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MATERNAL DEATHS IN MEDIEVAL SWEDEN: AN OSTEOLOGICAL AND LIFE TABLE ANALYSIS

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Summary. In a medieval population of Stockholm only three cases of maternal deaths were proved out of 330 burials of adult females, and only in one of the cases was a contracted pelvis found. However, life table analysis indicates a shorter life expectancy of females in the reproductive ages. This suggests a higher maternal mortality in the Middle Ages than in the 18th and 19th centuries in Sweden.

Introduction

In human reproduction, toxaemia, contracted pelvis with obstructed labour, and abruptio placentae are all life-threatening complications of pregnancy and delivery unknown among other mammals (Enhörning, 1984; Putschar, 1976). In addition, the higher susceptibility to infectious disease during pregnancy exposes females to an increased death risk (Waldron, 1983; Larsen & Galask, 1978; Finn *et al.*, 1972). Indeed it was suggested that fatalities for females in the process of reproduction were so high as to threaten the survival of mankind (Grauman, 1974). However, it has been questioned whether maternal mortality was as high in earlier societies as it was in 19th century Europe (Wells, 1975).

Examination of archaic societies suggests a consistent trend of excess female mortality during childhood and adulthood, a trend only reversed in western societies during the last few centuries (Wells, 1975; Hassan, 1981). The shorter life expectancy for adult females could be an indication of high maternal mortality.

The purpose of this study is to examine the extent of fatalities in childbearing in a medieval society, its contribution to female mortality and any secular trends there may be.

Definitions

The Committee on Maternal Mortality of the International Federation of Gynaecologists and Obstetricians defines maternal death as 'the death of any woman dying of any cause while pregnant or within 42 days of termination of pregnancy, irrespective of duration and site of pregnancy'. Deaths within 3 months

or 1 year after delivery are also included in some countries. Maternal deaths are further grouped as direct, indirect and non-obstetric. Direct deaths, such as from toxaemia and haemorrhage, result from complications of pregnancy, delivery or the puerperium. Indirect deaths, such as from heart disease and pneumonia, result from a previously existing disease or an intercurrent disease aggravated during pregnancy. Non-obstetric deaths are defined as accidents and homicide. The World Health Organization only reports direct maternal deaths in their statistics (Rochat, 1981a).

The archaeological definition of a maternal death is more controversial. It is indisputable when a female skeleton is found with a full-term infant in a deformed or obstructed pelvis (Wells, 1975). In addition, maternal death is taken to be the case when a female skeleton of reproductive age is found with a fetal skeleton not only in the pelvis but also between the legs or embraced by the woman (Acsadi & Nemeskeri, 1970). As there was a cultural taboo against burying an undelivered woman in Roman and German societies, according to *Lex Caesarea*, cases with a fetus buried near a woman may also indicate direct obstetrical complications (Trolle, 1982).

However, this archaeological definition of maternal death may be an underestimate. In seven Swedish parishes during the 19th century almost half of all female deaths in the reproductive ages were caused by complications of childbirth, but only 55 out of 176 children were stillborn or died within 1 week of the mother's death (Högberg, 1985). That is, only one-third of the cases of maternal death would be expected to be found buried with a child. Therefore, sex differences in mortality and life expectancy for adults may be a better indicator of reproductive risks than direct excavation findings (Hassan, 1981). However, methodological problems such as difficulties in age determination must be kept in mind when evaluating life expectancy tables.

Material and method

The material comes from the most comprehensive archaeological investigation ever made in Sweden. This was carried out between 1978 and 1980 in Helgeandsholmen (Island of the Holy Ghost), where the Swedish parliament building is now situated. On the island a hospital and an almshouse were found. Nearby there was a cemetery used during the years 1300–1531, from which scattered remains of human bones corresponding to at least 2800–4100 individuals (1339 untouched remains) were unearthed (Dahlbäck, 1982). The cemetery was primarily used by the inhabitants of the almshouse but may also have been used by the general population of the town (Iregren, 1984), a possible source of error in the analysis. A previous study examined skeletons of 20 individuals with regard to disease (Diener, 1984)

In the present analysis, age was calculated from the degree of closure of the cranial sutures, the relief of the os pubis, and the state of the teeth. The age groups used were: infant (under 1 year), child I (0–7 years), child II (5–14 years), juvenile (10–24 years), adult (18–44 years), mature (35–64 years), senile (50–79 years). Sex was determined (Dahlbäck, 1982) and calculations of height were made following the method of Trotter & Gieser (1952) and Werdelin (1985). The age of a

fetus was calculated from the development of the teeth, the skull and limbs (Hunger & Leopold, 1978).

