Stillbirth Rates in Singletons, Twins and Triplets in Sweden, 1869 to 2001

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The temporal variation in the stillbirth rates (SBR), measured as the number of stillborn per 1000 total births, among singletons, twins and triplets was studied on Swedish birth data for the period 1869 to 2001 and comparisons with data from other populations were made. Among both single and multiple births there were marked, almost monotonously decreasing trends in the stillbirth rates. Among singletons the stillbirth rate decreased from 29.5 per 1000 in the period 1869 to 1878 to 3.4 in the period 1991 to 2001. Among twins the stillbirth rate decreased from 94 per 1000 in 1869 to 1878 to a minimum of 8.2 in 1991 to 2001 and among triplets from 166 per 1000 to a minimum of 19.8. The relative declining pattern in the SBRs was almost the same, being 88% among singletons, 91% among twins and 88% among triplets. In the 1980s and 1990s the definition of the stillbirth rate was changed in many countries, including Finland, but no changes in the definition of stillbirths have been made in Sweden. The effect of the artificial reproduction techniques, including in vitro fertilization, on the rates of multiple maternities is also discussed. It was noted especially that they had a more marked effect on the triplet than on the twinning rate.

The stillbirth rate (SBR) shows great both regional and temporal variations. As a consequence of different definitions of stillbirth, comparisons between different countries are difficult. In some countries, although not in Sweden, a new definition of stillbirth was introduced at the end of the 20th century. Such a change was introduced, for example, in Finland in 1987 and in many other countries (e.g., within the Commonwealth) at approximately the same time. These changes, which vary in different countries, have to be considered when temporal and regional comparisons are made. Furthermore, the SBR is considerable higher among multiple births than singletons.

The main part of the Swedish data was also considered by Fellman and Eriksson (2005a, 2005b). In the former study we considered the period 1869 to 2003, but ignored the SBRs. We considered the variation in the secondary sex ratio among singletons and among twins, the frequency of monozygotic (MZ) and dizygotic (DZ) twin maternities, and how reliable Weinberg's differential rule is. In the latter study we considered the temporal variations in the rates of twin maternities. Especially we analyzed to what extent standardization according to maternal age could eliminate the fluctuations. Our conclusion was that, after standardization, other factors besides maternal age also still influence the twinning rate.

Material and Methods

Our material starts with birth data for the period 1869 to 1878, published by Berg (1880). For this period he presented the total number of singletons, the secondary sex ratio and the percentages of live and stillbirths among them. For multiple maternities, Berg (1980) gave exactly observed numbers of the composition of the twin pairs and the triplet sets with respect to live and stillbirths and to the sex combinations. Similar information published by Statistics Sweden was available for Sweden for the period 1901 to 1967, and the corresponding SBRs could easily be estimated for singleton and multiple births.

Since 1973, Socialstyrelsen in Sweden (the Centre for Epidemiology at the National Board of Health and Welfare) is responsible for the registration of stillbirths, and consequently our statistical analyses for the period 1973 to 2001 are based on their data. However, their published registers are not as informative as Berg's (1980) data or the data submitted by Statistics Sweden for the period 1901 to 1967. The distribution of stillbirths according to the type of maternity (singletons, twins, etc.) was not registered for the period 1973 to 2001, but the Centre for Epidemiology at the National Board of Health and Welfare has, for this study, submitted stillbirth data for all births, and twin and triplet births (Petra Otterblad Olausson, personal communication, 2005), and consequently, the data could be included in this study. The number of stillbirths among singletons was estimated by the authors as the total number of stillborn minus the number of stillborn twins and triplets.

