statistics are reported as 'H' values.

Chi-square tests were used to compare the distribution of either two discrete variables or one discrete and one continuous variable, for example, parity status and sulcus typology or sulcus typology and number of births. A X^2 test describes how much the observed frequencies in each cell of a contingency table differ from the frequencies which would be expected if there was no relationship between the two variables that define the rows and columns of the table. It allows for the fact that if a large number were expected to fall within a given cell, a difference of one case between the expected and observed frequencies is less important than in cases where only a few cases are expected. The number of degrees of freedom is computed associated with the contingency table and a critical values table is consulted to see if the observed value of X^2 exceeds what would be expected from random variation. (Results are given as X^2 values.)

Correlation coefficients were used to determine the extent to which two variables change in relation to one another, putting the observation from which the inference is made onto the base line. This test was used to look at such variants as preauricular sulcus length and antero-posterior diameter.

The two variables are plotted against one another on a scatter graph and a statement of causality defining the strength of the relationship assessed using a number between -1 and +1 to quantify the strength of the association (r). The tighter the relationship between the two variables the closer the magnitude of r to 1, the weaker the relationship, the closer r is to 0. Where r is greater than 0 the two variables increase together and r is less than 0 when one variable decreases as the other increases (Glantz 1987, 221). (Results are given as r values.)

Pearson's product moment correlation coefficient was utilised, a parametric statistic that describes the relationship of variables that are normally distributed along interval scales (Spearman's correlation coefficient is used for nonparametric testing and Kendal's for multiple independent variables). All test formulae are as described in Ryan 1981.

Significance levels are 5% ($P<.05$) unless otherwise stated. Unless a non-significant test result is close to $P<.05$ it is reported as not significant (NS). Exact values are given where possible if the test result is significant. All results are based on significance implying a rejection of the null hypothesis, this fact is not asserted when discussing the results.

When discussing the results of tests applied to both the left and the right innominates, unless both test results are $P<.05$, the overall test is reported as not significant. If the non-significant result is close to significance level then the overall test result is considered as interesting, but not consistently significant.

Chapter 5. Results 1: Scars of Parturition and Obstetric Data.

5.1. Descriptive analysis of "scars of parturition": The preauricular sulcus.

The distribution of each scar type is described separately for each innominate. This is because, as appendixes 1 and 13 illustrate, it was not unusual for an individual to have different morphological characteristics of varying dimensions on the left and the right innominate. Plate 22, CAS 2369 illustrates an example of this in respect of the preauricular sulcus. The problem created by differential survival of the pelvic bones was also overcome by this method of analysis.

The Preauricular sulcus.

Presence or Absence: The category presence or absence of a sulcus was added to the data set to alleviate the problem of subjectivity when scoring such criteria as type and severity. The left and right innominates are scored separately, the frequencies are illustrated in table 21.

Table 21. Absence or presence of the preauricular sulcus.

	Frequency		Percentage	
	Left	Right	Left	Right
Absence	15	12	13.3	10.8
Presence	98	99	86.7	89.2
Total	113	111	100.0	100.0

The type of sulcus recorded on each innominate is illustrated in figure 20 below. Although it was always possible to categorise each sulcus within the parameters described in chapters 1 and 4, it is possible that this area of inquiry might produce a large margin of inter-observer disparity particularly if the observers in question had differing levels of experience.

Key: 0 = absent, 1 = "groove of pregnancy", 2 = "groove of ligament", 3 = 3rd sulcus type, 4 = "male" type, see chapter 4 above.

Figure 20. Preauricular sulcus types.

Left Innominate n=113

Type	Freq	%	
0	15	13.3	***************
1	46	40.1	**
2	23	20.4	***********************
3	27	23.9	***************************
4	2	1.8	**

Right innominate n = 111.

Type	Freq	%	
0	12	10.8	************
1	43	38.7	***
2	26	23.4	**************************
3	11	29.9	*****************************
4	1	0.9	*

Plate 22. Different sulcus types in the same individual.

Cas 2369 - 55 year old female of unknown parity status.

Preauricular sulcus severity

It must be noted that this observation is very subjective and the trial run was essential to ensure familiarity with the variability within the sample. The results are illustrated below in figure 21.

Key: 0 = no sulcus. 1 = very slight sulcus. 2 = slight sulcus, 3 = moderately marked sulcus, 4 = severely marked sulcus. * = a count of two.

Figure 21. Severity of the preauricular sulcus.

Left innominate: n = 113.

```
Score Freq  %
 0      15  12.9 ********
 1      54  47.4 ****************************
 2      31  27.6 ****************
 3      12  11.2 *******
 4       1   0.9 *
```

Right innominate: n = 111.

```
Score Freq  %
 0      12  10.8 ******
 1      58  52.3 *****************************
 2      28  25.2 **************
 3      11   9.9 ******
 4       2   1.8 *
----------------------------------------------------------
```

There is a significant relationship between preauricular sulcus type and severity (X^2 = 126.206, DF = 16, P<.001). Type 1 proved most severe followed by 3 then 2.

Number of scoops.

This observation proved extremely subjective, usually requiring the "eye of faith" to distinguish between what was, and what was not a scoop. Furthermore, it proved unrepeatable in many cases. After the data collection was complete it was considered that this category was far too subjective to be considered scientific. Consequently, these data were removed from the data set prior to analysis as any results would have been dubious. For the purpose of future comparison the frequency of this feature in the left innominate is described below in figure 22.

<u>Figure 22: Number of "Scoops".</u>

<u>Left innominate:</u> n = 113. * = frequency of 2.

```
Score Freq  %
 0     63  55.8 ********************************
 1     19  16.8 **********
 2     18  15.9 *********
 3      7   6.2 ****
 4      4   3.5 **
 5      2   1.8 *
```

<u>Preauricular sulcus length</u> (mms.)

This was most easily defined in sulcus type 1, the margins of types 2, 3 and 4 proving more difficult to define on occasion. The results are illustrated below in table 22.

<u>Table 22. The length of the preauricular sulcus.</u>

	N	Mean	STDev	Min	Max
Left innominate:	98	26.3	7.6	8.0	44.0
Right innominate:	99	24.1	7.4	9.0	43.0

<u>Preauricular sulcus width (mms.)</u>

This measurement proved repeatable in all sulcus types except 3. One of the identifying features of this scar type is its poorly defined inferior margin so this problem was not surprising. This measurement was standardised by taking the limit of the "grainy" texture as the inferior margin. The results are illustrated in table 23 below.

Table 23. The width of the preauricular sulcus.

	N	Mean	STDev	Min	Max
Left innominate:	101	7.2	2.5	2.0	15.0
Right innominate:	100	6.8	2.7	2.0	14.0

Analysis of the relationship between preauricular length and width demonstrates that there is a significant positive correlation P<.01. Pearson's correlation coefficient takes the value of r = 0.733 (n = 113) for the left innominate and r = 0.711 (n = 110) for the right innominate. This result confirms the observation that it is unusual in females to find either a long and narrow, or a short and wide sulcus.

Analysis of variance of sulcus width in terms of sulcus type produces a significant F value of 3.28 corresponding to P<.05 for both innominates. However, the significant probability levels are explained by the narrowness of the small samples of male sulci (right innominate). The results are as illustrated in table 24:

Table 24: Sulcus type and sulcus width.

Left innominate

Score	Mean	S.D.	Frequency
1	7.2	2.6	46
2	6.5	2.2	23
3	8.1	2.5	27
4	3.5	0.7	2

Right innominate

Score	Mean	S.D.	Frequency
1	7.3	2.6	42
2	5.5	2.1	26
3	7.5	2.8	29
4	4.0	0.0	1

Analysis of variance of sulci types in terms of sulcus length produce significant F values; 4.78 for the left innominate which corresponds to P<.01 and 2.19 for the right which is not significant. The reduced length of the small group of type 4 sulci is again responsible for the significant result, a sample of 2 for the left innominate and of 1 for the right. The results are shown in table 25.

Table 25: Sulcus type and sulcus length.

Left innominate

Score	Mean	S.D.	Frequency
1	28.3	7.6	44
2	24.6	7.9	23
3	26.0	5.8	27
4	10.5	0.7	2

Right innominate

Score	Mean	S.D.	Frequency
1	23.6	7.8	41
2	23.5	6.7	26
3	25.9	6.9	29
4	9.0		1

In terms of sulcus length only the grade 4 sulcus is different and only on one innominate. The small sample sizes are obviously affecting these results and the differing significance levels indicate that the null hypothesis should be accepted.

5.2. Descriptive Analysis of Scars of Parturition": Pubic pitting

Counting the number of pubic pits can be problematic where they have coalesced into a sulcus or where they are very shallow, consequently, pitting has been scored and collected in two ways. Firstly, in terms of the number of pits and secondly, as either absent or present. The latter classification is considered the more reliable for the reasons discussed above concerning "scoops" and the preauricular sulcus.

The number of pubic pits

As stated above these results are considered to be highly subjective although the level of repeatability was greater than for preauricular "scoops". Consequently, the results merit discussion and are illustrated in figure 23.

Figure 23: The number of pubic pits.

Left innominate n =70.

```
Pits Freq %
0     41  58.6 *****************************************
1     18  25.7 ******************
2      6   8.6 ******
3      4   5.7 ****
4      1   1.4 *
```

Right innominate n =75.

```
Pits Freq %
0     44 58.7 ********************************************
1     19 25.3 *******************
2      7  9.3 *******
3      2  2.7 **
4      2  2.7 **
5      1  1.3 *
-------------------------------------------------------
```

Absence or presence of pubic pitting

The results of this observation are illustrated in figure 24 below. 0 =absent, 1 = present.

Figure 24: Absence or Presence of pubic pitting.

Left innominate: n = 70

```
Score Freq %
0      41  58.6 *********************
1      29  41.4 ***************
```

Right innominate: n = 75

```
Score Freq %
0      44  58.7 **********************
1      31  41.3 ****************
-------------------------------------------------------
```

Dimensions of pubic pits.

Measuring pubic pitting proved difficult because, as stated above, it was not always obvious where one pit started and another began. This problem was exacerbated by the fact that these pits often coalesce to form a sulcus. The procedure was made more difficult when severe exostoses or lipping partially obscured the pitting. The results are described below in table 26. It must be borne in mind that where there was only one pit its dimensions were entered in both the minimum and maximum categories.

Table 26: Dimensions of pubic pits.

	Maximum diameter				Minimum diameter			
Mms.	Left		Right		Left		Right	
	%	Freq	%	Freq	%	Freq	%	Freq
0	58.6	41	58.7	44	58.6	41	58.6	44
2	5.7	4	5.3	4	8.6	6	12.0	9
3	12.9	9	10.7	8	15.7	11	9.3	7
4	5.7	4	9.3	7	4.3	3	10.7	8
5	8.6	6	2.7	2	8.6	6	2.7	2
6			5.3	4			2.7	2
7	2.9	2			1.4	1	2.7	2
8	2.9	2	4.0	3	1.4	1		
9	1.4	1	1.3	1				
10			1.3	1			1.3	1
11	1.4	1			1.4	1		
12			1.3	1				
Total	100.0	70	100.0	75	100.0	70	100.0	75

As a result of the problems described above and the limited number of measurements which could be taken, it was decided not to proceed with the analysis of this data in association with the obstetric data.

5.3. Descriptive Analysis of "Scars of Parturition": The Pubic Tubercle.

The degree of development or extension of the pubic tubercle was subjective. It is considered, with hindsight, that perhaps this feature should be measured in some way although this would not be straightforward as there is no easily identifiable point from which to measure. However, with practice, scoring of this feature proved to be repeatable. The comparatively small sample sizes for this feature are due to the fact that it is fragile and often suffers post mortem damage. The results are illustrated in figure 25.

Figure 25: Extension of the pubic tubercle.

Left innominate: n = 47.

Score	Freq	%	
0	14	29.8	**************
1	13	27.6	*************
2	14	29.8	**************
3	6	12.8	******

Right innominate: n = 47

Score	Freq	%	
0	17	36.2	*****************
1	17	36.2	*****************
2	5	10.6	*****
3	8	17.0	********

5.4. Descriptive Analysis of "Scars of Parturition": Sacral Scarring.

Sacral scarring: this was scored as 0 = absent, 1 = unilateral, 2 = bilateral. This observation was measured in the few cases where it was evident, full details are available in appendix 1. The frequency of sacral scarring and its laterality are illustrated in table 27.

Table 27: Sacral Scarring

Score	Frequency	Percentage
0	75	84.3
1	6	6.7
2	8	9.0
Total	89	100.0

The Relationships between different "scars of parturition".

Chi-square tests demonstrate that there are no significant relationships on individuals between the presence or absence of the preauricular sulci, pubic pits, an accentuated pubic tubercle or sacral sulci. In all cases P>.05. Table 28 illustrates the details of this analysis.

Table 28. Relationships between different scar types.

Presence or absence of sulcus in relationship to:

	X^2	DF	N
Presence or absence of pubic pits			
Left innominate:	0.475	1	66
Right innominate:	0.294	1	72
Extension of the pubic tubercle:			
Left innominate:	1.832	3	44
Right innominate:	2.267	3	45
Sacral scarring:			
Left innominate:	2.80	2	84
Right innominate:	1.875	2	83

Presence or absence of pubic pitting in relation to:

	X^2	DF	N
Extension of the pubic tubercle:			
Left innominate:	6.829	3	46
Right innominate:	2.718	3	44
Sacral scarring:			
Left innominate:	3.457	2	58
Right innominate:	0.492	2	65
Sacral scarring in relation to the pubic tubercle:			
Left innominate:	5.128	6	41
Right innominate:	5.489	6	42

5.5 The Obstetric Histories of the Sample.

The parity status has been determined historically for 94 of the sample of 138 named females:

73 (77.6%) had borne children.

21 (22.4%) had not borne children.

The number of births they experienced was:

n = 94, range = 0 - 15, mean = 2.7, STDev = 2.82, SEMean = 0.29.

<u>Figure 26. The number of births.</u>

```
Midpoint  Frequency
   0         21 *********************

   2         30 ******************************
   4         24 ************************
   6         12 ************
   8          1 *
  10          3 ***
  12          1 *
  14          0
  16          1 *
```

The age at first birth was:

n = 64, range = 12 - 45, mean = 27.1, STDev = 7.1, SEMean = 0.9.

<u>Figure 27. The age at first birth.</u>

```
Midpoint  Frequency
  12          1 *
  16          2 **
  20         15 ***************
  24          7 *******
  28         18 ******************
  32          8 ********
  36          9 *********
  40          2 **
  44          2 **
```

The age at last birth was:

n = 61, range = 14 - 47, mean = 35.8, STDev = 7.2, SEMean = 0.9.

Figure 28. The age at last birth.

```
Midpoint   Frequency
  16           1 *
  20           1 *
  24           3 ***
  28           7 *******
  32           5 *****
  36          16 ****************
  40          13 *************
  44          12 ************
  48           3 ***
```

Birth spacing (in months) was:

n = 53, range = 0 - 141 (including nulliparas), mean = 29.4, median = 25.0, STDev = 24.2, SEMean = 3.3.

Those dying in childbirth:

n = 70, 5 (7.1%) died after giving birth, 65 (92.9%) did not.

Those experiencing a twin birth:

n = 69, 3 (4.3%).

5.6 The Preauricular Sulcus and Obstetric Data.

For the reasons described above, the relationship between the presence or absence of a sulcus, sulci typology, severity, width, and length with the woman's obstetric history were examined separately for each innominate.

Tabulation of data representing the presence, type and severity of the preauricular sulcus and parity status suggests that they are independent of one another, see table 29 below (left innominate). Furthermore, if the frequency, type or severity of a sulcus is examined in the parous group alone, given the sample sizes in each group, there is no apparent association between any one category and the parous state.

Table 29: Parity status and the preauricular sulcus.

		Nulliparous females	Parous females
Sulcus Present		14	56
Sulcus Absent		4	6
Sulcus Type	0	4	6
	1	7	29
	2	4	11
	3	3	14
	4	0	2
Total		18	62
Severity	0	4	6
	1	8	35
	2	3	15
	3	3	6
	4	0	1
Total		18	63

Statistical analysis of these data is presented below in table 30. Significance levels are 95%, unless otherwise indicated. (X^2 = chi square test result, F = one way ANOVA analysis of variance.)

Table 30. Sulcus frequency and obstetric data.

Presence or Absence of a Sulcus

Parity Status	N	X^2	DF	P
Left innominate:	80	2.007	1	N.S.
Right innominate:	53	0.008	1	N.S.
Number of Births:	N	F	DF	P
Left innominate:	79	0.30	1,77	N.S.
Right innominate:	75	0.12	1,73	N.S.
Age at First Birth:		W		
Left innominate:	55	179.0		N.S.
Right innominate:	54	211.5		N.S.
Age at Last Birth:		W		
Left innominate:	55	208.0		0.481
Right innominate:	51	220.0		N.S.0.063
Birth Spacing:		F		
Left innominate	42	0.01	1,40	N.S.
Right innominate:	45	1.87	1,43	N.S.