Age-specific mortality was calculated, from which a life table analysis (Siven, 1982) was made. For the calculation, the adults were re-classified into the following categories: adolescent (14–19), adult (20–39), mature (40–59) and senile (60–79). For comparison, the same methods were applied to the material from the agricultural community of Westerhus, 71 male and 83 female adults interred between 1100 and 1350 (Gejvall, 1960).

Individuals buried with a child were further examined as possible maternal deaths, with reference to intercurrent diseases and pelvic measures (Holmberg, 1968; Gebbie, 1981). Bands of increased density of the bones (Harris lines) were looked for as signs of episodes of disease during childhood (Garn *et al.*, 1968). The pelvic bones were also analysed with regard to parity; changes of the symphysis pubis (pars posterior and anterior) occur, a retropubic eminence being interpreted as an effect of parturition rather than of age (Putschar, 1976; Stewart, 1957). Pregnancy changes in the sacro-iliac joints also occur, with cavities and small craters within the sulcus pre-auricularis at the ilium (Houghton, 1974). The most consistent relationship between parity and pelvic change seems to involve the facies posterior of the pubic bone, and thus permits a 3-stage classification of parity (Bergfelder & Hermann, 1980). However, re-examination of the pelves of nulliparous women calls into question the reliability of such parity estimations, and the osteological changes are thought to be more related to age (Suchey *et al.*, 1979; Holt, 1978).

Results

From the age distribution, the population interred at Helgeandsholmen does not seem to be representative of comparable populations at that time, as the proportion of senile individuals is too high. There were difficulties in determining age and sex. Of the skeletal remains of 1072 individuals, there were 129 adults for whom it was impossible to determine sex and age group. The age of 130 skeletons could not be determined more closely than as 'adults'. Furthermore, in the age groups from juvenile onwards the sex of a further 133 individuals could not be ascertained. A total of 209 females and 296 males has thus been used for calculations.

Subsamples of the data were combined in different ways, and six analyses of the sex and age distribution carried out. The mortality rates are given in Table 1. In each analysis the females showed excess mortality in the age group 14–59, but not at the most advanced ages. In view of this consistency, the life table analysis related only to the observed material of Helgeandsholmen. Life expectancy was 3·5 years shorter for females at the age of 15, and 2·25 years shorter at the age of 20. The difference decreases for each succeeding age group and at the age of 45 the females had only slightly shorter life expectancy (Table 2, Fig. 1). To illustrate the extremely high mortality, out of a cohort of 15-year-olds only half of the females survived up to the age of 32, while half of the males survived up to the age of 41 (Fig. 2).

In the Westerhus population the pattern is slightly different. Only in the age group 20–30 years do the females have a shorter life expectancy than males (Table 2, Fig. 1).

Table 1. Mortality by age, investigation of Helgeandsholmen, observed and calculated rates (per 1000)

	Classes							
Age (years)	Females 1	2	3	4	5	6	7	Males 8
14–19	35·78	37·50	55·98	38·90	32·58	34·77	36·84	23·68
20–39	19·71	19·51	21·18	19·71	19·71	21·29	18·08	14·30
40–59	39·64	38·10	39·59	39·64	39·64	39·64	39·64	37·35
60+	356·77	362·46	359·04	356·77	356·77	356·77	356·77	367·60

Classes 1 and 8: only individuals determined by sex and age;
Class 2: 47 females unclassified by age were assigned equally to age intervals 20–39, 40–59, 60+;
Class 3: 133 individuals unclassified by sex were assigned equally to females and males;
Class 4: females in age interval 14–19 are increased by 10%;
Class 5: females in age interval 14–19 are decreased by 10%;
Class 6: females in age interval 20–39 are increased by 10%;
Class 7: females in age interval 20–39 are decreased by 10%.

Table 2. Life expectancy, investigation of Helgeandsholmen and Westerhus

	Helgeandsholmen		Westerhus	
Age (years)	Female	Male	Female	Male
15	26·96	30·50	23·07	21·31
20	26·77	29·01	18·65	19·19
25	24·26	25·95	16·62	16·91
30	21·50	22·67	14·21	14·25
35	18·44	19·14	11·34	11·15
40	15·06	15·35	7·39	7·52
45	12·79	12·96	7·53	7·23
50	10·01	10·07	6·90	6·68
55	6·61	6·58	5·64	5·58
60	2·45	2·35	3·27	3·44
65	2·45	2·35	3·27	3·43
70	2·44	2·35	3·24	3·40

Case studies

Three female adults (nos 176, 419, 900) were each found buried with a fetus (nos 178, 420, 901). In all other cases the buried children were found in graves of their own, buried infants below the age of 1 year numbering 45 (4%).

