

RETROSPECTIVE STUDIES ON THE TWINNING RATE IN SCANDINAVIA*

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The rates of human multiple maternities in the Nordic countries were studied from continuous series of data. In the Åland and Åboland archipelagos the parish records for births and baptisms since the 1650's were used. Various sources, some unpublished, in the archives of statistics were used for Sweden (since 1749) and Finland (since 1859) as a whole. Until recently, the rates of multizygotic multiple maternities in isolated island populations in the Åland and Åboland archipelagos have been some of the highest known among Whites (15-20‰). Highly significant temporal fluctuations in the twinning rates were noted. In Sweden, the twinning rate during the last part of 18th century was about twice as high as it was in 1966-70. The triplet and quadruplet rates were about three to four times as high as they are nowadays. There has been a secular decline in DZ twinning. This downward trend set in first in the isolated populations. In Sweden, it started in the 1930's, but in Finland, not until the 1960's. The steep downward trend in the twinning rates is shown to set in about one generation after the break-up of isolation. This can be interpreted as evidence that the changes in matrimonial migration patterns have affected the rates of DZ twinning.

In Sweden and Finland, there are population records for the whole nation covering several centuries (Table 1). Tax and census lists have been preserved for 300-400 years. In the 17th century the state church of the Kingdom of Sweden and Finland also began to record persons baptised, married and buried. By the ecclesiastical law of 1686, the parish clergy (Lutheran ministers) had to keep registers of the whole population of the parish divided by household and village.

Regular and completely organized official annual population statistics with fairly detailed standard tables were introduced in 1749, when the so-called *Tabellverket* came into force. For a whole nation these are the oldest continuous statistics in the world. All births, including multiple maternities, were registered in a book of births and baptisms. The tables included separate columns for information on women who had had twins or other multiple maternities. The importance of reporting the multiple maternities was stressed.

Furthermore, the names of members of the households, with dates of births and deaths, were registered in a parish book, which was rewritten every sixth year. Physical and mental defects were often mentioned as well, and twin sibs were noted. Thus, in Sweden and Finland, there are several different types of population registers and these are summarized in the parish book; consequently, cross-checking has been possible. The sources are considered to be of relatively high accuracy and reliability. The organization of the population statistics from the 18th century in Sweden and Finland has been used as a model for many other nations (Sundbärg 1923, Eriksson et al. 1973).

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Table 1. *Official records for population statistics in Sweden and Finland*I. *Tax and census lists*

In the 16th century:	Several tax lists.
From 1630:	Census lists with the names of taxable subjects.
From 1765:	Names of all living persons listed.

II. *Church registers*

In the 17th century:	Beginning of records for baptisms, marriages, and burials.
Ecclesiastical law of 1686:	Regular lists of births, marriages and deaths; parish books of the whole population by household and village (rewritten every sixth year).
From 1736:	Annual reports of persons born and deceased.
1749 <i>Tabellverket</i> :	Continuous statistics for the whole nation; annual reports on the state of the population and on vital statistics, baptisms, burials, etc.; information on women who had twins or other multiple maternities.

Registers kept in each parish

(1) The parish book; (2) Book of births and baptisms; (3) Book of deaths and burials; (4) Book of confirmations; (5) Book of bans and marriages; (6) Book of newcomers; (7) Book of departures; (8) Book of « non-existent », residence unknown.

Note: In 1773 the headings on the forms were changed from « baptisms » and « burials » to « births » and « deaths » (Lundell 1913). Before that, there was a possibility that infants who died before being baptised were only entered under burials. The significance of this source of error cannot be overlooked, for perinatal mortality was high in those times — especially among maternities with multiple fetuses.

Multiple Maternities and Hellin's Law. Fig. 1 shows the rates of multiple maternities in Sweden for a period of 220 years. The scales for twin, triplet and quadruplet maternities are drawn according to Hellin's law, and are in good accord with the actual frequencies of different multiple maternities. However, the quadruplet maternities show a surplus up to the middle of the 19th century. During this century there is a deficiency in the frequencies of both triplet and quadruplet maternities.