Statistical analysis of the obstetric data in relation to the presence or absence of a preauricular sulcus confirms that the variables are independent of one another with the exception of age at last birth. The test result on the right innominate is not significant at P<.05 whilst that from the left innominate is. As there is no apparent relationship between the presence or absence of a sulcus and parity status the meaning of this result is obscure. The results of the Mann Whitney test indicate that the 5 (Left) & 6 (Right) cases wih no sulcus had a median age of 44 years at last birth and the 50 (Left) & 45 (Right) cases with a sulcus had a median age at last birth of 36 years.

Preauricular Sulcus Type

Statistical analysis of the relationship between preauricular sulcus type and obstetric data is presented below in table 31.

Table 31. Preauricular sulcus type and obstetric data.

Parity status:	N	X^2	DF	P
Left innominate:	80	2.909	4	N.S.
Right innominate:	76	1.578	4	N.S.
Number of births:	N	F	DF	P
Left innominate:	79	0.48	4,74	N.S.
Right innominate:	75	0.67	4,70	N.S.
Age at first birth:		H		
Left innominate:	55	7.992		N.S.
Right innominate:	54	7.502		N.S.
Age at last birth:		H		
Left innominate:	55	12.28		<.025
Right innominate:	51	16.19		<.005
Birth spacing:		F		
Left innominate:	47	1.06	4,42	N.S.
Right innominate:	45	0,78	4,40	N.S.

The results of the variance of age at last birth with preauricular sulcus type are shown in table 32 below.

Table 32. Preauricular sulcus type and age at last birth.

	Left		Right	
Score	Median	N	Median	N
0	44.0	5	44.0	6
1	34.0	25	30.0	17
2	36.0	11	36.0	15
3	39.0	12	39.0	12
4	36.0	2	36.0	1

As the presence or absence of a sulcus is not related to parity status, the significance and possible value of these results remains obscure.

Statistical analysis of preauricular sulcus type in relation to parity status and obstetric factors suggests that there is no relationship between them. The rather puzzling exception being with age at last birth.

Severity of the preauricular sulcus

The results of statistical analysis of sulcus severity and obstetric data are described below in table 33.

Table 33. Sulcus severity and obstetric data.

Parity Status:	N	X^2	DF	P
Left innominate:	81	3.304	4	N.S.
Right innominate:	76	0.470	4	N.S.
Number of births:	N	F	DF	P
Left innominate:	80	0.11	4,75	N.S.
Right innominate:	75	0.61	4,70	N.S.
Age at first birth:		H		
Left innominate:	56	7.924		N.S.
Right innominate:	54	3.596		N.S.
Age at last birth:		H		
Left innominate:	56	6.597		N.S.
Right innominate:	52	7.400		N.S.
Birth Spacing:		F		
Left innominate:	48	3.80	4,43	<.01
Right innominate:	46	2.48	4,41	N.S.

Analysis of variance of birth spacing (in months) and sulcus severity produces a significant test result on the left innominate only. The test result reflects the diversity in this innominate of the 5 cases with grade 3 severity. There is no apparent trend evident among the other grades or on the right innominate and consequently this result is not considered important.

Preauricular Sulcus Length

The results of analysis of the relationship between preauricular sulcus length and obstetric data are described below in table 35. (r = Pearson's product moment correlation coefficient).

Table 35. Preauricular sulcus length and obstetric data.

Parity Status:	N	F	DF	P
Left innominate:	80	4.62	1,78	<.05
Right innominate:	76	3.20	1,74	N.S.
Number of Births:	N	r		P
Left innominate:	79	0.138		N.S.
Right innominate:	75	0.207		N.S.
Age at First Birth:				
Left innominate:	58	-0.080		N.S.
Right innominate:	54	-0.037		N.S.
Age at Last Birth:				
Left innominate:	58	-0.151		N.S.
Right innominate:	52	-0.159		N.S.
Birth Spacing:				
Left innominate:	43	0.006		N.S.
Right innominate:	46	0.124		N.S.

An interesting trend is apparent when analysis of variance is applied to preauricular sulcus length (mm) and parity status. The results are described below in table 36.

Table 36. Preauricular sulcus length and parity status.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Nulliparous	18.0	12.3	17	17.2	8.6	17
Parous	24.5	10.7	63	22.3	10.6	59

Although only the test result on the measurements from the left innominate are significant, these results suggest that there is a trend between the longer sulcus and parous females. However, no accurate predicion can be made from one variant to another due to the standard deviations.

Preauricular Sulcus Width:

The results of statistical analysis of the relationship between sulcus width (mm) and obstetric data are descibed in table 37.

Table 37. Preauricular sulcus width and obstetric data.

Parity Status:	N	F	DF	P
Left innominate:	81	4.08	1,79	<.05
Right innominate:	77	0.29	1,75	N.S.
Number of Births:	N	r		P
Left innominate:	80	0.026		N.S.
Right innominate:	76	0.025		N.S.
Age at First Birth:				
Left innominate:	58	0.080		N.S.
Right innominate:	55	-0.097		N.S.
Age at Last Birth:				
Left innominate:	56	0.234		N.S.
Right innominate:	53	-0.329		N.S.
Birth Spacing:				
Left innominate:	43	0.176		N.S.
Right innominate:	45	0.304		<.05

An interesting trend is suggested by analysis of variance of sulcus width with parity status. The variation is described in table 38 below.

Table 38. Preauricular sulcus width and parity status.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Nulliparous	4.7	3.1	18	5.5	3.1	16
Parous	6.5	3.3	63	6.0	3.3	61

There does seem to be a trend whereby the wider sulcus is associated with parous females. However, it is only statistically significant on the left innominate. The standard deviations are such that no reliable predictive value is apparent.

The significant, though low, positive correlation coefficient evident when analysing birth spacing ($P<.05$) with sulcus width, on the right innominate, must be considered inconclusive because the left innominate is not demonstrating the same trend. It is possible that the significant test result reflects chance.

5.7 Pubic Pitting and Obstetric Data.

Tabulation of the presence or absence of pubic pitting in relation to parity status is presented in table 39.

Table 39: Pubic pitting and parity status.

	Nulliparous females	Parous females
Absence of pitting	6	24
Presence of pitting	3	16
Total	9	40

There appears to be no association between pubic pitting and parity status. Examination of the parous females' results alone, to exclude any possible errors in the parity status of the nulliparous group, indicates that the absence or presence of pubic pits is independent of parity status.

Statistical analysis of obstetric data in association with the presence or absence of pubic pitting is presented below in table 40.

Table 40: Pubic pitting and obstetric data.

Parity status:	N	X^2	DF	P
Left innominate:	49	0.138	1	N.S.
Right innominate:	47	3.593	1	N.S.
Number of Births:	N	F	DF	P
Left innominate:	48	0.03	1,46	N.S.
Right innominate:	52	2.66	1,50	N.S.
Age at First Birth:		W		
Left innominate:	36	442.5		N.S.
Right innominate:	37	367.0		N.S.
Age at Last Birth:		W		
Left innominate:	34	352.0		N.S.
Right innominate:	36	275.5		N.S.
Birth Spacing:		F		
Left innominate:	26	0.03	1,24	N.S.
Right innominate:	33	0.00	1,31	N.S.

These results indicate that in this sample there is no apparent relationship between the absence or presence of pubic pitting on the dorsal aspect of the pubic symphysis and obstetric data.

The number of pubic pits and obstetric data.

In view of the data above it seems unlikely that there will be any association between the number of pubic pits and obstetric data, nevertheless the results are as follows.

Table 41: Number of pits and parity status.

Number of pits	Nulliparous females		Parous females	
	Left	Right	Left	Right
0	6	9	24	21
1	3	1	10	14
2	0	0	3	4
3	0	0	2	2
4	0	0	1	1
5	0	1	0	0
Total	9	11	40	42

These results indicate that there is no

relationship between the number of pubic pits and parity status. All that can be said is that in this sample the 7 females with more than one pit had borne children, but no prediction of parity status is possible for the remaining 34. The small numbers in categories 2 to 4 invalidate any X^2 test result run on this data as the cells were below 1 for categories 2 to 4. Analysis of variance was applied to the remaining obstetric categories and produced the results described in table 42.

Table 42. The number of pubic pits and obstetric data.

The number of births:	N	F	DF	P
Left innominate:	48	0.14	4,43	N.S.
Right innominate:	52	1.08	5,46	N.S.
The age at first birth:		H		
Left innominate:	36	3.521		N.S.
Right innominate:	35	4.770		N.S.
The age at last birth:		H		
Left innominate:	34	1.100		N.S.
Right innominate:	36	1.100		N.S.
Birth Spacing:		F		
Left innominate:	26	0.18	4,21	N.S.
Right innominate:	33	0.27	4,28	N.S.

The results described above illustrate that in this sample there is no association between pubic pitting and obstetric events.

5.8 The Pubic Tubercle and Obstetric Data.

The distribution of the degree of extension of the pubic tubercle and parity status is tabulated below, grade 0 = no extension, 1 = very slight, 2 = moderate and 3 = extended.

Table 43: The pubic tubercle and parity status.

Grade	Nulliparous females		Parous females	
	Left	Right	Left	Right
0	6	6	3	8
1	2	3	8	9
2	1	0	8	4
3	0	0	5	7
Total	9	9	24	28

These results suggest that, although females with a normal or slightly extended pubic tubercle can be either nulliparous or parous, those with moderately or severely extended tubercles have borne children. These results are in keeping with those of Bergfelder and Herrmann (1980, 611). This is very encouraging as their reference sample was a modern dissecting room collection with known obstetric data. This result suggests that the historical method of establishing parity status has produced sound results.

Evaluation of the extension of the pubic tubercle in the parous females only, to exclude any errors in the nulliparous group, suggests that there is no association between parity status and the extension of the tubercle. The complete range of scoring is well represented in these females.

Statistical analysis of this data and that evaluating the relationship of the extended tubercle with other obstetric data follows in table 44.

Table 44. The pubic tubercle and obstetric data.

Parity status:	N	X^2	DF	P
Left innominate:	33	10.369	3	<.02
*Right innominate:	37	6.151	3	<.10 N.S.
Number of Births:	N	F	DF	P
Left innominate:	33	3.76	3,29	<.05
Right innominate:	37	2.2	3,33	N.S.
Age at first birth:		H		
Left innominate:	22	1.701		N.S.
Right innominate:	25	2.858		N.S.
Age at last birth:		H		
Left innominate:	21	4.258		N.S.
Right innominate:	24	2.657		N.S.
Birth Spacing:		F		
Left innominate:	15	0.50	3,12	N.S.
Right innominate:	22	0.31	3,18	N.S.

* The value of this result is reduced by the fact that one

cell in the X^2 table has an expected value of below one.

Statistical analysis of this data produces ambivalent results concerning parity status in association with the extension of the pubic tubercle. It is unfortunate that the test result on the right innominate is questionable. However, the test illustrates that there is no significant trend in all grades but as is apparent in table 44, that there is an association between grades 2 and 3 and parous females.

The association between the number of births and the extended tubercle is remarkably similar to Bergfelder and Herrmann's (1980, 611) see chapter 1. For details see table 45 below. Key: 0 = no extended, 1 = slightly extended, 2 = moderately extended, 3 = markedly extended.

Table 45. Tubercle extension and the number of births.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	0.7	1.2	9	3.1	4.2	14
1	2.7	1.9	10	2.6	2.2	12
2	3.6	2.4	9	3.7	0.9	4
3	5.6	5.7	5	6.6	4.3	7

These results suggest that there is a tendency for women experiencing more births to have an extended tubercle, but that the trend is not statistically significate on both innominates.

5.9 Sacral Scarring and Obstetric Data.

Fortunately the pelvis only has one sacrum and for each test there is only one result to consider. The scarring on the facies sacral pelvina was scored as 0 = absent, 1 = unilateral and 2 = bilateral. Table 46 illustrates the distribution of these scores within the categories of nulliparous and parous females.

<u>Table 46: Sacral scarring and parity status.</u>

Score	Nulliparous females	Parous females
0	8	47
1	2	3
2	2	1
Total	12	51

These results indicate that the presence of sacral scarring is in fact unusual: there are 5 cases of unilateral scarring and only 3 of bilateral scarring. Their distribution between the two groups of females appears to be random, no trends are evident. Examination of the parous group in isolation supports this result, given the low frequency of this feature. Statistical analysis of this data proved impossible in the case above as the data set produces 2 of 6 cells with an expected value of below one.

Analysis of the remaining groups of obstetric data is listed below in table 47.

<u>Table 47. Sacral scarring and obstetric data.</u>

Obstetric data	N	F	DF	P
Number of births:	62	1.98	2,59	N.S.
		H		
Age at first birth:	44	3.692		N.S.
Age at last birth:	45	3.621		N.S.
		F		
Birth spacing:	40	0.91	1,38	N.S.

In this sample there appears to be no association between sacral scarring and obstetric data.

Evaluation of cortical variation near the pelvic joints in the Christ Church sample in relation to the obstetric histories of the females suggests that there is no one feature which can be used to indicate parity status. However, there is a tendency for preauricular sulcus length to be associated with parous females. This association is not consistently statistically significant and sulcus length cannot be used to predict parity status.

The evidence does suggest that the small percentage of female innominates with two or more pits on the dorsal aspect of the pubic symphysis have borne children and that the small number of female innominates with an extended pubic tubercle have also borne children. However, no particular aspect of these characteristics can be associated with women who have not borne children.

5.10 Twin Births and Scars of Parturition.

Of the 94 females whose obstetric histories are known in detail three are believed to have experienced a twin birth. The normal rate of twin births is 1:80 (Amiel 1981, 127) although there is geographical variation and the incidence is increased in older women. The rate at Christ Church, 1:207, is almost certainly an under representation of the real rate. Any twin birth where one or both of the infants dies before baptism cannot be detected historically.

A twin delivery can present more problems than the birth of one child. Such complications as polyhydramnios (excessive amniotic fluid in the uterus), anaemia, pe-eclampsia and both anti and post-partum haemorrhage occur more frequently than in single births (Linney 1983, 18-20). A major problem in multiple births can be malpresentation of the foetuses, in approximately 47% of twin births both present vertex first, 37% present one vertex and one breech, in 9% of cases both present breech, 5% present vertex and transverse, 2% transverse and breech and the remainder present both transverse (Linney 1983, 20). The second stage of labour is frequently prolonged in a twin delivery, the second baby often malpresenting.

If, those cortical changes colloquially known as "scars of parturition" are related to the stresses of pregnancy and parturition on the ligamentous attachments of the joints, it seems plausible that a twin birth, with two consecutive rotations of the sacrum, might be more damaging to the ligamentous attachments and necessitate more cortical remodelling than a single birth.

The three females in question all have a preauricular sulcus. Two are slight the third moderately marked, one is type one (groove of pregnancy) and two are type two (groove of ligament). The dimensions of all three sulci are very similar and not notably small or large. Unfortunately, the pubes are in all cases damaged, all that can be said is that one individual has pitting of the dorsal aspect of the symphysis. There is no sacral scarring.

This evidence suggests that if these females experienced more traumatic births than is usual, it cannot be detected by macroscopic reference to their pelvic bones. There is no indication that their pelvic joint ligaments underwent unusually severe trauma during parturition, as there is no indication of unusually pronounced remodelling of the attachment sites.

5.11 Maternal Mortality and Scars of Parturition.

Houghton (1975, 658) states that following the delivery of a child "...

> processes of reorganisation and repair gradually return the ligaments to their normal state within a few weeks. Thereafter, a slow and variable replacement of bone appears to occur over years at the sites of previous osteoclastic activity."

If he is correct in this assumption, it seems possible that the sites of attachment of the inferior portion of the ventral sacroiliac ligament and the dorsal transverse ligament of the pubic symphysis will be unusual in females who die shortly after childbirth.

Five females among the Christ Church sample are known to have died within days of giving birth. None of these had any obvious physiological condition, such as a rachitic pelvis, which would have prevented normal childbirth or any signs of pelvic disproportion.

The skeletons of four of this sample survive well enough for their preauricular area to be examined. All four had a preauricular sulcus, two had a type 1 (groove of pregnancy) and two had type 2 (groove of ligament). Three were slight and one moderately severe. The pubis survived only in one female, this had one pit on the dorsal aspect and a slightly extended tubercle. None had sacral scarring.

This evidence suggests that the theory that "scars of parturition" represent cortical remodelling which follows trauma incurred during pregnancy and parturition is incorrect. The morphological changes evident on the pelvic bones of these four females was not in any way unusual from that seen on other females, some who died several decades after giving birth.

5.12 Age at Death and Scars of Parturition.

The age at death of the Christ Church sample was known because as described in chapter 1, these skeletons were associated with securely contexed coffin plates which stated age at death. In those individuals whose date of birth could be checked by reference to their baptism records, the age at death proved to be accurate for all but a small number of elderly males who all claimed greater longevity than they actually experienced. An example is Mr Daniel Pontardant whose coffin plate and death register entry stated that he was ninety two whereas in fact he had been born a mere eighty-six years previously. This is an interesting phenomenon particularly when it has been asserted (Durand 1959, 370) that the age at death on tombstones in the Roman period are likely to be unreliable for females who, the author considered, wished to be thought younger than they really were!