The fetal ages were: no. 178, 8–9 lunar months; no. 420, 8½–9½ lunar months; no. 901, 7½–8 lunar months. Regarding the fetal positions in relation to the female

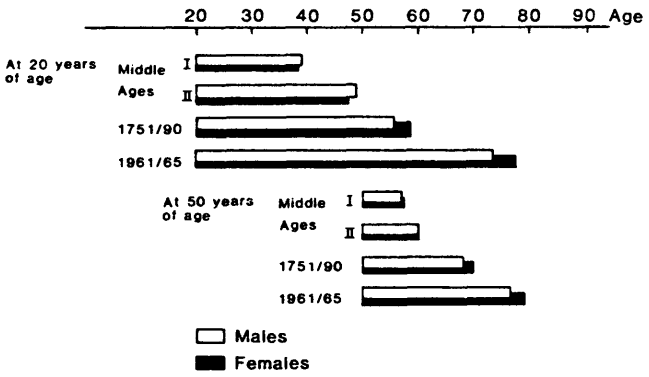

Fig. 1. Expectation of life at 20 and 50 years of age in the Middle Ages, 18th and 20th centuries in Sweden.

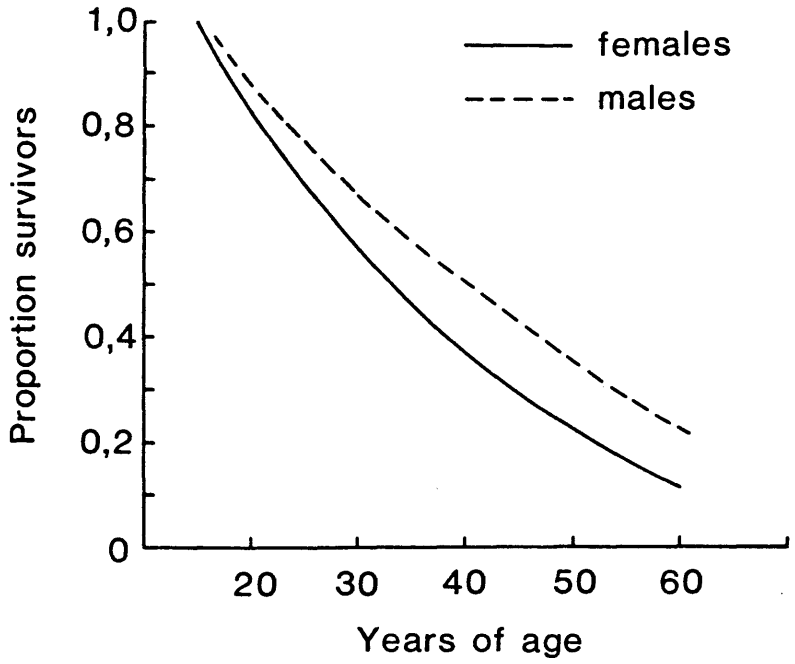

Fig. 2. Proportion of survivors from the age of 15 and by sex in the medieval population of Helgeandsholmen, Sweden (life table analysis).

skeletons, bones of fetus 178 were found at and beside the right knee of the mother (no. 176); it may have been stillborn and the birth may have been preterm. The other two fetuses were still *in utero* or in the birth canal when the females were buried. Fetus no. 420 was clearly inside the pelvic bones of its mother (no. 419), and so was fetus no. 901 (no. 900).

No intercurrent diseases could be detected among the three cases, using osteopathological analysis, including X-ray examination. Harris lines were observed in the femur and tibia of no. 900, and the tibia of no. 419. The pelvic measurements were incomplete in no. 176 because of partly destroyed pelvic bones. The other two had gynecoid pelves, and no. 900 had a contracted pelvic inlet. No other pelvic abnormalities could be detected. Number 176 had clear osteological changes, with pits and small craters in the sulcus pre-auricularis, and also changes in the sacrum consistent with high parity. Number 419 had no osteological changes on either the pars posterior of the pubic bone, or the sacrum. Ulceration was observed in the pars anterior of the pubic bone and the sulcus pre-auricularis of the ilium. The woman may have been primiparous. Number 900 showed no changes on either the pars posterior of the pubic bone, or the sacrum, but there were small changes with ulceration at the pars anterior of the pubic bone and sulcus pre-auricularis. The woman was not of high parity but probably had given birth to some children.