Secular Trends in Sweden. The highest rates of multiple maternities occurred during the last three decades of the 18th century. There is no other European country for which such high national values of multiple maternities have been recorded, twin maternities being over 17 per thousand, triplet maternities over 3 per 10,000, and quadruplet maternities almost 7 per million maternities. However, in some areas in Europe, e.g., in Åland, even higher frequencies have been observed. From 1836 to 1855 the twinning rate in Sweden decreased to values of less than 14‰. There was then a slight upward trend. After the 1930's a marked decrease in the twinning rate took place in Sweden. During the past decade the twinning rate has been only about half what it was 200 years earlier. The fall in the triplet and quadruplet maternities is even more accentuated, the frequencies being only about a quarter of what they were centuries ago. The estimated rates of MZ twin pairs remain rather constant.

During the periods with very high rates of multiple maternities the mean maternal age was not particularly high. From the 1860's to the 1930's the mean maternal age decreased in Sweden by over two years before the downward trend in the twinning rate set in.

Age-Specific Twinning Rates. During 1958-1967 the twinning rate in Sweden was highest between the ages of 34 and 40 years (average 15.4‰, Fig. 2). This peak is so low that it cannot account for the high average twinning rate of more than 17‰ that Sweden had during the last part of the 18th century. The marked decrease in the twinning rate in Sweden since the 1930's remains even after standardization according to maternal age in Sweden in 1954-1962 (Eriksson and Fellman 1973, Eriksson et al. 1973). Thus, higher maternal age alone does not explain the higher twinning rate in the past.

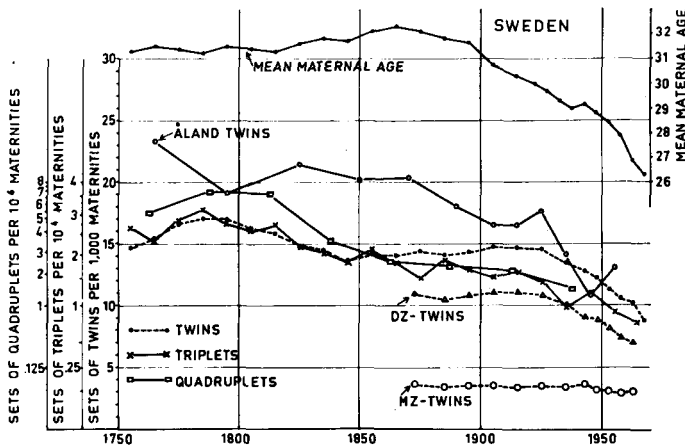


Fig. 1. Rates of multiple maternities in Sweden, 1751-1970, and the twinning rate in Åland, 1750-1959.

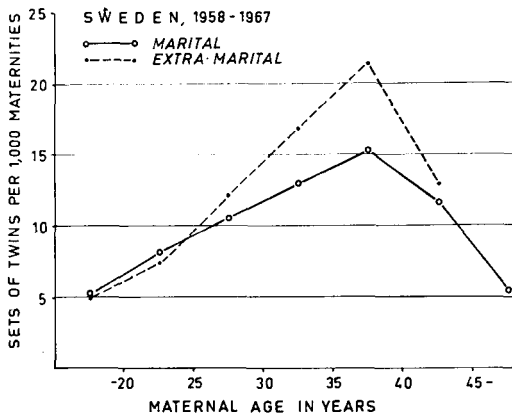


Fig. 2. Age-specific twinning rates for married and unmarried mothers (or marital and extramarital maternities) in Sweden, 1958-1967. Note that the twinning rates in Sweden are considerably lower than in Finland (cf. Fig. 3).