The ages at death of 137 adult females from Christchurch are described below in figure 29.

Figure 29. Age at death of the female sample.

```
Midpoint Frequency %
10            1    0.7  *
20            7    5.1  *******
30           11    8.0  ***********
40           13    9.5  *************
50           25   18.2  *************************
60           26   19.0  **************************
70           25   18.2  *************************
80           23   16.8  ***********************
90            6    4.4  ******
-----------------------------------------------------------
```

The mean age at death was 56.7 years, the median 57 years, standard deviation is 18.9 years, the standard error of the mean 1.6 years, the range was from 13 to 90 years. The first quartile is 45.5 and the third 73 years. These results show that approximately 75% of this sample were post reproductively aged.

The results of statistical evaluation of the relationship between the age at death and scars of parturition are described in table 48.

Table 48. Scars of parturition and age at death.

The presence or absence of the preauricular sulcus:	N	W	DF	P
Left innominate:	112	724.0		0.5585
Right innominate:	110	624.0		0.8969
Preauricular sulcus type:		H		
Left innominate:	112	5.865		0.10
Right innominate:	110	1.008		0.50
Preauricular sulcus severity:		H		
Left innominate:	112	3.346		0.50
Right innominate:	110	1.009		0.10
Preauricular sulcus width:	N	r		
Left innominate:	113	0.095		>0.50
Right innominate:	111	0.022		>0.50
Preauricular sulcus length:		r		
Left innominate:	112	0.159		>0.50
Right innominate:	110	0.54		>0.50
Absence or presence of pubic pits:		W		
Left innominate:	69	1362.5		0.6529
Right innominate:	75	1542.5		0.1652
Number of pubic pits:		H		
Left innominate:	69	1.560		>0.50
Right innominate:	75	4.404		>0.50
Extension of the pubic tubercle:		H		
Left innominate:	69	2.919		>0.25
Right innominate:	48	3.764		>0.25
		H		
Sacral scarring:	87	0.4967		>0.50

This analysis indicates that age at death and scars of parturition are independent variables (P<.05) in this sample.

Chapter 6 Results 2: "Scars of Parturition" and Pelvimetry.

6.1 The Preauricular Sulcus and Pelvimetry.

The frequency of the preauricular sulcus and pelvimetry.

As chapter 4 illustrated, condition of the material permitting, a wide range of pelvic measurements was taken on each innominate, the sacrum and the rearticulated pelvis. For the sake of brevity, details will only be given and discussed on those measurements which have a statistical association with the frequency of the sulcus. This chapter will also include discussion of such non-metric variants as the shape of the sciatic notch, the number of sacral vertebrae, the extent of sacral articulation and the shape of the pelvis, should they prove to be significant. This format will also be applied to the remaining variables which are being examined.

After the application of the appropriate statistical test on the complete range of measurements taken and on those observations described above, in association with the absence or presence of the preauricular sulcus, no variable proved to have a statistical relationship with the sulcus. However the following variants, as described in table 49 below, merit discussion as there was a significant association with the sulcus on one innominate and a measurement.

Table 49. The preauricular sulcus and pelvimetry.

Pubo-sacroiliac joint diameter:	N	F	DF	P
Left innominate:	64	4.57	1,62	<.05
Right innominate:	66	1.75	1,64	N.S.
Ischial spine to symphysion:				
Left innominate:	59	1.35	1,57	N.S.
Right innominate:	62	5.06	1,60	<.05
Sciatic notch width:				
Left innominate:	99	2.62	1,97	N.S.
Right innominate:	95	4.47	1,93	<.05
Right ischium to the apex of the sacrum:				
Left innominate:	54	0.00	1,52	N.S.
Right innominate:	54	4.68	1,52	<.05

The results of analysis of variance of the pubo-sacroiliac diameter in relation to the absence or presence of the sulcus are described in table 50 below.

Table 50. The preauricular sulcus and the pubo-sacroiliac diameter.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	112.3	7.9	13	112.7	4.4	8
Present	117.1	7.0	51	116.6	8.1	58

These results suggest that there is a tendency for a sulcus to be present on a pelvis with a larger pubo-sacroiliac diameter. However, the relationship between these two variables is not significant on both innominates.

Details of the relationship between the variance of the ischial spine to symphysion diameter and the frequency of the preauricular sulcus are described below in table 51.

Table 51 . The preauricular sulcus and the diameter from the ischial spine to the symphysion.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	106.2	10.8	11	100.9	14.3	8
Present	109.1	6.6	48	108.4	7.8	54

The results of this analysis indicate that there is a tendency for pelves with a larger ischial spine to symphysion diameter to have a preauricular sulcus. However, this trend is only statistically significant on the right innominate.

The relationship between the frequency of the preauricular sulcus and the sciatic notch width is described in table 52 below.

Table 52. Sciatic notch width and the preauricular sulcus.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absence	54.0	5.2	12	52.7	4.8	11
Presence	57.5	7.3	87	57.2	6.8	84

These results illustrate that there is a tendency for the presence of a preauricular sulcus to be associated with a wider sciatic notch. However, this relationship is not significant on the left innominate.

Unlike the the trends apparent above, whereby the association of the presence of a sulcus seems to be with the larger dimensions, analysis of the distance from the ischium to the apex of the sacrum in association with the sulcus produces the reverse trend on the right innominate. The presence of a sulcus seems to be associated with a reduced measurement. The results are described below in table 53.

Table 53 . The preauricular sulcus and the right ischial to sacral diameter.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absence	87.8	9.1	8	96.6	7.5	5
Presence	87.6	10.3	46	86.8	9.9	49

The left innominate shows no such trend neither do the left or right innominates regarding the diameter between the left ischium and the sacrum. Consequently, the significant result is considered to reflect chance and is not considered important to this project.

There does appear to be an association between the presence of a preauricular sulcus and the larger pubo-sacroiliac diameter, ischial spine to symphysion diameter and the width of the sciatic notch. However, these are not statistically significant and the standard deviations are such that no prediction of one variant can be made from the other.

6.2 Preauricular Sulcus Type and Pelvimetry.

Application of statistical tests to examine whether or not the range of measurements and observations, as described in chapter 4, are significantly associated with the type of preauricular sulcus, produced the significant or interesting results presented below in table 54.

Table 54. Preauricular sulcus type and pelvimetry.

Antero-posterior	N	F	DF	P
diameter inferior:				
Left innominate:	53	2.90	4,48	<.05
Right innominate:	53	2.87	4,48	<.05
Bispinous diameter:				
Left innominate:	70	6.39	4,65	<.01
Right innominate:	70	4.15	4,65	<.01
Bi-tuberous diameter:				
Left innominate:	73	3.43	4,68	<.05
Right innominate:	73	3.35	4,68	<.05
Left ischium to inferior aspect of the sacrum:				
Left innominate:	54	3.87	4,49	<.01
Right innominate:	54	3.68	4,49	<.05
Right ischium to inferior aspect of the sacrum:				
Left innominate:	54	2.50	4,49	N.S.
Right innominate:	54	5.13	4,49	<.05
Right ischial spine to inferior aspect of the sacrum:				
Left innominate:	53	1.68	4,48	N.S.
Right innominate:	53	4.11	4,48	<.01
Sciatic notch width:				
Left innominate:	99	2.10	4,94	N.S.
Right innominate:	95	3.53	4,90	<.05
Sacral width inferior:				
Left innominate:	83	2.89	4,78	<.05
Right innominate:	82	1.52	4,77	N.S.
Transverse diameter:				
Left innominate:	80	1.60	4,75	N.S.
Right innominate:	81	4.01	4,76	<.01
Greatest pelvic diameter:				
Left innominate:	65	2.27	4,60	N.S.
Right innominate:	64	2.88	4,59	<.05

The significant result derived from the antero-posterior diameter inferior and sulcus type reflects solely that type 4 (one case only) has a much smaller diameter than the other three types and grade 0. In both innominates, types 0 to 3 have mean diameters of between 108 and 116mms. which are not statistically different, type 4 has a diameter of only 84mm . Consequently, the significance of the test result is rejected, although it is noted with interest that the one case of a type 4 sulcus is related to what appears metrically to be an outlier.

The result obtained from analysis of the bispinous diameter and sulcus type is also affected by this outlier, but the other results are more interesting. They are described in table 55 below.

Table 55. Bispinous diameter and preauricular sulcus type.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	97.7	8.8	11	99.7	10.2	9
1	109.4	6.7	27	106.7	8.9	27
2	108.9	6.8	14	109.6	7.0	17
3	102.4	10.8	16	103.2	9.3	16
4	92.0	14.1	2	82.0		1

Examination of these results suggests that both type 0 (no sulcus) and type 4 (male sulcus) seem to be found in pelves with smaller bispinous diameters. However, it appears that only the type 4 sulcus is significantly different from the other types. With sub-sample sizes of 1 and 2 respectively these are not considered important in any sense other than that this sulcus type seems to relate to smaller pelves.

The bi-tuberous diameter in association with sulcus type shows the trend as the bispinous diameter. In view of their close proximity in the pelvis this is hardly surprising. Again, type 4 (2 & 1 cases respectively) is atypical relating to mean diameters of 98.5 and 83mm respectively. The range for types 0 to 3 is 109 to 120.8mm .

The result of analysis of variance of both the left and right ischium to the apex of the sacrum with sacral type is also affected by the diameters which relate to the one case of a type 4 sulcus. The differences evident in the types 0 to 3 are very slight ranging from 84.9 to 96.6mm , whilst type 4 has a diameter of 48mm relating to the left ischium and 58mms. relating to the right. (All outlying measurements were checked prior to analysis.) Despite the statistically significant result described in table 54, there is no apparent association between the variation associated with these dimensions and the type of sulcus apart from type 4, which is based on one individual.

The same dimension but on the right side of the rearticulated pelvis produces a similar test result. Types 0 to 3 range from 84.2 to 96.6mm , whilst type 4 is associated with a diameter of 58mm . The same conclusions are drawn from this as above.

The result obtained by applying analysis of variance to the relationship between the diameter between the right ischial spine and the apex of the sacrum is also largely caused by the one case of a type 4 sulcus. Within the categories 0 to 3 the range is from 63.4 to 71.0mm , the differences between these results are not significant. The type 4 sulcus is associated with a measurement of 54.0mm . Once again, these results are not meaningful despite the test result in table 54. The same measurement on the left side of the pelvis is not significant.

Analysis of variance of the width of the sciatic notch in relation to sulcus types produces a significant result only for the left innominate. An inconclusive result; it is based on the extreme variation evident in the sub-sample of one type 4 sulcus, and whilst interesting in terms of the type 4 sulcus, it is not of overall significance. The results are described in table 56.

Table 56. Preauricular sulcus type and sciatic notch width.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	52.7	4.8	11	54.0	5.5	12
1	57.1	6.4	34	58.0	7.9	41
2	58.1	6.4	25	57.9	6.4	22
3	57.4	7.1	24	57.3	5.9	22
4	38.0		1	46.0	14.1	2

The association between the width of the anterior sacrum, at the level of the inferior edge of the sacro-iliac joint, and the type of sulcus is statistically significant on the left innominate only. Again, this result is an artefact created solely by the variation evident in the one case of type 4 which cannot be considered meaningful other than as an individual case. The range of variation in types 0-3 in the left innominate are 88.4 to 92.6mm , in the right innominate the range is from 90.2 to 91.7mm , whilst the one case of type 4 is associated with a dimension of 78mm .

Analysis of the variance of the transverse diameter and sulcus type produces a significant result only when analysing the left innominate. The results are described below in table 57.

Table 57. Sulcus type and the transverse diameter.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	122.7	6.9	12	124.0	8.9	10
1	132.0	6.9	31	129.7	7.8	30
2	126.8	7.0	17	130.4	7.2	19
3	128.5	10.0	19	128.6	8.8	20
4	121.0	4.2	2	118.0		1

The significant result obtained on the left innominate would seem to result from the difference between types 1 and 4, of which the latter is a sub-sample of only 2 cases. The same trend is not evident on the right innominate consequently, these results cannot be considered important to this project.

The significant result obtained using variance analysis to test the relationship between sulcus type and the greatest pelvic diameter is caused by the measurements relating to the type 4 sulcus. The range evident within the sub-samples types 0 to 3 is between 121.1 and 128.4mm , whilst type 4 has a mean of 111.5 mm on the left innominate (n = 2) and 97.0 mm on the right (n = 1). Again, an interesting result in terms of the pelvimetric distribution of type 4 but one that has no overall importance.

Evaluation of the possibility of a relationship between pelvimetry and preauricular sulcus type indicates that in this sample there is no significant association. What is interesting is that unusually small pelves appear to be associated with the least frequent sulcus type.

6.3 Preauricular Sulcus Severity and Pelvimetry.

The significant and interesting results obtained from analysis of sulcus severity with pelvimetry are described below, all other results were P>.05.

Table 58. Preauricular sulcus severity and pelvimetry.

Transverse diameter:	N	F	DF	P
Left innominate:	82	2.95	3,78	<.05
Right innominate:	81	1.30	4,76	N.S.
Bispinous diameter:				
Left innominate:	70	3.46	3,66	<.05
Right innominate:	69	2.14	3,65	N.S.
Sciatic Notch Width;				
Left innominate:	101	4.55	4,96	<.01
Right innominate:	96	2.21	4,91	N.S.

The significant result obtained by variance analysis of sulcus severity and transverse diameter on the left innominate reflects a trend whereby a more severe sulcus is associated with a larger transverse diameter. The same trend is evident on the right innominate but it is not significant. For details see table 59 below. The main difference in both case lies in the difference between grades 0 and 1.

Table 59. Preauricular sulcus severity and the transverse diameter.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	122.7	6.9	12	124.0	8.9	10
1	129.3	7.9	42	128.3	8.2	44
2	129.0	9.1	22	130.2	8.4	18
3	133.0	5.1	6	131.7	7.0	8
4			0	132.0		1

The test result on the association between the bispinous diameter and sulcus severity also reflects smaller measurements where there is no sulcus, particularly on the left innominate. The result from the right also has a reduced dimension for grade 2. Again, these results are inconclusive, for details see table 60.

Table 60. Preauricular sulcus severity and the bispinous diameter.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	97.7	8.8	11	99.7	10.2	9
1	107.3	9.1	35	107.2	9.5	38
2	105.3	9.5	20	102.9	9.7	15
3	109.7	6.4	4	107.9	5.3	8

Analysis of the variance of sciatic notch width in association with sulcus severity follows the same pattern as the transverse and bispinous diameters. The larger the measurement, the more likely it is to be associated with a severe sulcus. Details of this analysis are described in table 61.

Table 61. Sulcus severity and sciatic notch width.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	54.0	5.5	12	52.7	4.8	11
1	55.4	6.7	48	56.1	7.4	50
2	58.8	7.1	27	59.4	6.2	24
3	60.6	6.5	13	57.9	3.9	10
4	75.0		1	59.0		1

The significant result on the left innominate is largely the result of the one case of grade 4. However, despite this there is an overall trend indicated whereby more severe scarring is associated with a wider sciatic notch.

6.4 Preauricular Sulcus Width and Pelvimetry.

The results of statistical tests producing significant and interesting results in terms of measurements which appear to influence the width of the preauricular sulcus are described in table 62 below.

Table 62. Preauricular sulcus width and pelvimetry.

	N	F	r	DF	P
Sciatic notch width:	N		r		P
Left innominate:	101		0.415		<.01
Right innominate:	96		0.346		<.01
Sacral width inferior:					
Left innominate:	84		0.264		<.05
Right innominate:	83		0.228		<.05
Transverse diameter:					
Left innominate:	82		0.392		<.01
Right innominate:	82		0.290		<.05
Bispinous diameter:					
Left innominate:	70		0.336		<.01
Right innominate:	70		0.271		<.05
Inlet circumference:					
Left innominate:	61		0.346		<.05
Right innominate:	61		0.286		<.05
Pubo-sacroiliac diameter:					
Left innominate:	65		0.356		<.05
Right innominate:	66		0.249		N.S.
Sciatic notch shape:	N	F		DF	P
Left innominate:	112	3.42		4,107	<.05
Right innominate:	108	2.39		4,103	N.S.
Sciatic notch depth:	N		r		p
Left innominate:	101		0.240		<.05
Right innominate:	95		0.097		N.S.
Antero-posterior diameter inferior:					
Left innominate:	53		0.347		<.05
Right innominate:	53		0.073		N.S.
Greatest pelvic diameter:					
Left innominate:	65		0.387		<.01
Right innominate:	65		0.245		N.S.
Left ischial spine to inferior sacrum:					
Left innominate:	52		0.354		<.05
Right innominate:	51		0.058		N.S.
Left ischium to inferior sacrum:					
Left innominate:	54		0.292		<.05
Right innominate:	53		0.062		N.S.
Pelvic outlet index:					
Left innominate:	48		0.321		<.05
Right innominate:	48		-0.064		N.S.

Statistical analysis suggests that there are several pelvic dimensions that are associated with the width of the preauricular sulcus. It must be mentioned at this point that, when the pelves were examined, it was noticeable that there seemed to be a relationship between larger pelves and larger scarring generally, although this could not be quantified without mathematical analysis.