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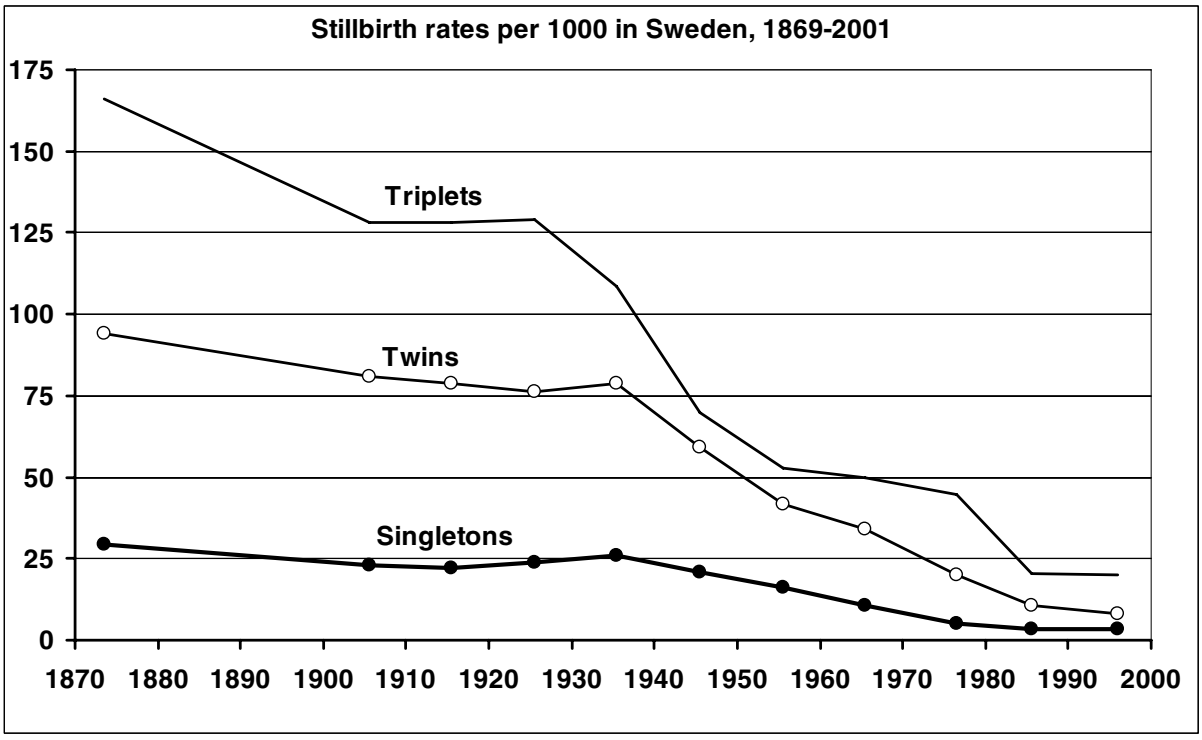

Figure 1

The stillbirth rates (SBRs) per 1000 total births among singletons, twins and triplets.

Note: Marked decreasing trends can be observed. After the 1930s the decreases are accentuated. For the period 1869 to 1878, the data were given by Berg (1880). The data for the period 1901 to 1967 are registered by Statistics Sweden. For the period after 1973 the data concerning multiple births are given by the Centre for Epidemiology at the National Board of Health and Welfare (Sweden), but the SBR among singletons is estimated by the authors (for details, see the text).

These estimates were performed on yearly data, and after that, the results obtained were pooled into the periods 1973 to 1980, 1981 to 1990 and 1991 to 2001.

Results

The temporal trends in the SBRs for singletons, twins and triplets are presented in Figure 1 and detailed data of the secular results in Table 1. Among singletons, the SBR decreased almost monotonically from about 29.5 per 1000 in the period 1869 to 1878 to 3.4 in the period 1991 to 2001. This decrease was accentuated after the 1930s. Among twins there was a more marked decrease in the SBR, starting from 94 per 1000 to a minimum of 8.2, and also showed a similar accentuated decrease after the 1930s. The triplet SBR decreased from about 166 per 1000 in 1869 to 1878 to a minimum of 19.8 in the period 1991 to 2001.

For the last period 1991 to 2001, the SBR had decreased in singletons to only 11.6%, in twins to 8.7% and in triplets to 12.0% of the initial levels in 1869 to 1878. Consequently, the relative declines in the SBRs were almost the same in these groups and are presented in Figure 2. If this assumption holds, then the ratios between the SBRs for singletons, twins and triplets are constant. Using the overall data in Table 1, the ratio between the SBR for twins and for singletons is 3.4 and for triplets and singletons 4.7.

Table 1

Number of Births and Stillbirths and Corresponding Stillbirth Rates According to Type of Birth in Sweden, 1869 to 2001

Period	Singletons			Twins			Triplets		
	Total births	Stillbirths	SBR	Total births	Stillbirths	SBR	Total births	Stillbirths	SBR
1869–1878	1,303,440	38,450	29.5	38,590	3628	94.0	627	104	165.9
1901–1930	3,671,429	84,190	22.9	109,614	8642	78.8	1728	222	128.5
1931–1967	4,006,042	74,824	18.7	95,770	5334	55.7	1239	88	71.0
1973–2001	2,870,826	11,438	4.0	65,704	763	11.6	1814	36	19.8
Total	11,851,737	208,902	17.6	309,678	18,367	59.3	5408	450	83.2