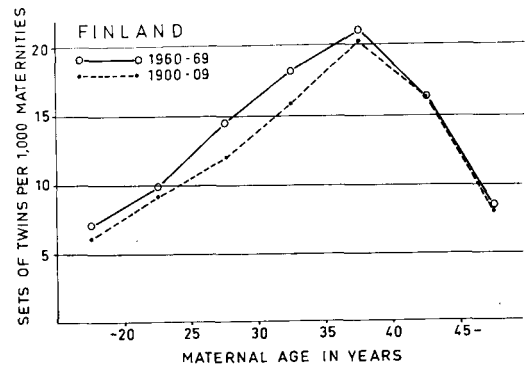


Fig. 3. Age-specific twinning rates in Finland, in 1900-1909 (mean maternal age 31.8) and in 1960-1969 (mean maternal age 27.4).

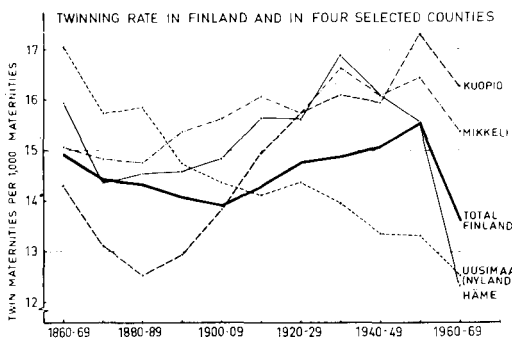


Fig. 4. The twinning rates, 1860-1969, in Finland as a whole, in the adjacent counties of Kuopio, Mikkeli and Häme, and in the southernmost and most urbanized Uusimaa (Nyland).

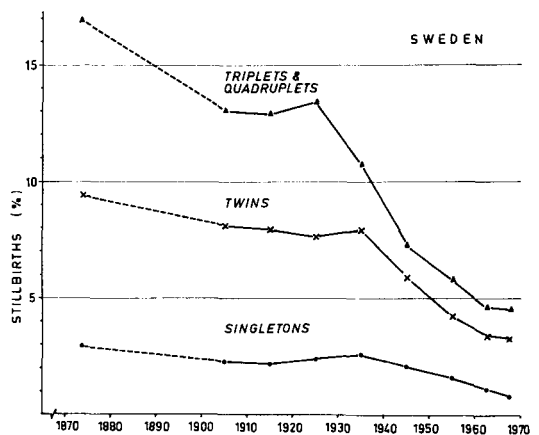


Fig. 5. Comparisons of stillbirth rates in Sweden, 1869-1878 and 1901-1970, among singletons, twins, and triplets and quadruplets.

Also the effect of the parity (birth rank) on the twinning rate seems not to be so strong. Fig. 3 shows that during this century, in all age groups below 40, the age-specific twinning rates in Finland have increased, in spite of the fact that the mean number of children has decreased considerably. These findings are in agreement with the conclusions of some authors who hold that the phenomenon of parity represents more an epiphenomenon of maternal age than an index of some additional factor concerned in gemellogenesis (see Gedda 1961).

Marital Status and Fecundity. Fig. 2 shows that unmarried mothers have considerably higher twinning rates than married mothers, particularly between the ages of 30 and 40. This is so, even though unmarried mothers have a much lower average parity than married mothers. In Sweden (1958-67), in the age group 35-39 years, the twinning rate is a good 40% higher for unmarried than for married mothers. The difference between the twinning rates in marital and extramarital maternities is significant in the age groups 30-34 years ($\chi^2_{(1)} = 7.8, p < 0.01$) and 35-39 years ($\chi^2_{(1)} = 9.9, p < 0.01$).