There are significant positive correlations between the width of the preauricular sulcus and;

(a) the width of the sciatic notch,

(b) the width of the anterior sacrum at the level of the inferior limit of the sacroiliac joint,

(c) the transverse diameter,

(d) the bispinous diameter and

(e) the inlet circumference.

The larger these dimensions, the wider the sulcus. This it must be remembered is independent of sulcus type or severity. These results are however, low correlation coefficients.

The results of pairwise correlations between the width of the sulcus and;

(a) the pubo-sacroiliac diameter,

(b) the inferior antero-posterior diameter and

(c) the greatest pelvic diameter are also noteworthy.

In all cases the result is not significant for both innominates, but is very close to the 95% level and the two r values are similar. These represent interesting but inconclusive results.

Analysis of the shape of the sciatic notch with sulcus width variation illustrates that in both innominates the wider and shallower the notch, the greater the width of the sulcus. The significant result on the left innominate is caused by the three grade 4 and one grade 5 notches. The variation between the wider grades is not significant, although this result is interesting, it is not as conclusive as others described above. It would seem that to measure sciatic notch width and depth produces more accurate results than to assess the shape of the notch visually which is subjective and more prone to inter-observer error. The variation is described in table 63 below.

Table 63. Sciatic notch shape and sulcus width.

	Left			Right		
Score	Mean(mm)	N	STDev	Mean	N	STDev
1	7.4	37	3.4	6.9	39	3.4
2	6.0	58	3.1	6.0	52	3.1
3	5.5	13	2.7	5.4	14	3.0
4	1.7	3	2.9	2.0	2	2.9
5	3.0	1			0	

The test results obtained from correlating the left ischium to the inferior sacrum, the left ischial spine to the apex of the sacrum and the pelvic outlet index with the width of the preauricular sulcus are widely divergent on the different innominates and are probably chance results which would not appear to be important.

6.5 Preauricular Sulcus Length and Pelvimetry.

Details of those measurements which appear to be statistically associated with the length of the preauricular sulcus are described below in table 64. The remaining tests all produced probability values >.05, which indicate that the null hypothesis be accepted in terms of any relationship between them and sulcus length.

Table 64. Preauricular sulcus length and pelvimetry

Pubo-sacroiliac diameter:	N	r	P
Left innominate:	63	0.336	<.05
Right innominate:	66	0.337	<.05
Sciatic notch width:			
Left innominate:	98	0.311	<.05
Right innominate:	97	0.373	<.01
Transverse diameter:			
Left innominate:	81	0.426	<.01
Right innominate:	81	0.220	<.05
Bispinous diameter:			
Left innominate:	69	0.361	<.01
Right innominate:	70	0.294	<.05
Antero-posterior diameter inferior:			
Left innominate:	52	0.307	<.05
Right innominate:	52	0.228	N.S.
Greatest pelvic diameter:			
Left innominate:	64	0.333	<.01
Right innominate:	63	0.236	N.S.
Inlet circumference:			
Left innominate:	60	0.275	<.05
Right innominate:	59	0.227	N.S.
Left ischium to inferior sacrum: (Right = >.05)			
Left innominate:	51	0.333	<.05
Right innominate:	51	0.070	N.S.
Ischial spine to symphysion:			
Left innominate:	58	0.218	N.S.
Right innominate:	63	0.322	<.05

There are statistically significant, but low, positive correlations between the length of the preauricular sulcus and the following dimensions;

(a) pubo-sacroiliac diameter,

(b) sciatic notch width,

(c) transverse diameter and

(d) bispinous diameter.

The correlations between sulcus length and the inferior antero-posterior diameter, greatest pelvic diameter, inlet circumference and ischial spine to symphysion are all inconclusive as for each a significant result is only obtained for one innominate. However, the results in each case are close and they represent interesting trends. The result obtained for the left ischium to the inferior sacrum with sulcus length is not consistent and, as the results for the right ischium to the sacrum are not significant, can be dismissed as reflecting chance.

It is interesting to note that both sulcus width and sulcus length are positively correlated to sciatic notch width, transverse diameter and bispinous diameter and that either width or length are associated significantly with sacral width inferior, inlet circumference and pubo-sacroiliac diameter. Interesting results, which are not statistically significant, are obtained in association with the inferior antero-posterior diameter and the greatest pelvic diameter.

It has always been considered that if the preauricular sulcus represented stress and trauma during pregnancy and parturition, the sulcus would be more marked in smaller pelves. That the opposite seems to be the case, in this sample, supports the results described in chapter 5, that no aspect of the sulcus is strongly related to obstetric events.

6.6 Pubic Pitting and Pelvimetry.

The presence or absence of pubic pitting and pelvimetry.

The results of statistical analysis between the absence or presence of pitting of the dorsal aspect of the pubic symphysis in relation to pelvimetry are presented below in table 65. As before only those results which are significant or interesting are described and discussed.

Table 65. Absence or presence of pubic pitting and pelvimetry.

Bispinous diameter:	N	F	DF	P
Left innominate:	58	5.84	1,56	<.05
Right innominate:	58	6.55	1,56	<.05
Right ischial spine to inferior sacrum:			(Left	P>.05)
Left innominate:	41	5.91	1,39	<.05
Right innominate:	46	10.83	1,44	<.01
Pelvic shape:				
(excluding types 2 & 4)		X^2	DF	P
Left innominate:	56	3.827	1	<.05
Right innominate:	61	1.833	1	N.S.
Pubo-sacroiliac diameter:		F	DF	P
Left innominate:	61	4.74	1,59	<.05
Right innominate:	65	3.09	1,63	N.S.
Ischial spine to symphysion:				
Left innominate:	56	3.30	1,54	N.S.
Right innominate:	61	5.51	1,59	<.05
Sacral width inferior:				
Left innominate:	55	2.50	1,53	N.S.
Right innominate:	63	4.13	1,61	<.05
Transverse diameter:				
Left innominate:	59	2.69	4,54	<.05
Right innominate:	66	1.17	1,64	N.S.
Antero-posterior diameter superior:				
Left innominate:	59	5.58	1,57	<.05
Right innominate:	61	0.69	1,59	N.S.
Antero-posterior diameter inferior:				
Left innominate:	44	4.03	1,42	N.S.
Right innominate:	47	7.85	1,45	<.01
Greatest pelvic diameter:				
Left innominate:	56	4.5	1,54	<.05
Right innominate:	59	1.68	1,57	N.S.

Pairwise statistical analysis of the absence or presence of pitting on the dorsal aspect of the pubic symphysis and pelvimetry suggests that there is a significant association between pitting and the bispinous diameter, pelvic shape and the right ischial spine to the apex of the sacrum.

Details of the variance in the bispinous diameter and the presence or absence of pubic pitting are shown below in table 66.

Table 66. Pubic pitting and the bispinous diameter

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	102.5	9.6	35	102.9	9.1	33
Present	108.43	7.7	23	108.7	7.7	25

There is a statistically significant relationship between the size of the bispinous diameter and the presence of pitting. It appears that the wider this dimension, the greater the possibility that it will be associated with pubic pitting.

Analysis of variance of the distance from the right ischial spine to the apex of the sacrum is presented below in table 67 . Again, the wider the dimension, the greater the possibility that there will be pubic pitting. The diameter between the left ischial spine to the sacrum presents the same trend, but it is not statistically significant.

Table 67 Pubic pitting and the ischial spine - sacral dimension.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	63.3	6.7	24	63.2	6.8	26
Present	68.7	7.5	17	69.6	6.2	20

Evaluation of the shape of the pelvic inlet (Caldwell & Maloy's classification, 1938) in association with pubic pitting produced a significant X^2 value on the left innominate only. The $<.05$ probability value reflects the fact that of the five android pelves, none had pubic pitting. Of the 51 gynecoid pelves 28 of 51 were not pitted. This result suggests that the smaller android pelves are not subject to pitting whilst the gynecoid pelves, which are more variable in size, are subject to both absence and presence of pitting. The same trend is apparent on the right innominate, where five of six android pelves are not pitted, 30 of the 55 gynecoid pelves are not pitted.

The pubo-sacroiliac diameter also seems to affect the distribution of pubic pitting. The larger the diameter the more likely the pubis will be pitted. The results of analysis of the variance of this dimension in relation to the absence or presence of pitting is described below in table 68, the value from the left innominate is significant, that from the right is not, although it follows the same trend.

Table 68. Pubic pitting and the pubo-sacroiliac diameter.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absence	115.2	7.4	35	115.0	7.6	38
Presence	119.1	6.0	26	118.4	7.6	27

The ischial spine to symphysion diameter also seems to relate to the absence or presence of pubic pitting, again, the larger the dimension the more likely the innominate will be pitted. The test value indicates that this relationship is significant in the right innominate but not on the left, although, it follows the same trend. The test results are described below in table 69.

Table 69 Pubic pitting and the ischial spine to symphysion diameter.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	107.6	7.9	30	105.4	9.9	36
Present	111.0	5.7	26	110.7	6.6	25

Analysis of variance of the measurement across the anterior aspect of the sacrum, at the level of the inferior aspect of the sacroiliac joint, in association with pubic pitting, also follows the trend seen above whereby the larger the dimension the greater the possibility of pitting. The results are described below in table 70.

Table 70. Pubic pitting and sacral width (inferior).

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	89.8	6.5	31	89.3	6.1	36
Present	92.4	5.2	24	92.4	5.6	26

Only the value from the right innominate is significant despite the similar results.

The results from analysis of variance of the transverse diameter and pubic pitting is illustrated below in table 71. Again, although only the test value from one innominate, the left, is significant both innominates demonstrate that the larger the diameter the more likely the pubis will be pitted.

Table 71 Pubic pitting and the transverse diameter.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	127.8	7.7	33	127.7	8.9	37
Present	132.0	7.7	26	129.9	7.2	29

The results described below in table 72 illustrate that both superior and inferior antero-posterior diameters also follow the same trend as those diameters described above. The test results from one innominate only are significant in each case, although both innominates follow the same trend.

Table 72. Antero-posterior diameters and pubic pitting.

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Superior						
Absent	103.3	9.0	33	104.3	9.9	34
Present	109.5	11.2	26	106.6	11.3	27
Inferior						
Absent	111.2	11.7	25	109.8	11.5	27
Present	117.9	9.9	19	118.6	9.3	20

The relationship between the greatest pelvic diameter and pubic pitting is that the larger the diameter the greater the probability of pubic pitting. Only the left innominate produced a significant P value, although the right follows the same trend. See table 73 for details of this relationship.

Table 73. Pubic pitting and the greatest pelvic diameter

	Left			Right		
	Mean	STDev	N	Mean	STDev	N
Absent	124.1	10.3	31	124.4	10.9	34
Present	129.4	7.9	25	127.7	8.0	25

The significance test results discussed above illustrate that, in the Christ Church females, there is a noticeable trend for pubic pitting to be present on pelves of larger dimensions. The smaller pelves do not appear to be pitted. The bispinous diameter produces a significant probability value in association with pubic pitting on both innominates whilst the following dimensions seem to influence the distribution of pubic pitting although the association is not significant statistically;

(a) ischial spine to the apex of the sacrum,

(b) pubo-sacroiliac diameter,

(c) ischial spine to symphysion,

(d) sacral width inferior,

(e) transverse diameter,

(f) the superior and inferior antero-posterior diameters, (g) the greatest pelvic diameter.

Furthermore, there appears to be a trend whereby the smaller android pelves are not pitted although the gynecoid pelvis, which is more variable in size in this sample, is not discriminatory in terms of the absence or presence of pits.

6.7 The Number of Pubic Pits and Pelvimetry.

Only the lacro-sacral angle appears to be significantly related to the number of pits on the dorsal aspect of the pubic symphysis. However, several other measurements produced interesting trends on both left and right innominates, although they were only significant on one innominate. The probability values for these dimensions are listed below in table 74.

Table 74. The number of pubic pits and pelvimetry.

Lacro-sacral angle:	N	F	DF	P
Left innominate:	57	2.58	4,52	<.05
Right innominate:	63	5.83	5,57	<.01
Right ischium to the inferior sacrum:				
Left innominate:	41	4.10	4,36	<.01
Right innominate:	40	3.54	4,35	<.01
Left ischium to the inferior sacrum:				
Left innominate:	41	2.78	4,36	<.05
Right innominate:	44	1.10	5,38	N.S.
Pelvic inlet index:				
Left innominate:	58	3.57	4,53	<.05
Right innominate:	61	0.45	5,55	N.S.
Sacral width inferior:				
Left innominate:	55	2.84	4,50	<.05
Right innominate:	62	1.68	5,56	N.S.
Antero-posterior diameter superior:				
Left innominate:	59	6.10	4,54	<.01
Right innominate:	61	1.0	5,55	N.S.
Transverse diameter:				
Left innominate:	59	2.69	4,54	<.05
Right innominate:	59	1.47	1.57	N.S.

The significant results obtained by analysing the variance of the lacro-sacral angle in sub-samples with the same number of pubic pits, reflects the unusually large angle of 81 degrees on the single pelvis with five pits. The variation within the sub-samples with fewer pits is not significant and ranges from 56 to 64.3 degrees. There is no association apparent between these two variables.

There appears to be an interesting, though not conclusive trend for the number of pubic pits to increase with an increase in the distance from the ischial tuberosity to the apex of the sacrum. The significant test results obtained on the left innominate in relation to both left and right dimensions and the right innominate in relation only to the right ischial tuberosity to the sacrum are based very much on the small numbers of pelves with 3, 4 and 5 pits. The results are presented below in tables 75. These are considered indicative of a positive correlation but are not conclusive due to the small sample sizes.

Table 75. Pubic pitting and the diameter from ischium to sacrum.

Right ischium to sacrum

Number of		Left			Right	
Pits	Mean	STDev	N	Mean	STDev	N
0	63.3	6.7	24	63.2	6.8	26
1	67.2	5.1	10	66.9	4.5	10
2	63.3	9.2	3	71.3	7.5	6
3	75.0	7.2	3	70.5	2.1	2
4	82.0		1	82.0		1
5				73.0		1

Left ischium to sacrum

Number of		Left			Right	
Pits	Mean	STDev	N	Mean	STDev	N
0	62.7	8.0	23	63.4	7.6	25
1	66.1	5.9	11	66.0	5.6	9
2	61.7	13.6	3	67.3	10.9	6
3	77.0	6.1	3	70.5	4.9	2
4	74.0		1	74.0		1
5			0	74.0		1

The significant test result obtained from analysing the variance in the superior antero-posterior diameter in relation to the number of pubic pits on the left innominate is an artefact of one case with 4 pits which has a much reduced diameter. The mean diameters range from 103 to 120mms., the outlier is 85mms. There is no trend indicated by this test in either innominate and this result should be disregarded.

The number of pubic pits on the left innominate seem to increase in conjunction with a larger inferior sacral width. The significant test result is based very much on the evidence of small sample sizes, the same trend is evident but not significant on the right innominate. The results are shown below in table 76.

Table 76. Pubic pitting and the inferior sacral width.

Number of	Left			Right		
Pits	Mean	STDev	N	Mean	STDev	N
0	89.8	6.5	31	89.3	6.1	36
1	91.1	4.2	14	91.8	5.4	14
2	89.6	2.6	5	90.4	3.4	7
3	97.5	5.7	4	97.0	12.7	2
4	103.0		1	98.5	6.4	2
5			0	93.0		1

The significant relationship implied by analysis of variance of the pelvic inlet index and the number of pits on the left innominate is caused by one case with a markedly different value from the others. There is no trend implied in the test result on either innominate and this result should be disregarded. All mean results range from 78 to 91 except the single outlier which has a value of 62.

There appears to be an association between the variance within the sub-samples with specific numbers of pits and the transverse diameter. The results are presented in table 77 and illustrate that in the small samples with several pits the transverse diameter is usually greater than in the larger groups with no or small numbers of pits. However, this result is based on very small numbers and is not significant in the right innominate.

Table 77. Pubic pitting and the transverse diameter.

Number of	Left			Right		
Pits	Mean	STDev	N	Mean	STDev	N
0	127.7	7.7	33	127.7	8.9	37
1	129.4	7.0	16	127.4	6.3	17
2	133.6	9.1	5	130.6	7.7	7
3	139.0	4.5	4	138.0	8.5	2
4	137.0		1	138.0	1.4	2
5				135.0		1

Analysis of the number of pubic pits in relation to pelvimetry does not produce any consistent statistically significant results. There are trends suggested in association with the transverse diameter and the diameters between the ischial tuberosities and the apex of the sacrum. In both cases the larger the measurement the more pits are present, but in neither case is the association significant. It must be remembered that scoring the "number of pits" was problematic in some cases, it frequently proved difficult to be certain of where one pit started and another ended and they frequently coalesced into a sulcus.

6.8 The Pubic Tubercle and Pelvimetry.

The application of statistical tests, to examine the possibility that the extension of the pubic tubercle might relate to pelvimetry, produced no significant results on both innominates. The following measurements produced one significant result. The test values are listed in table 78 and the meaning of these values is discussed below.

Table 78. The pubic tubercle and pelvimetry.