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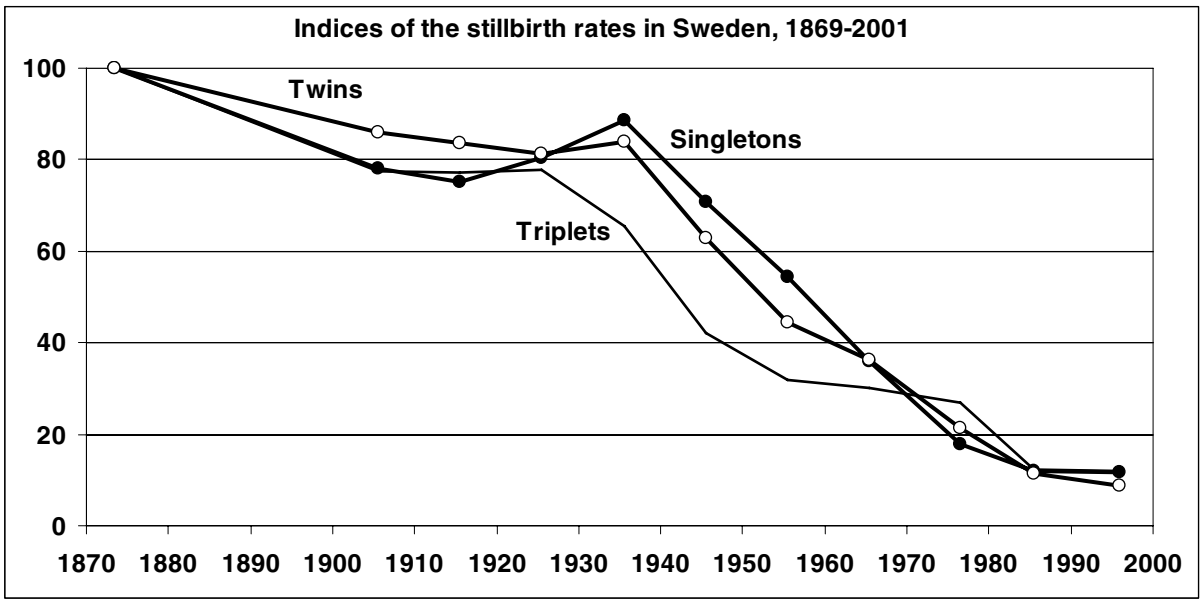

Figure 2

The relative decline in the SBR among singletons, twins and triplets.

Note: The indices for the SBR for the period 1869 to 1878 are 100 for all groups. The relative decreases are almost the same in all groups.

In Figure 3 the SBR among all births in Sweden 1971 to 2004 was compared with the corresponding data for England and Wales 1971 to 2003, and for Finland 1971 to 1994. In 1987 the definition of stillbirth was changed in Finland from at least 28 weeks of gestation to 22. The effect of this change can be observed as a marked upward step in the graph. After that, the decreasing trend in the SBR continues. In England and Wales a similar change in the definition was made in 1992. From October 1, 1992 the *Still-Birth Act 1992* redefined stillbirths to include losses between 24 and 27 weeks gestation. No redefinition was performed in Sweden. Up to the 1980s, Sweden and Finland had among the lowest SBRs in the world