Studies in the Nordic countries (Eriksson and Fellman 1967*a, b*) and U.S.A. (Allen and Schachter 1970 and 1971, Myrianthopoulos 1970) have shown that the differences in twinning rates between married and unmarried mothers are due solely to differences in the DZ twinning rates. Therefore, it has been suggested that unmarried mothers comprise a selected elite from the standpoint of fecundity. They may be more apt to become pregnant because of having, for example, fewer anovulatory cycles or a higher polyovulation rate. Higher FSH (follicle-stimulating hormone) levels have been found in mothers of twins (Nylander 1974). These findings support the view that a higher production of pituitary gonadotropins, resulting in a higher incidence of multiple ovulation, may be responsible for the high incidence of twinning in the Negro populations in Nigeria. However, multiple maternities are the end result of a period of intrauterine existence when much may happen. Unfortunately, we know so little of interindividual differences in prenatal selection of twins. According to the sparse information available, only a part of the twins conceived survive to the end of pregnancy. This survival percentage seems to be considerably smaller than among singletons (for references, see Eriksson 1964). There is evidence that women who bear twins have more pregnancies than other women (Stocks 1952, Renkonen 1969, Wyshak and White 1969, Eriksson 1973). Twinning rates are higher in the first year of marriage than in the second, in spite of the well-established positive maternal age effect and parity effect in DZ twinning (Pollard 1969, Bulmer 1970).

Parity. The downward trend in the twinning rate might, at least partly, have been caused by decreased mean parity (Scheinfeld and Schachter 1963). There are no statistics in Sweden about the trends in mean parity. We know, however, that mean parity is strongly correlated with total fertility, i.e., the average number of children per woman of child-bearing age, which up to this century has been between 4 and 5.

Not until after the turn of this century was there a marked decrease in Sweden in the mean number of children per woman of child-bearing age. The minimum was reached during the 1930's, and since then the level has remained at about 2.3.

Sweden had a marked decrease in total fertility in the beginning of this century, but the twinning rate, standardized for maternal age, did not begin to decline until the 1930's and has continued to fall even though the total fertility has risen again.

Twinning in Rural and Urban Regions. Stockholm, the capital of Sweden, has had a considerably lower twinning rate than the neighbouring rural areas (Berg 1880, Eriksson 1973). In Sweden as a whole, the twinning rate during this century has been considerably lower in towns than in rural communities. In Finland, too, the twinning rate in rural communities since the turn of the century has been about 1-2% units higher than in the towns. During this century the triplet rate in Finnish towns has been only about two-thirds of the rate in rural areas (Eriksson 1973).

The differences in twinning rates between Finnish rural and urban regions cannot be explained by differences in mean maternal age. In all age groups under 45 years the twinning rate during the period 1921-1940 was significantly higher in rural than in urban districts.

Differences in parity do not seem to give a definite explanation, since in a Finnish series (1953-1964) the age-specific twinning rate increased by only about 1‰ units per every earlier maternity, and somewhat more among unmarried than among married mothers (Eriksson and Fellman 1967a). In some groups, e.g., in unmarried mothers, the effect of parity seems to be slight or masked by other factors. Women in rural isolates seem to be more prone to twinning. It may also be that, owing to greater physical capacity, mothers in the countryside are better fit to carry through pregnancies with multiple fetuses. It seems logical to assume that mothers with a low rate of spontaneous abortions would have a relatively high twinning rate (Eriksson 1964).

Differences in Secular Trends of Twinning. In Finland, a steep decrease in the gross twinning rate did not set in until the 1960's. Of the four counties studied, only the rather highly urbanized county of Uusimaa (Nyland) shows a distinct fall throughout the whole period 1860-1969. In the 1930's the twinning rate in the county of Häme attains its maximum after which a marked decrease is observed, the twinning rate being the lowest in the whole country in the 1960's. In spite of a decrease in parity and mean maternal age, the counties of Kuopio and Mikkeli show marked increases in the twinning rate from the 1880's to the 1950's, when the twinning rates, in these counties were the highest known in Europe. After that, a steep downward trend set in.

Table 2. Mean maternal age, twinning rate, and standardized twinning rate, in four selected Finnish counties and in the whole of Finland, 1960-1969

Region (county)	Mean maternal age (years)	Total twinning rate	Standardized total twinning rate
Uusimaa (Nyland)	26.67	12.54	12.86
Häme	26.99	12.35	12.55
Mikkeli	28.15	15.35	14.87
Kuopio	28.10	16.25	15.80
Finland	27.40	13.64	13.64

Table 2 shows that in the counties of Uusimaa and Häme, which have low twinning rates, the mean maternal age is low. After standardization according to maternal age, with the aid of the age-specific twinning rates for the whole of Finland in 1960-69 and Hill's indirect method, the differences in the twinning rates between the counties remain, although slightly reduced.