Ischial spine to symphysion:	N	F	DF	P
Left innominate:	40	3.24	3,36	<.05
Right innominate:	42	0.15	3,38	N.S.
Pubo-sacroiliac diameter:				
Left innominate:	43	0.71	3,39	N.S.
Right innominate:	43	2.86	3,39	<.05
Antero-posterior diameter superior:				
Left innominate:	40	3.16	3,36	<.05
Right innominate:	40	0.11	3,36	N.S.
Inlet circumference:				
Left innominate:	40	4.15	3,36	<.05
Right innominate:	37	1.01	3,33	N.S.

There appears to be a positive association between the extension of the pubic tubercle from grades 0 to 2 and the distance from the ischial spine to the pubic symphysis on the right innominate. The same trend is apparent on the left innominate but to a lesser degree which is not significant. The results are described in table 79. It is suggested that, despite the test result, the fact that the trend is not continuous indicates that this result is not important.

Table 79. The pubic tubercle and the ischial spine to symphysion diameter.

	Right			Left		
Score	Mean	STDev	N	Mean	STDev	N
0	103.9	8.3	11	105.9	8.4	14
1	110.5	6.6	13	106.4	6.7	16
2	112.7	6.9	12	108.4	8.6	5
3	107.7	5.6	4	106.6	2.1	7

Analysis of variance of the pubo-sacroiliac diameter within the four grades of tubercle extension produces a wide range of variation in the left innominate, but not one that indicates any meaningful trend or association. The variation evident on the right innominate is less diverse and not significant. The results are described in table 80.

Table 80. The pubic tubercle and the pubo-sacroiliac diameter.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	112.8	9.4	13	113.9	7.5	15
1	120.3	5.1	13	114.2	8.5	16
2	118.1	6.1	13	119.6	9.7	5
3	113.7	5.5	4	115.0	4.8	7

The significant test result obtained on the left innominate, by analysis of variance of the antero-posterior diameter in terms of grades of tubercle extension, is reflecting the divergence of the mean in grade 1 only. The mean for this grade is 111.8mm , the variance for grades 0, 2 and 3 ranges from means of 99.8 to 105.5mm in both innominates. Consequently, the significant result obtained from the left innominate is not considered important.

The significant result obtained on the left innominate, when analysing the variance of the inlet circumference within the four grades of extension, results from the fact that the mean for grade 0 is notably different from grades 1 to 3. The results are described below in table 81.

Table 81. Tubercle extension and inlet circumference.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	365.2	26.6	12	371.8	24.8	13
1	391.3	14.2	12	377.0	28.0	14
2	391.9	23.5	12	395.5	20.9	4
3	385.7	7.9	4	382.5	15.4	6

These results suggest that the non-extended (grade 0) tubercle is associated with a small pelvic inlet. However, as there is no consistent trend within grades 1 to 3 and as the right innominate does not appear to be significant with respect to grade 0, this result is probably of little importance.

None of the test results described above produce results which suggest that there is a significant trend between the variables. In the Christ Church females, the extension of the pubic tubercle appears to be completely independent of pelvic size or shape.

6.9 Scarring of the Sacrum and Pelvimetry.

Analysis of variance of pelvic measurements in association with either the absence , the unilateral or bilateral presence of sacral scarring produced only two interesting results. The test values of these are presented in table 82 and the implications of the results are discussed below.

Table 82. Sacral scarring and pelvimetry.

Transverse diameter:	N	F	DF	P
	76	3.23	2,73	<.05
Pubic symphysis depth:				
Left innominate:	55	3.05	2,52	N.S.
Right innominate:	58	3.59	2,55	<.05

In this sample there is a significant positive correlation between the transverse diameter and sacral scarring, the mean diameter where there is no scarring is 127.6mm (S.D. = 8.3mm), with unilateral scarring the mean diameter is 133.0mm and with bilateral scarring the mean is 134.4mm . The presence of a sulcus, regardless of its laterality, seems to be associated with a mean diameter of approximately 134mm . While the absence of a sulcus is associated with a mean of 127mm . It should be noted however, that only 13 pelves had sacral scarring whilst 63 did not.

Analysis of the variance of pubic symphysis depth produced a significant probability value only on the right innominate. However, the same trend whereby the measurement is reduced on those without scarring, is evident on the left innominate, although not quite to the same extent. Again, these results are based on a sample where only 8 of 58 pelves were scarred. Full details are listed below in table 83. Key: 0 = absent, 1 = unilateral, 2 = bilateral.

Table 83. Sacral scarring and pubic symphyseal depth.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	35.6	4.1	47	35.8	3.8	50
1	39.5	1.0	4	40.0	2.9	4
2	39.0	2.2	4	39.0	1.4	4

Despite the fact that cortical resorption along the anterior sacroiliac margins of the sacrum is a comparatively unusual feature in the Christ Church females, there does appear to be a statistically significant, positive association between the transverse diameter of the pelvic inlet and the frequency of this feature. There also appears to be a trend between the depth of the pubic symphysis and localised cortical resorption, again the larger the dimension the more likely that it will be associated with sacral scarring. However, this relationship is not statistically significant. In both cases the standard deviations are too large to allow accurate prediction of one variable from the other.

Discussion of the results obtained by a statistical analysis of "scars of parturition" and dimensions supports the trend observed during examination of the pelves. The larger the pelvis the more likely it is to be associated with either pubic pitting and / or large preauricular sulci.

Although a wide range of measurements appears to relate to the size of the preauricular sulcus and the presence or absence of pubic pits, the following proved to be statistically significant;

With the width of the preauricular sulcus;

(a) sciatic notch width,

(b) inferior anterior sacral width,

(c) transverse diameter,

(d) bispinous diameter and

(e) inlet circumference.

With preauricular sulcus length;

(a) pubo-sacroiliac diameter,

(b) sciatic notch width,

(c) transverse diameter and

(d) bispinous diameter.

Only the bispinous diameter is significantly associated with the absence or presence of pubic pitting and the transverse diameter with sacral scarring. In all cases however, the standard deviations are such that no prediction of one variable from another is possible.

6.10 Stature Estimation and "Scars of Parturition".

As cortical changes near the pelvic joints appear to be positively associated with the pelvic dimensions described above, it was decided to examine the possibility they they might also relate to stature estimation.

Stature was estimated using the formulae established by Trotter and Gleser (1952), for use on white females and in order of preference according to the standard errors (courtesy S. Gauthier). The formulae applied to the long bone measurements were determined by the condition of each skeleton.

The results are shown below, the formula applied to the total female sample is 0.68 X R. Hum + 1.17 x Fem + 1.15 x Tib + 50.12. (personal communication S. Gauthier)

Table 84A. Stature of the Christ Church females.

	N	Mean	STDev	Min	Max
Named females	113	156.2	5.30	142.0	170.0
All females	139	157.7	6.31	141.5	172.8

The frequency distribution for stature is illustrated below in figure 30.

Figure 30. Stature of the named females (using the Trotter & Gleser formulae 1952).

```
Midpoint Frequency  %
142         1      0.9    *
144         1      0.9    *
146         1      0.9    *
148         5      4.4    *****
150         9      8.0    *********
152        10      8.8    **********
154        13     11.5    *************
156        18     15.9    ******************
158        21     18.6    *********************
160        12     10.6    ************
162         8      7.1    ********
164         7      6.2    *******
166         5      4.4    *****
168         0
170         2      1.8    **
```

Statistical analysis of the relationships between "scars of parturition" and stature is described below in table 84B.

Table 84B. Stature and scars of parturition.

Absence or presence of a preauricular sulcus:	N	F	DF	P
Left innominate:	101	0.09	1,99	N.S.
Right innominate:	100	0.19	1.98	N.S.
Type of preauricular sulcus:				
Left innominate:	101	0.32	4,96	N.S.
Right innominate:	100	0.13	4,95	N.S.
Preauricular sulcus severity:				
Left innominate:	103	0.63	4,98	N.S.
Right innominate:	101	0.36	4,96	N.S.
Preauricular sulcus width:		r		P
Left innominate:	103	0.134		N.S.
Right innominate:	102	0.069		N.S.
Preauricular sulcus length:				
Left innominate:	102	0.137		N.S.
Right innominate:	101	0.141		N.S.
Absence or presence of pubic pits:	N	F	DF	P
Left innominate:	64	2.52	1,62	N.S.
Right innominate:	70	0.06	1,68	N.S.
Number of pubic pits:				
Left innominate:	64	2.72	4,59	<.05
Right innominate:	71	0.38	5,65	N.S.
Pubic tubercle:				
Left innominate:	42	3.86	3,38	<.05
Right innominate:	45	1.08	3,41	N.S.
Sacral scarring:	83	1.07	2,80	N.S.

The result obtained from the analysis of variance of stature within sub-samples with specific numbers of pubic pits produced a significant result on the left innominate only. This result reflects the mean stature of those with 2 and 3 pits, samples of 6 and 3 respectively. The same trend is less marked on the right innominate. As this trend is not progressive, and because it is not significant on both innominates, it is not considered important. The results are presented below in table 85.

Table 85. Stature and the number of pubic pits.

Number of Pits	Left Mean	Left STDev	Left N	Right Mean	Right STDev	Right N
0	156.0	5.6	36	156.3	6.3	42
1	156.3	3.7	18	156.0	4.5	18
2	162.7	4.2	6	158.4	2.6	7
3	160.0	3.6	3	159.0	2.8	2
4	156.0		1	156.0		1
5				153.0		1

The results of analysis of variance of stature and the extension of the pubic tubercle are described below in table 86.

Table 86. Stature and the pubic tubercle.

Score	Left Mean	Left STDev	Left N	Right Mean	Right STDev	Right N
0	152.8	5.8	10	155.1	5.1	15
1	158.1	4.9	13	154.6	5.9	17
2	158.8	4.7	13	159.2	3.9	5
3	152.8	3.3	6	155.4	3.1	8

There is a tendency for stature to increase in association with grades 0 and 1 on the left innominate and grades 1 and 2 on the right innominate. That this trend does not affect grade 3 as well suggests that these results probably represent chance.

There does not appear to be any association between the incidence, type or size of "parturition scars" and stature. If stature can be considered as as an indication of overall body size, it appears that there is no relationship between body size and cortical resorption adjacent to the pelvic joints in this sample, but that resorption is related to pelvic size.

6.11 "Scars of Parturition" and Pathologies.

It is worth considering the possibility that resorption at the ligamentous attachment sites might occurr as a result of pelvic instability. This question is one that may not be resolved by examination of skeletal evidence of pathologies as many conditions causing great discomfort and inconvenience during life do not affect the skeleton. Nevertheless, it is an issue worth pursuing within the limits of the skeletal data. As chapter 4 described, skeletal pathologies affecting the vertebrae and lower limbs were scored. The results are described below in table 87.

Table 87. Pathologies in the female sample.

Score N = 122	Frequency	%
0 = no pathologies	37	30.3
1 = degenerative of vertebrae	37	30.3
2 = degenerative of lower limbs	4	3.3
3 = degenerative to both	30	24.6
4 = fracture of pelvis or lower limbs	1	0.8
5 = other see Appendix 1	10	8.2
6 = degenerative and fracture	3	2.5

Due to the small numbers in categories 2, 4 and 6 it proved impossible to run X^2 tests on this data in association with preauricular sulcus presence, type or severity, sacral scarring, pubic pitting or the extension of the pubic tubercle. All variants produced cells with expected values of below one and whilst it is usually considered acceptable to have one cell per table with an expected value of below one (Snedecor & Cochran 1967), more than one is unacceptable. The discrete nature of the data prevents the combining of classes. Tabulation of the results is presented in table 88, the data is taken from the left innominate.

Analysis of variance was examined with respect of preauricular sulcus width and length with pathologies. In both cases the resulting F values were small and not significant ($P>.05$).

Table 88. Pathologies and pelvic scarring.

Variant	Pathology 0	1	2	3	4	5	6
Absence or presence of preauricular sulcus N = 113							
0	5	3	1	5	0	1	0
1	30	31	2	22	1	9	3
Preauricular sulcus type N = 113							
0	5	3	1	5	0	1	0
1	10	17	1	14	0	4	0
2	9	5	0	4	1	2	2
3	10	9	1	3	0	3	1
4	1	0	0	1	0	0	0
Preauricular sulcus severity N = 115							
0	5	3	1	5	0	1	0
1	20	16	1	11	0	5	1
2	8	11	0	9	0	2	2
3	2	4	1	3	1	2	0
4	0	1	0	0	0	0	0
Pubic pits absent or present N = 70							
0	13	10	2	11	1	2	2
1	7	7	0	11	0	3	1
Pubic pits number N = 70							
0	13	10	2	11	1	2	2
1	5	5	0	6	0	2	0
2	2	0	0	3	0	0	1
3	0	1	0	2	0	1	0
4	0	1	0	0	0	0	0
Sacral scarring N = 88							
0	23	25	3	17	1	3	2
1	2	1	0	1	0	2	0
2	2	1	0	5	0	0	0
Pubic tubercle N = 47							
0	6	4	1	0	1	2	0
1	4	3	0	4	0	0	2
2	3	5	0	6	0	0	0
3	2	2	0	1	0	1	0

The only trend suggested by these data is that there seems to be a tendency for sacral scarring to be associated with the presence of degenerative changes to both the vertebrae and the lower limbs. Five of the 8 cases of bilateral sacral scarring are found in females with this category of pathological change. No other trends are suggested by these data.

Chapter 7. Results 3 . The Sample: Descriptive Analysis.

7.1 The Female Pelvis from Christ Church, Spitalfields: Metrical Analysis of the Innominates.

Descriptive analysis of the female pelvis from the named sample at Christ Church is illustrated below. The data are arranged so that the left and right innominates are comparable. This table (89) will precede the description of the sacrum (90) which is followed by data relating to the rearticulated pelvis (91). Abbreviations are as follows: N = sample size, STDev = standard deviation, SEMean = standard error of the mean.

Metrical data relating to the left and right innominates.

Data are from the left innominate, in all cases the differences between the mean for the left and right innominates was below 1mm. All measurements are in mms.

Table 89. Descriptive analysis of the (left) female innominates: metric.

Pubo-sacroiliac	N	Mean	STDev	SEMean	Min	Max
diameter:	65	116.2	7.4	0.9	96.0	131.0
Pubic symphyseal depth:	63	36.2	4.0	0.5	28.0	45.0
Pubic symphyseal width superior:	66	11.6	2.2	0.3	8.0	18.0
Pubic symphyseal width inferior:	70	11.1	2.0	0.2	6.0	16.0
Ischial spine to symphysion:	59	108.6	7.5	1.0	89.0	128.0
Sacroiliac joint maximum length:	97	57.5	5.0	0.5	48.0	69.0
Sacroiliac joint maximum width:	108	53.4	6.0	0.6	38.0	69.0
Sciatic notch width:	101	57.0	7.1	0.7	36.0	75.0
Sciatic notch depth:	101	34.0	3.3	0.3	25.0	41.0

7.2 Metrical analysis of the sacrum.

Table 90. Descriptive analysis of the female sacrum: metrics.

Sacral width	N	Mean	STDev	SEMean	Min	Max
superior(anterior):	96	108.5	6.8	0.7	85.0	124.0
Sacral width inferior:	87	90.6	5.8	0.6	76.0	106.0
Sacral body width:	106	43.2	4.0	0.4	35.0	56.0
Sacral body depth:	101	28.5	2.2	0.2	23.0	34.0
Sacral length (anterior height):	64	101.0	12.5	1.6	70.0	128.0
Sacral depth:	60	24.9	5.6	0.7	15.0	39.0
Lacro-sacral angle:	84	63.0	5.7	0.6	46.0	81.0

7.3 Metrical analysis of the rearticulated pelvis.

Table 91. Descriptive analysis of the reaticulated female pelvis: metrics.

	N	Mean	STDev	SEMean	Min	Max
Transverse diameter:	82	128.5	8.2	0.9	109.0	146.0
Antero-posterior diameter superior:	67	105.3	10.4	1.3	81.0	135.0
Antero-posterior diameter inferior:	53	113.0	11.2	1.5	84.0	139.0
Greatest pelvic diameter:	65	125.6	9.8	1.2	97.0	147.0
Bispinous diameter:	70	105.4	9.5	1.1	75.0	122.0
Bi-tuberous diameter:	74	115.5	11.9	1.4	83.0	142.0
Sub-pubic angle:	59	86.3	8.4	1.1	67.0	106.0
Inlet circumference:	61	380.3	24.0	3.1	322.0	423.0
Left ischial spine to apex of the sacrum:	52	65.1	8.2	1.1	49.0	84.0
Right ischial spine to apex of the sacrum:	53	66.0	7.7	1.1	48.0	86.0
Left ischium to apex of sacrum:	54	85.7	11.8	1.6	48.0	111.0
Right ischium to apex of the sacrum:	54	87.7	10.0	1.4	58.0	113.0
Pelvic inlet index:	66	82.4	7.9	1.0	62.0	113.0
Pelvic outlet index:	48	106.4	12.4	1.8	68.0	137.0
Pelvic index:	47	76.3	10.6	1.6	60.0	109.0

7.4 Descriptive Analysis of Non-metric Variants: The Female Innominates.

Sciatic notch shape: (Graded from 1 to 5, the smaller the number the wider and shallower the notch, for details see chapter 4.) See table 92 below.