Only in one case (no. 900) could the osteological analysis add information on the cause of death, namely an observed contracted pelvis with a possible obstructed labour.

Discussion

Osteological analysis of suspected maternal deaths should only be the starting point for evaluating the death risk of childbearing in archaic societies. Additionally, sex differentials of mortality in the reproductive ages may indicate a low maternal mortality (Högberg, 1985). Analysis of mortality by age and sex helps to answer the controversial question of whether the risk of childbearing was higher in archaic societies than during later centuries.

Archaeological case studies of maternal deaths are few. Two ancient Egyptian women showed a deformed pelvis and a fetal head in the pelvic cavity (Smith & Jones, 1910). The mummified Queen Makere, from the 21st dynasty (a puerperal death), was buried with a little infant (Dawson & Smith, 1924). An early Anglo-Saxon obstetric death probably caused by obstructed labour and two medieval cases of maternal deaths with pelvic deformation have been described (Hawkes & Wells, 1975; Wells, 1978; Sjovold, Swedborg & Diener, 1974). The pelvic cavity of the last woman was obstructed by multiple exostoses.

When fetal remains are found in the pelvis of the woman it means that the woman died during pregnancy or delivery, even if no skeletal abnormalities are observed. The oldest case found in Scandinavia is from the mesolithic period (4300–4000 BC), but there was no obvious skeletal deformity (Persson & Persson, 1984). A medieval case of a possible 'coffin-birth' was described from Scandinavia (Möller-Christensen, 1958).

Using the broader archaeological definition of maternal deaths, fetal remains close to a female skeleton, twelve out of 531 females may have succumbed (Acsadi & Nemeskeri, 1970). From the early Iron Age in Germany eight cremations of adult females together with one fetus and neonate have been described (Kuhl, 1983). In earlier investigations of cremated bones from burials of the same period in western Sweden, two mothers buried with a fetus were found among 531 burials (Gejvall, 1948, 1954). These archaeological findings of maternal death probably

underestimate the real extent of fatalities in pregnancy and delivery in ancient societies.

Mortality is strongly influenced by environmental and cultural behaviour. Osteological examination suggests that at earlier ages females suffered more often from malnutrition than did males in the early periods of farming (Wells, 1975). Infanticide, so commonly practised in earlier times, mainly affected females (McKeown, 1976), perhaps reflecing the lower status of the women in societies of hunters and gatherers, and in the early societies of farmers and herdsmen. This would result in higher female mortality during childhood, and provide one explanation of the shorter life expectancy of females. However, excess female mortality in the reproductive ages must be caused mainly by very high maternal mortality and even if this is partly explained by malnutrition in childhood, it leaves the adult woman with a contracted pelvis and a high susceptibility to infections.

The excess female mortality disappears at ages above those of reproduction (Table 1). This is further confirmation of the suggestion that complications of childbirth are responsible for the higher mortality in females than in males. This disparity is not seen in national mortality data of 18th century Sweden (Fig. 1), implying that maternal mortality was higher during the Middle Ages. Also from southern Scandinavia the pattern of excess female mortality during the reproductive years has been described for the same period as our study (Boldsen, 1984). The reversal of sex differences in mortality, which in Sweden occurs between the Middle Ages and the 18th century, may well be a later cultural phenomenon in other parts of Europe. During the 17th and 18th centuries in England (Dobbie, 1982), and during the 19th century in Germany (Imhof, 1979) and France (Tubretin, 1980), excess female mortality is reported.

A similar condition is seen in the developing countries of today, where the risks of childbearing are further heightened by poor environmental conditions, malnutrition, excessive work and high morbidity from infections (Buchanan, 1975). The pattern of excess female mortality in the reproductive ages is reported from Bangladesh, which has one of the highest rates of maternal deaths in the world (Rochat, 1981b).

To conclude, the osteological evidence of maternal deaths can, in a few cases, explain the fatal outcome of the childbirth but cannot determine the range of maternal mortality: instead, comparable analyses of mortality by age and sex are more informative. The present data suggest a higher maternal mortality in Sweden during the Middle Ages than during the 18th century.

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