According to the age-specific twinning rates in the county of Uusimaa (Nyland) during the decade 1900-1909, the twinning rate for 1960-1969 should have been 12.1, which is in good agreement with the observed 12.54.

The downward trend in this county thus seems to be mainly a consequence of a decrease in mean maternal age. This does not seem to be the case in the county of Kuopio, however. When the total twinning rate for the county of Kuopio was estimated according to the age-specific twinning rate from 1900-1909, the total twinning rate for 1960-1969 should have been only 11.8, but the actual twinning rate observed was 16.25. This is in spite of the fact that the parity has also declined markedly during the last fifty-year period. Hence, there seem to be factors other than maternal age and parity that can increase the twinning rate considerably.

Stillbirths. Fig. 5 shows that the stillbirth rate among singletons has decreased only slightly, but among twins it has decreased markedly, and even more so among triplets and quadruplets. Thus, there seems to be no evidence that the decreasing trends in multiple maternities could be attributed to higher rates of late prenatal selection, as far as the latter can be statistically assessed from the stillbirths.

DISCUSSION AND CONCLUSIONS

With few exceptions (Shipley et al. 1967 in California, U.S.A.) there seems to have been a decline in twinning rates, not only in Scandinavian countries (Eriksson 1962, 1964, 1973; Eriksson and Fellman 1973), but also in the United States (Jeanneret and MacMahon 1962), Scotland (MacGillivray 1970), Hungary (Czeizel and Acsádi 1971), the Netherlands (Hoogendoorn 1973), and Poland (Rola-Janicki 1974). These downward trends in the twinning rate do not seem to be accounted for by changes in maternal age and parity alone.

However, these secular variations in twin maternities are rather slight in comparison with those found in Sweden and in the Åland and Åboland archipelagos (Eriksson et al. 1973). James (1972) likewise showed that in several different populations the DZ twinning rates declined substantially during the 1960's. He speculated that these declines were due to the hormones or pesticides widely used in animal breeding and agriculture. However, the decline in the Åland Islands and in Sweden started long before such substances were in wide use.

The considerably higher incidence of multiple maternities, particularly of DZ twinning, in endogamous populations than in the surrounding populations suggests hereditary tendencies (Bonnieve and Sverdrup 1926, Eriksson 1962 and 1973, Scragg and Walsh 1970, Nylander 1970, Stevenson 1971). Furthermore, women of mixed racial origin have lower DZ twinning rates than would be expected if the factors determining inheritance were additive (Morton et al. 1967, Eriksson 1973). In neighbouring populations and even in the same country, there may be considerable temporal and regional variations in the twinning rate which cannot be explained simply by differences in maternal age and parity. High DZ twinning rates have been noted in unmarried mothers and among mothers in rural regions. In many populations there is a downward trend in the twinning rate about one generation after the break-up of isolates due to increased population size and urbanization. This may be interpreted as evidence that the degree of relationship between the parents of mothers of twins (and not between the parents of twins themselves) is important for the manifestation of DZ twinning.

From longitudinal studies on the population structure of the Åland Islands since the 17th century, there is evidence that the changes in the matrimonial migration patterns (the distances between the original domiciles of the marriage partners) have also had an effect on the twinning rates (Eriksson 1962, 1964, 1973). The high twinning rates during the 18th century in the archipelagos of Åland and Åboland and in Sweden presumably reflect, in part, a high endogamy made possible by the population increase. The drop in twinning rates during the latter half of the 19th century and the accelerated decline after the First World War are also matched by the rapidly decreasing trend of parish and regional endogamy in the Åland Islands (Mielke et al. 1976). The low twinning rates in the urban, highly mixed populations in the towns of Stockholm, Mariehamn and Helsinki, including the county of Uusimaa (Nyland), are also consistent with this hypothesis. The DZ twinning rate is doubtless the result of a highly complex interaction of multiple determinants, both genetic and environmental.

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