Table 92. Sciatic notch shape

Grade	Left innominate Frequency	%	Right innominate Frequency	%
1	37	32.5	42	37.8
2	60	52.6	53	47.7
3	13	11.4	14	12.6
4	3	2.6	2	1.8
5	1	0.9	0	0
Total	114	100.0	111	100.0

Ischial spine shape:

Grade 1 (blunt & wide) Grade 2 (sharp). See table 93 below.

Table 93. Ischial spine shape.

	N	Frequency	%	Frequency	%
Left:	44	31	70.4	13	29.6
Right:	38	23	60.5	15	39.5

7.5 Descriptive Analysis of Non-metric Variants: the Sacrum.

Sacralization: N = 106

Table 94. Sacralization.

Grade		Frequency	%
0	Absent	93	87.7
1	Unilateral	2	1.9
2	Bilateral	11	10.4

Number of sacral vertebrae per sacrum: N = 70

Table 95. Number of sacral vertebrae per sacrum.

Score	Frequency	%
5	47	67.1
6	23	32.9

Point of maximum sacral depth (vertebra number): N = 78

Table 96. Point of maximum sacral depth (vertebra number).

Score	Frequency	%
3	71	91.0
4	7	9.0

Extent of sacral articulation: N = 96

Table 97. Extent of sacral articulation. 2 = auricular surface extending into the second sacral vertebra, 3 = auricular surface extending into the third sacral vertebra.

Score	Frequency	%
2	19	19.8
3	77	80.2

"Spitalfields" (rachitic) sacrum: N = 104

Table 98. Spitalfields sacrum.

Score		Frequency	%
0	Absent	100	96.2
1	Present	4	3.8

Fusion of sacral vertebrae 1 and 2. N = 103 Key: 1 = fused, 2 = fusion in process, 3 = unfused at margins of discal bodies.

Table 99. fusion of sacral vertebrae 1 and 2.

Score	Frequency	%
1	78	75.7
2	13	12.6
3	12	11.6

The mean ages for the above scores are described below in table 100. These figures illustrate that, as would be expected, the unfused and fusing stages are largely confined to young adults. The relationship between fusion of sacral vertebra 1 to 2 with age is statistically significant (H = 40.91 P<.001).

<u>Table 100. Fusion of sacral vertebrae 1 and 2 and its relationship with age.</u>

Score	N	Median Age
1	78	61.0
2	12	35.0
3	12	26.0

<u>7.6 Descriptive Analysis of Non-metric Variants: the Rearticulated Pelvis.</u>

<u>Pathologies:</u> N =122

<u>Table 101. Pathologies.</u>

Score		Frequency	%
0	No pathologies	37	30.3
1	Degenerative to vertebrae	37	30.3
2	Degenerative to legs	4	3.3
3	Degenerative to both	30	24.6
4	Fracture of lower limbs	1	0.8
5	Other, see notes	10	8.2
6	Degenerative & fracture	3	2.5

The mean ages at death for the categories of pathology described above are as follows:

<u>Table 102. Pathologies and their relationship with age.</u>

Score	N	Median Age
0	37	36.0
1	36	68.0
2	4	44.0
3	30	65.0
4	1	56.0
5	10	65.0
6	3	60.0

All of the categories described above, apart from degenerative changes to the lower limbs, tend to be present among women aged over 55 years. The absence of pathology is associated with younger women as would be expected. The tendency for pathology to be associated with increasing age is significant at P<.001 (H =

55.23).

Table 103. "Fit" at the pubic symphysis. (N = 59)

Grade		Frequency	%
0	Symphyses aligned, minimal gap.	1	1.7
1	Gap of more than 4mm between.	32	54.2
2	Symphyses not aligned.	19	32.2
3	Misaligned and gap of 4mm plus.	7	11.9

Table 104. Pelvic shape (Caldwell & Maloy) N = 73.

Grade		Frequency	%
1	Gynecoid	64	87.7
2	Anthropoid	1	1.4
3	Android	7	9.6
4	Platypelloid	1	1.4

The mean transverse and antero-posterior (superior) diameters (mm) for the pelvic shapes described above are presented in table 105 below.

Table 105. Transverse and antero-posterior diameters in respect of pelvic shape.

Shape	N	Trans Mean	STDev	N	A/P Mean	STDev
1	60	129.6	7.6	57	106.6	8.5
2	1	120.0	0.0	1	135.0	0.0
3	7	118.4	6.5	7	95.3	11.8
4	1	137.0	0.0	1	85.0	0.0

Table 106. Point of maximum diameter. (N = 77)

Score		Frequency	%
1	Anterior of central	1	1.3
2	Central	39	50.6
3	Posterior of central	34	44.2
4	Anterior to sacrum	3	3.9

7.7 Descriptive Analysis of Degenerative Changes to the Female Pelvis: their Association with Age.

Degenerative change and "scars of parturition".

Statistical analysis of the association between parturition scars and degenerative changes indicated that there was no relationship ($p = >.05$) in all cases except the presence of pitting on the dorsal aspect of the pubic symphysis with lipping or exostosis of the dorsal margin of the symphysis. This is a puzzling result as there seems to be no relationship between pubic pits and age (see 5.9 above) whilst there is between exostosis and age, see table 121 below. The results of this analysis are presented in table 107 below.

Table 107. Pubic pitting and exostosis.

Left innominate:	$X^2 = 10.399$	DF = 4	N = 69	$P<.05$
Right innominate:	$X^2 = 16.790$	DF = 4	N = 75	$P<.01$

These results suggest that there is an association between the more severe grades of exostosis and pubic pitting.

Exostosis can be the result of either hyperostosis poroma (Hensyl 1987, 264) or of a cartilage capped bony projection arising from any bone that develops from cartilage. Perhaps bone resorption along the dorsal aspect of the pubic symphysis is part of the skeletal response to the underlying conditions causing exostosis.

Degenerative changes to the sacroiliac joints:

Porosity of the auricular surfaces of the ilia.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 108. Porosity of the auricular surface of the ilium.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	37	32.2	38	34.2
1	36	31.3	35	31.5
2	25	21.7	18	17.1
3	15	13.0	14	12.6
4	2	1.7	5	4.5
Total	115	100.0	111	100.0

The association between porosity and age is described below:

Table 109. Association between porosity of the auricular surfaces of the ilia and age.

	Left		Right	
Score	N	Median	N	Median
0	37	38.0	38	38.5
1	36	57.0	35	57.0
2	24	64.0	18	67.5
3	15	77.0	14	75.5
4	2	69.0	5	74.0

The increased severity of porosity in association with increasing age is statistically significant $P<.001$ (H = 47.05 & 44.42).

Porosity of the auricular surfaces of the sacrum.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 110. Porosity of the auricular surfaces of the sacrum.

	Left aur/surface		Right aur/surface	
Score	Frequency	%	Frequency	%
0	41	42.3	42	46.1
1	38	39.2	30	33.0
2	13	13.4	14	15.4
3	5	5.1	5	5.5
4	0	0	0	0
	N = 97		N = 91	

The association between the variants described above and age is illustrated below in table 111. The tendency for increased porosity to be associated with increased age is statistically significant $P<.001$ (H = 40.91 & 21.62).

Table 111. Association between porosity of the auricular surfaces of the sacrum and age.

	Left articulation		Right articulation	
Score	N	Median	N	Median
0	41	47.0	42	45.0
1	38	61.0	30	58.0
2	12	73.5	13	74.0
3	5	78.0	5	78.0
4	0		0	

Osteophytosis of the anterior and inferior margins of the auricular surfaces of the ilium.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 112. Osteophytosis of the auricular surface of the ilium.

	Left articulation		Right articulation	
Score	Frequency	%	Frequency	%
0	26	22.4	21	18.4
1	55	47.4	59	51.7
2	31	26.7	28	24.6
3	1	0.9	3	2.6
4	3	2.6	3	2.6
Total	116	100.0	114	100.0

The association between osteophytosis of the auricular surface of the ilium and age is presented below in table 113:

Table 113 . Association between osteophytosis of the auricular surfaces of the ilia and age.

	Left articulation		Right articulation	
Score	N	Median	N	Median
0	26	47.0	21	47.0
1	54	55.0	58	55.5
2	31	71.0	28	65.0
3	1	52.0	3	60.0
4	3	82.0	3	70.0

The positive correlation between osteophytosis and age is statistically significant $P<.001$ & $P<.01$ (H = 20.71 & 13.87). The results reflect the variation between the mean age where the condition is absent and the mean age where the condition is present. The small sample sizes in the more severe grades might be affecting these results.

Osteophytosis of the anterior and superior margins of the auricular surface of the sacrum.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 114 . Osteophytosis of the auricular surfaces of the sacrum.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	39	41.5	37	40.6
1	48	51.0	42	46.1
2	4	4.2	10	11.0
3	1	1.1	1	1.1
4	2	2.1	1	1.1
	N = 94		N = 91	

The statistically significant association, P<.001 & P<.025, between increasing severity of osteophytosis of the margin of the auricular surfaces of the sacrum is described below in table 115. As with the same variants on the ilia, the results reflect that the main difference lies between the mean ages where the condition is absent and where it is present to any degree. It is possible that the smaller sample sizes in the severe grades might be biasing these results. (H = 20.35 & H = 11.92)

Table 115 . Association between osteophytosis of the auricular margins of the sacrum and age.

	Left articulation		Right articulation	
Score	N	Median	N	Median
0	39	48.0	37	47.0
1	47	63.0	41	61.0
2	4	83.0	10	55.0
3	1	60.0	1	57.0
4	2	73.0	1	79.0

Fusion of the sacroiliac joints.

Table 116. Fusion of the sacroiliac joints.

	Left articulation		Right articulation	
Score	Frequency	%	Frequency	%
0	108	97.3	103	94.5
1	3	2.7	6	5.5
	N = 111		N = 109	

The association between fusion of the sacroiliac joints and increasing age is statistically significant at P<.04165 for the left sacroiliac joint only. The results are presented in table 117 below (W = 5827.0) The test result from the right sacroiliac joint (P<.1279) is not statistically significant although it follows the same trend (W = 5445.0).

Table 117. Association between age and fusion of the sacroiliac joints.

	Left		Right	
Score	N	Median	N	Median
0	107	56.0	102	56.5
1	3	85.0	6	68.0
	N = 110		N = 108	

Degenerative changes to the the pubic symphysis:

Porosity of the symphyseal faces.

Graded 0 to 4 in order of severity as described in chapter 4. The results are described below in table 118.

Table 118. Porosity of the pubic symphyseal faces.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	11	15.7	14	17.5
1	26	37.1	24	30.0
2	19	27.1	23	28.7
3	12	17.1	18	22.5
4	2	2.9	1	1.2
Total	70	100.0	80	100.0

The association between porosity of the symphyseal face and increasing age is statistically significant P<.01 &

P<.001 (H = 14.44 & 27.41).

Table 119. Association between porosity of the symphyseal faces and age.

	Left		Right	
Score	N	Median	N	Median
0	11	35.0	14	35.0
1	26	56.0	24	53.5
2	18	69.0	22	70.0
3	12	67.5	18	67.5
4	2	56.5	1	76.0

Exostosis of the dorsal margin of the pubic symphysis.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 120. Exostosis of the pubic symphysis.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	6	8.3	7	8.7
1	22	30.6	28	35.0
2	30	41.7	28	35.0
3	11	15.3	13	16.2
4	3	4.2	4	5.0
	N = 72		N = 80	

The association between exostosis and age is illustrated below in table 121 . There is a statistically significant positive correlation between the two variants on the right pubis only P<.005 (left = P>.10). This largely reflects the vast difference between the mean age when the condition is absent and the closely grouped ages when the condition is present, regardless of its severity. (H = 7.569 & 16.86)

Table 121. Association between exostosis of the pubic symphyses and age.

	Left		Right	
Score	N	Median	N	Median
0	6	29.0	7	17.0
1	21	60.0	28	54.5
2	30	57.0	28	60.0
3	1	67.0	13	65.0
4	3	84.0	4	76.0

Degenerative changes to the lumbo-sacral articulation.
Porosity of the discal surfaces of lumbar vertebra 5 and sacral vertebra 1.

Graded 0 to 4 in order of severity as described in chapter 4.

Table 122. Porosity of the discal surfaces of lumbar vertebra 5 and sacral vertebra 1.

Score	Frequency	%
0	58	56.3
1	20	19.4
2	11	10.7
3	13	12.6
4	1	1.0
	N = 103	

There is a statistically significant association between increased porosity of this articulation and increased age $P<.001$ ($H = 34.74$).

Table 123. Association between age and porosity of the discal surfaces of lumbar vertebra 5 and sacral vertebra 1.

Score	N	Median
0	58	47.5
1	20	65.0
2	10	73.0
3	13	70.0
4	1	79.0

Osteophytosis of the margins of the discal surfaces of lumbar vertebra 5 and sacral vertebra 1.

Graded 0 to 4 in order of severity as described in chapter 4. The results are presented below in table 124.

Table 124. Osteophytosis of the diskal margins of lumbar vertebra 5 and sacral vertebra 1. N = 100

Score	Frequency	%
0	29	29.0
1	24	24.0
2	30	30.0
3	16	16.0
4	1	1.0

The association between osteophytosis of the margins of lumbar vertebra 5 and sacral vertebra 1 are statistically significant, $P<.001$. The major difference lies between the mean ages where the condition is absent and where it is present, although the positive correlation between severity and age is a continuous trend throughout. For details see table 125 below ($H = 54.32$).

Table 125. The association between osteophytosis of lumbar vertebra 5 and sacral vertebra 1 and increasing age.

Score	N	Median
0	29	30.0
1	24	59.5
2	29	71.0
3	16	71.0
4	1	79.0

The data presented in 7.7 above, as with chapter 7 as a whole, is intended to provide adequate descriptive material to facilitate comparative research in the future.

7.8 Metrical Associations Within the Female Pelvis.

The data collected specifically to examine the association between cortical variation near the female pelvic joints with obstetric data and pelvimetry, provides an opportunity to examine the relationships between different pelvic dimensions. This has not been undertaken on the male sample as the sample size is very small. The possibility of relationships between stature estimation and pelvimetry has also been examined.

Examination of pairwise relationships with respect to pelvimetry was largely based upon those dimensions which logically might relate to one another, for example, inlet circumference and transverse diameter, or sacral width and the size of the sacroiliac joints. Only those variants which are significantly associated are described. For details see table 126 below.

Table 126. Associated dimensions in the female pelvis.

Variants	Test result	N	P
Inlet circumference with:			
Transverse diameter	r = 0.796	61	<.01
Anteroposterior diameter - superior	r = 0.721	61	<.01
Anteroposterior diameter - inferior	r = 0.455	47	<.01
Bispinous diameter	r = 0.452	56	<.01
Bi-ischial diameter	r = 0.425	50	<.01
Greatest pelvic diameter	r = 0.635	58	<.01
Sciatic notch width	r = 0.380	55	<.01
Sciatic notch width with:			
Transverse diameter	r = 0.295	74	<.05
Anteroposterior diameter - superior	r = 0.405	60	<.01
Greatest pelvic diameter	r = 0.433	59	<.01
Bispinous diameter	r = 0.304	67	<.05
Bi-ischial diameter	r = 0.327	69	<.05
Sacral width superior with:			
Sacroiliac joint maximum width	r = 0.434	83	<.01
Transverse diameter	r = 0.670	81	<.01
Bi-ischial diameter	r = 0.307	73	<.05
Sacral width inferior with:			
Sacroiliac joint maximum length	r = 0.441	76	<.01
Sacroiliac joint maximum width	r = 0.308	73	<.05
Sacral length with:			
Anteroposterior diameter - superior	r = 0.485	50	<.01
Extent of sacral articulation	F = 29.48	62	<.01
Sacroiliac joint maximum width	r = 0.3	62	<.05
Sacroiliac joint maximum length with:			
Transverse diameter	r = 0.336	74	<.01
Greatest pelvic diameter	r = 0.440	60	<.01
Greatest pelvic diameter with bispinous diameter	r = 0.323	58	<.05

These associated pairs of dimensions illustrate clearly that the "large" pelvis comprises a series of dimensions which are positively correlated (Pearson's product moment) one to another. An association can be seen in the size of the pelvic inlet and outlet by reference to the inlet circumference with the bispinous diameter, the bi-ischial diameter and the anteroposterior diameter inferior. This suggests that an adequate pelvic inlet is rarely reduced at the outlet in this sample.

Possibly the most useful data described above is that relating to the width of the sciatic notch. It appears, in the Christ Church sample, that a wide sciatic notch is indicative of an obstetrically efficient pelvis. Conversely, a small notch appears to indicate a reduced pelvic inlet and outlet. This is a useful guide in archaeological material where the sciatic notch is more likely to survive intact than the various features necessary to take a full range of pelvic measurements.

A further interesting relationship to emerge from this analysis is the relationship between the extent of sacral articulation and sacral length. Full details are described below in table 127. Key: 2 = second sacral vertebra, 3 = third sacral vertebra (F = 29.48).

Table 127. Extent of sacral articulation and sacral length.

Score	N	Mean	STDev.
2	11	85.5mms.	12.9
3	51	104.3	9.8

It is considered (Brothwell 1981, 61) that the auricular surface of the sacrum is usually limited to the first and second sacral vertebrae in females but that it often extends to the third in males. The association evident in the Christ Church females suggests that the extent of sacral articulation is a response to sacral length; the longer sacrum requiring a more substantial area of articulation. Interestingly, in the Christ Church sample, sacral length is one of the few pelvic measurements which is not sexually dimorphic, see 8.6 below. The relationship between extent of sacral articulation and sacral length has not been tested in the male sample. However, the results described above and the lack of dimorphism in sacral length suggest they will be similar.

7.9 Stature and Pelvic Measurements.

As stature estimates for the Christ Church sample are available it was decided to examine the possibility that stature, as an indication of body size, might relate to pelvic dimensions.

There appears to be no relationship between stature estimation and pelvic shape estimation in the Christ Church females. Those dimensions which are, in this sample, positively correlated with stature are described below in table 128. In those cases where the dimension is replicated in the pelvis, for example pubo-sacroiliac diameter, the results are from the left innominate. The result from the right innominate is significant to the same probability level.

Table 128. Stature and pelvimetry.

Variant	N	Test value	P
Transverse diameter	79	r = 0.520	<.01
Anteroposterior diameter superior	64	r = 0.579	<.01
Anteroposterior diameter inferior	53	r = 0.374	<.01
Greatest pelvic diameter	74	r = 0.576	<.01
Inlet circumference	58	r = 0.674	<.01
Pubosacroiliac diameter	60	r = 0.702	<.01
Ischial spine to - symphysion.	60	r = 0.656	<.01
Pubic symphysis depth	58	r = 0.322	<.05
Sacroiliac joint - maximum length	89	r = 0.435	<.01
Sacroiliac joint - maximum width	99	r = 0.393	<.01
Sacral width superior	88	r = 0.370	<.01
Sacral width inferior	83	r = 0.477	<.01
Lacro-sacral angle	81	r = -0.247	<.05
Number of sacral - vertebrae	68	F = 4.54	<.05

The concept that the shape and size of the pelvis is related to general physique has been discussed in the literature. Thoms (1940) and Bernard (1952) discuss this issue in depth and agree that the difficult births resulting from pelvic disproportion are more common amongst women below 159 cm tall (Bernard 1952, 8). The results described in table 128 (above) agree with the findings of Bernard, who noted that the superior anteroposterior diameter (true conjugate) was related to height (ibid).

The relationship between lacro-sacral angle and stature suggests that a decrease in angle (the sacral curve therefore increasing), is associated with an increase in height. The significance of this result is unclear. However, it is considered that a more curved sacrum is usually found in males (Bass 1971, 89), perhaps it actually relates to stature, not sex. This relationship requires examination in the male sample.

The dimensions described above, lacro-sacral angle excepted, are all positively associated with an increase in stature and confirm that taller women usually have obstetrically efficient pelves.

7.10 Age and Pelvic Dimensions.

The work of Abitbol (1988, 58) suggests that the location of the ischial spines within the pelvis changes during childhood as a result of the backward movement of the sacrum. That during adolescence the spines turn medially eventually becoming visible on antero-posterior roentgenograms of the pelvis. In response to Abitbol's findings it was decided to examine the possibility that bispinous diameter might change in association with age in the younger females in the Christ Church sample. In fact they do not. However, other pelvic dimensions were also correlated with age and those described below in table 129 proved to be significantly associated.

Table 129. Pelvic dimensions and age at death.

Variant	N	r	P
Transverse diameter	81	0.384	<.01
Greatest pelvic diameter	64	0.294	<.05
Inlet circumference	50	0.310	<.05

Interestingly, age at death does not appear to be significantly associated with stature estimation ($r = 0.184$, $n = 112$). This is surprising in view of the relationship between the measurements mentioned in table 129 and their association with stature, see table 128 above.

The significant positive correlations between transverse diameter, greatest pelvic diameter and inlet circumference with age at death are particularly interesting. These three measurements are good indicators of the obstetric efficiency of the female pelvis and of overall body size. Their positive association with age at death suggests the preferential survival of those women who bear children without the complications of pelvic disproportion and of larger women. That stature is not significantly associated with age at death suggests that obstetric efficiency, rather than overall body size, is the important consideration.

Chapter 8 Results 4: The Male Pelvis.

8.1 The Male Pelvis and "Scars of Parturition".

Although this thesis particularly seeks to examine the relationship between the obstetric histories of females and the preauricular sulcus, sacral scarring, the pubic tubercle and pubic pitting, the adult males in the named sample, N = 82, were also examined for the frequency of these features. The frequency distribution of the preauricular sulci in the males from the Christ Church named sample is presented below in table 130.

Table 130. The frequency of the preauricular sulcus in males.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0 Absent	25	40.9	22	36.7
1 Present	36	59.1	38	63.3
	N = 61		N = 60	

The distribution of sulcus type in the male sample is described below in table 131.

Preauricular sulcus type.

Key: 0 = absent, 1 = groove of pregnancy, 2 = groove of ligament, 3 = third type, see chapter 4, 4 = male type

Table 131. Preauricular sulcus types and the male sample.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	25	41.0	22	36.7
1	1	1.6	1	1.7
2	1	1.6	1	1.7
3	1	1.6	0	0.0
4	33	54.0	36	60.0
	N = 61		N = 60	

Preauricular severity.

The severity of the sulcus in males is presented below in table 132. Key: 0 to 4 indicates grades of increasing severity.

Table 132. Preauricular sulcus severity in males.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	25	41.7	22	36.7
1	23	38.3	28	46.7
2	11	18.3	10	16.7
3	1	1.7	0	0.0
4	0	0.0	0	0.0
	N = 60		N = 60	

8.2 The Sexual Dimorphism of the Preauricular Sulcus.

That the preauricular sulcus is present more frequently on female rather than male innominates was first stated by Derry (1909, 271), commenting upon the earlier work of Zaaijer (1866) and Lohr (1894). Maclaughlin (1987) found that the variation in occurrence of the sulcus in males and females was statistically significant. The comparative figures for the male and female samples from Christ Church are described below in table 133 with those from the 3 samples observed by Maclaughlin. The figures from Christ Church are from the left innominate, the remaining data was collected from the right innominate.

Table 133. Male and female occurrence of the preauricular sulcus (all types).

Sample	Females%	N	Males%
Christ Church	86.7	220	59.1
St. Brides	23.1	141	0.0
Dutch	53.7	141	1.3
Scottish	64.0	53	7.1

The wide discrepancy between the Christ Church data and that collected by Maclaughlin, reflect the differing criteria used for scoring the occurrence of a sulcus. At Christ Church, as described in chapter 4, both resorption and the deposition of cortical bone in association with a pyriformis tubercle, were considered as criteria for establishing whether a sulcus was present, a method also advocated by Novotny, Prague (personal communication). Maclaughlin however, used only cortical resorption as her criterion. Another factor which might be affecting the results as shown above is the differing levels of experience of the observers, in scoring and classifying the cortical variations described in chapter 4. A forthcoming paper by Novotny (Human Evolution 1989) attempts to classify the differences he has observed in the typology of "the preauricular sulcus".

Interestingly, the size of the preauricular sulcus is sexually dimorphic in the male and female samples. For details see table 134 below. The female measurements precede those from the male sample.

Table 134. T test results on preauricular sulcus size in the Christ Church male and female samples.

Variant	N	Mean	T	P
Preauricular sulcus - width (left)	101 14	7.2 4.7	4.53	<.00001
Preauricular sulcus - width (right)	100 16	6.8 3.7	7.07	<.00001
Preauricular sulcus - length (left)	98 13	26.3 15.4	6.90	<.00001
Preauricular sulcus - length (right)	99 16	24.1 14.3	8.64	<.00001

This result concurs with that of Dunlap (1981, 40) and of Derry (1909, 273). This is an observation that has, in the later 20th century, aroused little interest; the accent being on the sexual dimorphism of the type and the frequency of the preauricular sulcus.

The results from Christ Church are described below in table 135 where they are compared with those of Derry (1909, 273) and Dunlap (1981, 40).

Table 135. Comparison of the size of the Christ Church preauricular sulci with Dunlap's (1981) and Derry's (1909).

Sample	N	Mean Width	Mean Length	Greatest Width	Greatest Length
Christ Church females	139	7.2	26.3	15.0	44.0
Christ Church males	21	4.7	15.4	10.0	23.0
Dunlap's females	67	9.2	31.1	17.6	51.7
Dunlap's males	26	2.9	15.3	7.2	33.7
Derry's females	239	8.0	29.5	13.5	35.0
Derry's males	167			5.0	22.0

There is inter-sample variation evident in these results which might be real or might reflect that it is not always easy to identify the margins of the sulcus. Nevertheless, the results support the t-test result from Christ Church that the width and length of the preauricular sulcus is sexually dimorphic.

The sexual dimorphism in the frequencies of sulcus types are illustrated below in table 136, the data is from the left innominate in both cases. Key: 0 = absent, 1 = groove of pregnancy, 2 = groove of ligament, 3 = third type, see chapter 4, 4 = male type.

Table 136. Frequency of sulcus types in males and females.

	Males		Females	
Score	Frequency	%	Frequency	%
0	25	41.0	15	13.3
1	1	1.6	46	40.1
2	1	1.6	23	20.4
3	1	1.6	27	23.9
4	33	54.0	2	1.8
	N = 61		N =113	

These results illustrate that in the Christ Church sample, the distribution of the 4 sulcus types is clearly dimorphic. Fewer females than males have no sulcus. Types 1, 2 and 3 are rarely found in males and type 4 is rarely seen in females.

Table 137, below, illustrates the distribution of sulci of differing degrees of severity in males and in females. In both samples the data is from the left innominate. Key: 0 to 4 indicates grades of increasing severity.

Table 137. Sulcus severity in males and females.

	Males		Females	
Score	Frequency	%	Frequency	%
0	25	41.7	15	13.3
1	23	38.3	54	47.8
2	11	18.3	31	27.4
3	1	1.7	12	10.6
4	0	0.0	1	0.9
	N = 60		N =113	

Again a far higher percentage of males have no sulcus than females. Within grades 1 and 2 there is not a significant difference between the sexes, although the more severe grades 3 and 4 are present more frequently in females than in males.

8.3 The Pubic Tubercle and the Male Pelvis.

Extension of the Pubic tubercle.

The results obtained from the male sample are presented below in table 138. Key: 0 to 3 = absent to pronounced. It was observed that the male tubercle is generally broader, appearing more robust than the female tubercle. However, generally the range of extension appears similar in the two samples.

Table 138. The pubic tubercle in males.

	Left innominate		Right innominate	
Score	Frequency	%	Frequency	%
0	3	9.7	2	7.4
1	6	19.3	5	18.5
2	15	48.4	14	51.8
3	7	23.3	6	22.2
	N = 31		N = 27	

The distribution of the degree of extension of the pubic tubercle in males and females is described below in table 139. The data is taken from the left innominates.

Table 139. The distribution of the pubic tubercle in males and females.

	Males		Females	
Score	Frequency	%	Frequency	%
0	3	9.7	14	29.8
1	6	19.3	13	27.6
2	15	48.4	14	29.8
3	7	23.3	6	12.9
	N = 31		N = 47	

These results suggest that in the Christ Church sample, the presence of an extended tubercle, particularly grades 2 and 3 is greater in males than is females. There is a higher incidence of grades 0 and 1 in the female sample.

8.4 Sacral Scarring and Pubic Pitting in the Male Sample.

Both sacral scarring (n = 63) and pubic pitting (n

= 51) were absent in this sample. Both are present on the female sample, although sacral scarring is uncommon. In the Christ Church sample, both pubic pitting and sacral scarring are sexually dimorphic.

Pubic pitting on the male innominate is unusual. Maclaughlin (1987) noted its occurrence in only one of the 3 samples she observed. In her Scottish sample pubic pitting occurred in 3.6% of males and 25% of females.

8.5 Descriptive Analysis of the Male Pelvis (including age and stature).

After the evaluation of the preauricular sulcus, pubic pitting, the pubic tubercle and sacral scarring in relation to pelvimetry in females, it was decided to measure a sample of male pelves. This was to establish if those dimensions which proved to relate to female scarring were also determining the distribution and size of pitting and sulci in males. It was decided to examine only those pelves which were complete and undamaged, a sample of 21. The description of the male sample is illustrated below in tables 140, 141, 142 and 143.

Table 140. Age at death.

N = 21, Mean = 54.0 years, Median = 58.0, STDev = 17.1, SEMean = 3.7, Min = 22.0, Max = 91.0, Q1 = 37.0, Q3 = 65.0.

Table 141. Descriptive analysis of the male pelvis.

	N	Mean	STDev.	SEMean.	Min.	Max.
Preauricular sulcus width mms.						
Left innominate:	14	4.7	1.8	0.5	3.0	10.0
Right innominate:	16	3.7	1.4	0.3	2.0	7.0
Preauricular sulcus length.						
Left innominate:	13	15.4	5.0	1.4	8.0	23.0
Right innominate:	16	16.3	3.4	0.9	10.0	21.0
Sacral length:	16	105.8	14.2	3.5	80.0	138.0
Sacral width superior:	21	104.5	4.4	1.0	92.0	109.0
Transverse diameter:	21	121.1	6.3	1.4	109.0	133.0
Antero-posterior diameter superior:	21	100.7	5.5	1.2	87.0	110.0
Antero-posterior diameter inferior:	16	96.5	6.0	1.5	80.0	107.0
Greatest pelvic diameter:	21	116.9	5.5	1.2	105.0	126.0
Bispinous diameter:	14	86.6	8.5	2.3	74.0	100.0
Inlet circumference:	20	350.9	14.0	3.1	320.0	378.0
Sciatic notch width:						
Left innominate:	18	48.4	4.9	1.2	38.0	59.0
Right innominate:	16	48.1	4.6	1.1	42.0	54.0
Sciatic notch depth:						
Left innominate:	17	35.4	3.7	0.9	26.0	40.0
Right innominate:	15	36.0	3.5	0.9	27.0	41.0

Pelvic shape: N = 21:

Score		Frequency	%
1	Gynecoid	11	52.4
2	Anthropoid	0	0
3	Android	10	47.6
4	Platypelloid	0	0

Table 142. Stature of the Christ Church males:

Formula = 1.31 X (Fem + Fib) + 63.05 (Trotter & Gleser 1952).

N = 311, Mean = 169.3cm , STDev = 6.1, Min = 152.4, Max = 182.8. (courtesy S. Gauthier)

Table 143. Stature of the selected Christ Church males.

(Trotter & Gleser 1952)

N = 21, mean = 168.0cm , STDev = 4.6, SEMean = 1.0, Min = 160.0, Max = 178.0.

Comparison of the selected sample with the total male sample suggests that in terms of stature the selected sample is representative of the majority of the total sample. This is an important result as it indicates that the selected sample are likely to be a representative sub - sample of the males from Christ Church.

8.6 The Sexual Dimorphism of the Pelvis, with Particular Reference to Pelvimetry.

Comparison of the results obtained from those measurements taken on both the male and female samples are presented below. Unpaired t-tests were applied to the male and female samples to compare the sample means and analyse the variance between the two groups. The results are described below in table 144, in each test the female data is described first.

Table 144. T test results on pelvic dimensions in the Christ Church male and female samples.

Variant	N	Mean	T	P
Transverse diameter	82	128.5	4.48	<.00001
	21	121.1		
Antero-posterior	67	105.3	2.66	<.01
diameter superior	21	100.7		
Antero-posterior	53	113.0	7.67	<.00001
diameter inferior	16	96.5		
Greatest pelvic	65	125.6	5.09	<.00001
- diameter	21	116.9		
Bispinous diameter	70	105.4	7.42	<.00001
	14	86.6		
Inlet circumference	61	380.3	6.70	<.00001
	20	350.9		
Sciatic notch width	101	57.0	6.32	<.00001
(left)	18	48.4		
Sciatic notch width	98	56.8	6.53	<.00001
(right)	16	48.1		
Sciatic notch depth	101	34.0	-1.49	<.15
(left)	17	35.4		N.S.
Sciatic notch depth	97	34.0	-2.11	<.049
(right)	15	36.0		
Sacral length	64	101.0	-1.25	<.22
	16	105.8		N.S.
Sacral width superior	96	108.5	3.38	<.0016
	21	104.5		

Analysis of variance of those pelvic dimensions described above in the male and female samples from Christ Church illustrate that the pelvis is sexually dimorphic, metrically. Only sciatic notch depth and sacral length are not significant at P<.01 and the antero-posterior diameter superior is the only significant result to have a higher probability level than P<.00001. These results are not surprising as the measurements discussed all relate to the size of the pelvic inlet which is of obstetric importance. As would be expected, the female pelvis is significantly larger in this respect than the male and is consequently better suited to child bearing.

8.7 The Preauricular Sulcus in Males; its Association with Pelvimetry.

Appropriate statistical tests were used to examine the relationship between those pelvic dimensions described above in association with preauricular sulcus type, severity, width and length, and the extension of the pubic tubercle. In no instance was the result statistically significant for both the right and left innominates. Several variants produced results which were significant on either the left or right innominate. The results are presented below in Table 145.

Table 145. The preauricular sulcus in males and metrics.

Pelvic shape and the absence or presence of a preauricular sulcus:	Test result	DF	N	P
Left innominate:	$X^2 = 4.677$	1	21	<.05
Right innominate:	$X^2 = 2.007$	1	21	N.S.<.157
Preauricular sulcus type and transverse diameter:				
Left innominate:	F = 4.30	3,17	21	<.05
Right innominate:	F = 1.06	2,18	21	N.S.
Preauricular sulcus type and inlet circumference:				
Left innominate:	F = 4.99	3,16	20	<.05
Right innominate:	F = 1.40	2,17	20	N.S.
Preauricular sulcus width and stature:				
Left innominate:	r = -0.040		21	N.S.
Right innominate:	r = -0.494		21	<.05
Preauricular sulcus length and stature:				
Left innominate:	r = -0.177		21	N.S.
Right innominate:	r = -0.531		21	<.05

The significant result obtained on the absence or presence of a sulcus in association with pelvic shape reflects the tendency for the gynecoid pelvis to have more cases of no sulcus and fewer cases of a sulcus than would be expected if they were independent variables. The opposite trend is evident in the android pelvis. However, this result is not significant for both innominates, it is interesting and requires further investigation using a larger sample.

The relationship between sulcus type and the transverse diameter is rather confused. The result from the right innominate shows no real difference in respect of measurement and type, that from the left has similar diameters for types 0 and 4. Details are presented below in table 146, it seems probable that they are of little importance to this project.

Table 146. Preauricular sulcus type in males and the transverse diameter.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	n
0	120.6	4.7	5	123.4	6.0	7
1			0			0
2	126.5	3.5	2	125.0		1
3	131.5	2.1	2			0
4	118.7	5.6	12	119.5	6.5	13

The significant result from analysis of variance of inlet circumference and sulcus type is based on the reduced circumference in the group with type 4 sulci, those with larger circumferences and different or no sulci are in the minority. The results are presented in table 147. Another interesting result that requires further investigation in a larger sample.

Table 147. Preauricular sulcus type in males and inlet circumference.

	Left			Right		
Score	Mean	STDev	N	Mean	STDev	N
0	354.8	10.1	5	355.8	10.1	6
1			0			0
2	366.5	4.9	2	366.0		1
3	378.0		1			0
4	344.4	11.6	12	347.5	15.0	13

The results obtained by correlating preauricular sulcus width and length with stature are very different on each innominate. The inconsistent results suggest that these results are not important to this project.

Unlike the female pelvis, where the preauricular sulcus, particularly in terms of its width and length, appears to be significantly associated with pelvimetry, the results of statistical analysis on the male sulcus and pelvimetry produces no significant results, although that from pelvic shape and the inlet circumference are interesting. It is possible that the statistical tests failed to demonstrate any associations because of the small sample sizes. Statistical tests on larger sample sizes are more likely to detect relationships between variables than those applied to small samples (Glantz 1987, 139). It is possible that examination of a larger sample would produce a more reliable result than that obtained from a sample of 21. However, this project was designed specifically to examine the female pelvis and similar work on the male pelvis remains to be undertaken.

8.8 Stature and pelvic shape in males.

The results of analysis of variance of stature, in association with pelvic shape in the male sample, produced the results presented in table 148 below. ($F=9.09$ DF 1,19)

Table 148. Pelvic shape and stature.

Variant	N	Mean	STDev	P
Gynecoid	11	170.4cm	4.4	<.01
Android	10	165.3	3.3	

Although P<.01 was obtained from analysis of variance of stature with pelvic shape, it must be remembered that the sample sizes are only 11 and 10 respectively for the 2 pelvic shapes present amongst this male sample. Nevertheless, these results are interesting and support the findings of Bernard (1952, 13) that the android (scutiform) pelvis is associated with men of reduced stature and the gynecoid (round) pelvis with taller men (these classifications are independant of pelvic size). Bernard attributes the android pelvis and reduced stature to nutritional stress. It is interesting that the same tendency is not evident in the female sample (see 7.9 for details) from Christ Church, this probably reflects that the male is more responsive to nutritional stress than the female (Goodman et al. 1980).

Chapter 9. Conclusions.

9.1 Summary.

The primary aim of this thesis was to examine areas of cortical resorption and remodelling adjacent to the pelvic articulations in females in relation to their obstetric histories. The reference sample upon which this research was based is an archaeological series from Spitalfields in East London (n = 968) dating from the period 1640 to 1860. The life histories and life styles of the individuals recovered in association with securely contexed coffin plates (n = 387) have been reconstructed from historical data. These data will facilitate comparative studies in terms of culture and environment.

The Christ Church sample were largely of French origin. Their presence in East London was due to their Protestantism, a religion prohibited in France but tolerated in England. The Huguenots, who settled in Spitalfields were silk weavers. Their descendants, who returned to the area for burial, were frequently engaged in the professions. These people were middle class by the standards of the day. They lived in comfort, were largely well fed and were rarely employed in manual labour.

Skeletally, there is very little evidence of nutritional deficiency. The high rate of cribra orbitalia may suggest that they were exposed to the increased pathogens associated with rapid urbanisation and industrialisation. Their skeletons bear witness to their longevity by the high prevelance of age related disease and degenerative changes. The mean age at death of the named females was 56.7 years, 75% were post menopausal at death.

This sample is typical of the period in that they married in their mid to late twenties and bore children until either death or the menopause intervened. The majority of the named females were mothers, 22.4% (n = 94) appear to have been childless. About half of the nulliparas were women who died younger than the normal age of marriage. The mean age at first birth was 27.1 with last births occurring at a mean age of 35.8. The range was from 12 to 47 years. The average number of children per family was 2.7, although the range was from 0 to 15. Three (4.3%) of the females are known to have experienced a twin birth. Five (7.1%) died shortly after childbirth.

Historical reconstruction of obstetric histories is dependent upon registration (in this case baptism) of all births. This method does not detect stillbirths, except in unusual circumstances, nor does it detect miscarriages. As with all documentary methods of determining parity status it is unable to detect any birth which the mother kept secret. However, the fact that the sample under discussion was reputed to be family orientated, that their sobriety and conformity were the subject of satire (see Hogarth's "Noon" 1738); when combined with their religious commitment would suggest that the majority of births took place within marriage and that the majority of infants born were baptised.

No evidence of illegitimacy among the Christ Church sample has been traced. Morality leaves few skeletal markers. However, two cases of syphilitic skeletal involvement are present in the sample (n = 968).

There are no cases of congenital syphilis nor of Reiter's syndrome, which can result from non-specific urethritis. Gonorrhea does not affect the skeleton.

Skeletally, the females from the named sample (n = 138) appear to have obstetrically efficient pelves. There are no rachitic pelves although there are 4 (3.8%) cases where the sacrum has the accentuated curve that can be associated with rickets. Sixty - four (87.7%) had gynecoid pelves and seven (9.6%) android pelves. One female (1.4%) had an anthropoid pelvis and one a platypelloid pelvis.

The frequency distribution of the various changes, previously considered to relate to obstetric events, could vary on the left and right innominates within the same individual. The incidence of preauricular sulci on the left innominate was 86.7% (98/113) and on the right 89.2% (99/111). Resorption on the dorsal aspect of the pubic symphysis was evident in 41.4% (29/70) of cases on the left innominate and 41.3% (31/75) on the right. Extension of the pubic tubercle was pronounced in 12.8% (6/47) of cases on the left innominate and 17.0% (8/47) on the right. The variation evident in these figures also reflects differential survival of the innominates in some cases. Resorption adjacent to the margins of the auricular surfaces of the anterior sacrum were infrequent and often unilateral. Bilateral frequency was 9% (8/89); unilaterally it was 6.7% (6/89).

Preauricular sulcus frequency, typology, severity and size were all examined in relation to obstetric events. These variants proved to be independent of obstetric data. There was a tendency, but not a consistent statistically significant one, for sulcus width and length to be greater in parous than non-parous females.

Both the frequency and the number of pubic pits were assessed in association with obstetric data. They are statistically independent variables. In this sample, the six females with more than one pubic pit had borne children. However, the lack of pits or only one does not imply nulliparity.

Statistical evaluation of the degree of extension of the pubic tubercle, in association with obstetric data, suggests that there is no consistent significant association. Nevertheless, the test results are interesting both when evaluating parity status and the number of births with the extension of the tubercle. In this sample the extended tubercle is associated both with parous females and those experiencing a greater number of births. However, the lack of a tubercle or a very slightly extended tubercle is associated with both parous and non-parous females, and with women having both small and large families.

Resorption on the anterior aspect of the sacrum is completely independent of obstetric data in the Christ Church sample.

Evaluation of "scars of parturition", among only those females known to have had children, illustrates that the complete range of cortical variation in question is found within this group. This result supports those obtained by analysis of the variation evident in both those believed to be nulliparous and the parous females.

Evaluation of cortical variation near the pelvic joints in the Christ Church females, in relation to their obstetric histories, suggests that there is no one feature which can be used to indicate parity status. There is a slight tendency for greater preauricular sulcus width and length to be associated with parous females. However, it is not consistently statistically significant. Furthermore, the evidence suggests that the small percentage of female innominates with two or more pits on the dorsal aspect of the pubic symphysis have borne children, as have the small number with an extended pubic tubercle. The greater the extension of the tubercle, the greater the number of births. However, no particular aspect of these characteristics can be associated with nulliparous females.

Childless women are, in most cultures, in the minority. As such, these are the ones it is sought to identify and to quantify. To be able to identify only a small proportion of those who have borne children is, in real terms, of very little value when seeking to understand either the incidence of motherhood or female fertility in past populations.

The second intent of this thesis was to examine resorption near the articular surfaces as a component part of the female pelvis, with particular emphasis on its obstetric efficiency and capaciousness. This analysis produced surprising results. As stated in chapter 1, it has always been assumed that if parturition scars relate to obstetric events, the smaller pelvis would be more severely scarred than the larger pelvis. That is why extensive measurements were taken as part of this project.

However, in the Christ Church females the opposite seems to be the case. The larger pelvis seems to be associated with larger scars. This result, which suggests that parturition scars are caused by a factor other than childbearing, would appear to enhance the reliability of the findings that parturition scars are in fact independent of obstetric events.

There is, in this sample, a tendency for the presence of a preauricular sulcus to be associated with a larger pubo-sacroiliac diameter, a larger ischial spine to symphysion diameter and a wider sciatic notch. These associations are not statistically significant however.

Concerning preauricular sulcus typology, only the "type 4" sulcus, the least frequent in the female sample, seems to be associated with the size of the pelvis. This sulcus type seems to occur in females with very small pelves. The reduced dimensions which are significantly associated with this sulcus type are the inferior antero-posterior diameter, the bispinous and bi-tuberous diameters. These results are however, based on very small sample sizes.

Sulcus severity is positively associated with larger transverse diameters, larger bispinous diameters and the wider sciatic notch. The results are interesting but not consistently statistically significant. Severity is to a large extent a method of scoring size, although it also considers depth, which could not be quantified. The results obtained by analysis of variance of sulcus width and length produced very interesting results.

Statistically significant, positive associations between sulcus width and the following dimensions are indicated in the Christ Church sample; sciatic notch width, bispinous diameter, inlet circumference, transverse diameter and the width of the anterior sacrum at the level of the inferior limit of the sacroiliac joint. Other dimensions which appear to relate to sulcus width but not consistently are; pubo-sacroiliac diameter, the inferior antero-posterior diameter and the greatest pelvic diameter. Sciatic notch shape also influences the width of the sulcus but not significantly.

Preauricular sulcus length has positive, statistically significant associations with the following variants; pubo-sacroiliac diameter, sciatic notch width, transverse diameter and bispinous diameter. Interesting, but not consistent significant, trends were apparent with; inferior antero-posterior diameter, greatest pelvic diameter, inlet circumference and ischial spine to symphysion diameter. Both sulcus width and sulcus length are positively associated with sciatic notch width, transverse diameter and bispinous diameter.

Examination of the frequency of pubic pitting in association with pelvimetry illustrated a positive statistically significant association with an increased bispinous diameter and a significant association between pitting and pelvic shape. The five android pelves with intact pubes were not pitted, whilst the 51 gynecoid pelves were variable (left innominate). Other variants which appear to influence the distribution of pitting, although not significantly, are; ischial spine to the apex of the sacrum, pubo-sacroiliac diameter, ischial spine to symphysion diameter, sacral width inferior, transverse diameter, the superior and inferior antero-posterior diameters and the greatest pelvic diameter. In all cases the greater the diameter the more likely the pubis will be pitted. The number of pubic pits does not seem to be associated with measured pelvic variables.

Neither the degree of extension of the pubic tubercle or sacral scarring are associated with pelvimetry in this sample.

As a consequence of the positive association between preauricular sulcus frequency, size and pubic pitting with pelvic size, it was decided to examine the possibility of a relationship between scars of parturition and stature estimation. The probability values in all cases were >.05 suggesting that in so far as stature is an indication of overall body size there is no relationship between the two variants. There is, in the Christ Church sample, no association between age at death and parturition scars. Evaluation of cortical variation in relation to pathologies produced no apparent associations except that bilateral sacral scarring occurred, in 5 cases out of 8, on females with degenerative changes to both the vertebrae and the lower limbs.

Evaluation of the preauricular sulcus, pubic pitting, the pubic tubercle and sacral scarring in relation to pelvimetry in males was undertaken as a consequence of the results described above. There were no cases of either pubic pitting or sacral scarring in the male sample (n=82), the incidence of the preauricular sulcus was less than in females, typological distribution varied drastically and in terms of size the female sulcus was significantly wider and longer.

A sample of 21 complete male pelves were examined. Only those dimensions which related to the sulcus in females were measured. None proved to be significantly associated with either sulcus frequency, type, severity, width or length. The reasons for this are difficult to deduce. The probability values (>.05) could be reflecting the fact that it is difficult to obtain significant results in small samples. However, in view of the sexual dimorphism of the size and shape of the pelvis and of the dimorphism apparent in the frequency, typology and size of the sulcus, it could be that the forces which result in resorption and remodelling in the female pelvis are not comparable in the male pelvis. Just what these forces might be remains to be determined. The female pelvis is significantly more capacious than the male pelvis and this probably demands larger ligaments at the areas of articulation. Larger ligaments would result in larger attachment sites, and larger areas would consequently be affected by resorption and remodelling if the joints are traumatised. However, this does not explain the differences in the distribution of the preauricular sulcus, pubic pitting and sacral scarring within the female sample, nor the comparative differences in the morphological typology of the sulcus in the male and female samples.

This thesis concludes that cortical resorption and remodelling adjacent to the areas of articulation of the female pelvis are not responses to obstetric events. They seem to reflect pelvic capaciousness. The larger pelvis being more likely to have a preauricular sulcus or pubic pitting than the smaller pelvis. The larger pelvis is also more likely to have a wider and longer preauricular sulcus than the smaller pelvis. This response to size is not evident in the small sample of males which were examined.

9.2. Suggestions for future research.

In order to understand the significance of "scars of parturition", on both the female and male pelvis, further research needs to be undertaken on the biomechanics and stress factors of the skeletal pelvis in large samples of both male and female material. This material needs to be of known sex. The Christ Church project (see forthcoming report) has illustrated that a small number of skeletons which appear skeletally to be either male or female are actually from robust females or gracile males lacking the expected secondary sex characteristics. Emphasis needs to be placed on both the effects of, and the relationship between, load bearing (body weight) and gait upon pelvic shape and size. The work of Dunlap (1981) and Tague (1988) have provided a start in this area. The findings of this study suggests new lines of direction.

The fact that localised cortical resorption has always been more frequent in the female than in male pelvis led to the hypothesis that they reflected parturition. A factor worth pursuing is that oestrogen affects bone calcification. Both males and post menopausal females produce oestrogen however only premenopausal females produce oestradiol (Chard 1983, 93). This is produced by the ovaries during the menstrual cycle. It is possible that the dimorphic nature of the preauricular sulcus and pubic pitting are in some way associated with oestradiol. The absence of these features in some females complicates the issue, but could reflect varying levels of oestradiol in individual females.

In terms of skeletal parity assessment, future work must take new directions. Microscopic analysis of skeletal tissue is worth pursuing and will be undertaken on the Christ Church sample in the near future. Perhaps the starting point should be those women known to have died shortly after child birth. If they reveal comparatively unusual microscopic features, they could lead to an understanding of the skeletal changes, if indeed there are any, that occur in response to either the mechanics and / or to the endocrinology of pregnancy and parturition. The question of mineral bone loss in parous females of similar ages needs to be evaluated and compared to the bone status of nulliparous females in the same age groups.

Other potentially fruitful areas of investigation are by the study of animals. Pelvic changes are known to occur in, for example, guinea pigs and pocket gophers (Tague 1988, 253) during pregnancy and parturition. However, comparative studies with other primates might be more relevant given the similar characteristics they share with human beings.