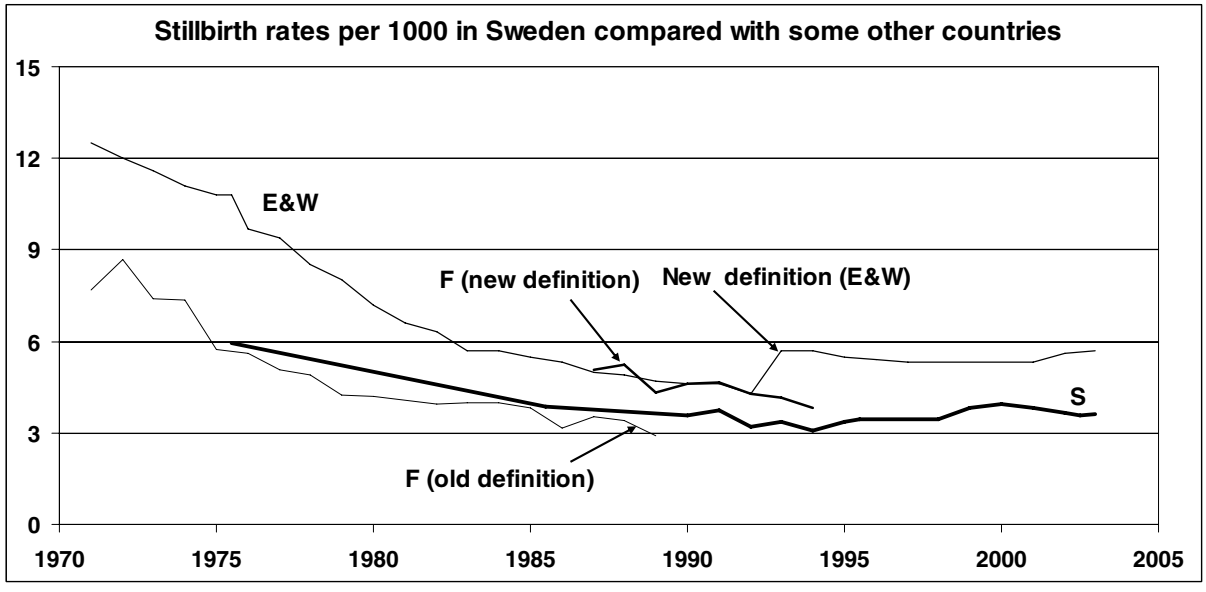

Figure 3

Stillbirth rate (SBR) in Sweden (S), 1971 to 2004, England and Wales (E&W), 1971 to 2003, Finland (F), 1971 to 1994.

Note: In 1987 the definition of stillbirth changed in Finland from at least 28 weeks of gestation to 22 weeks. The effect of this change can be observed as a marked upward step in the graph. After that the decreasing trend in the SBR continues. In England and Wales a similar change in the definition was made in 1992. No redefinition was performed in Sweden. For details, see the text.

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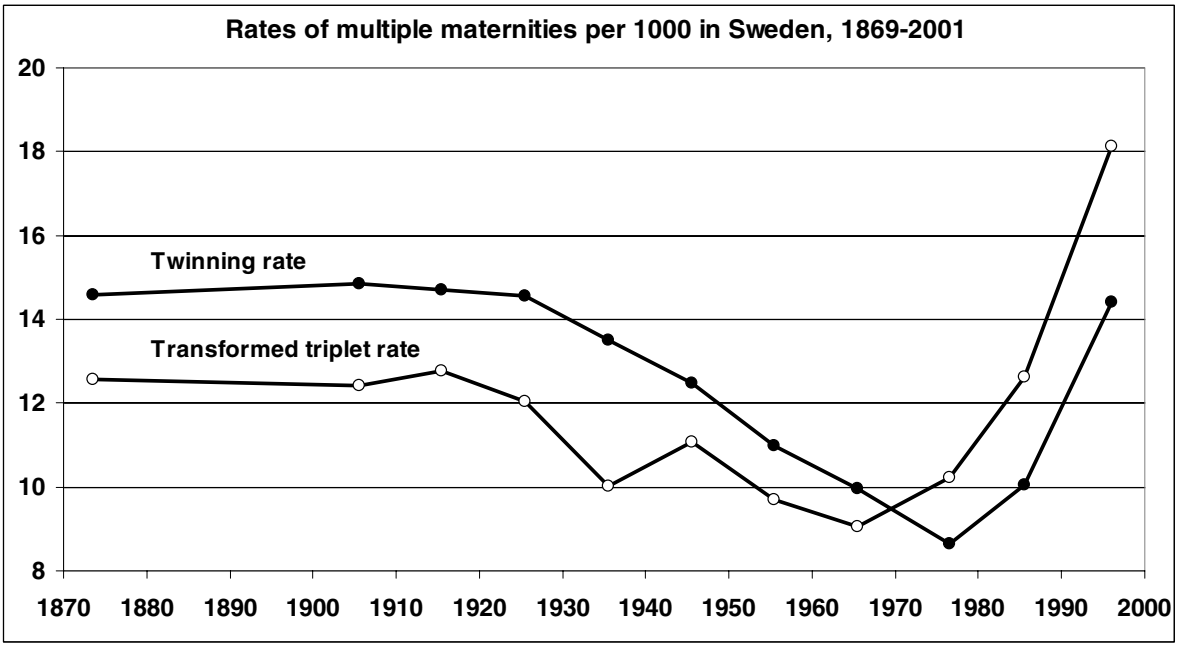

Figure 4

The secular trends in the twinning rate and the transformed triplet rate for Sweden, 1869 to 2001.

Note: In order to improve the comparisons, the triplet rate is transformed according to Hellin's law. In comparison with Hellin's law, before 1970 there is a deficit of triplet maternities and after 1970 there is an accentuated surplus.

for both singletons and multiples. In England and Wales for the period 1998 to 2003, the SBR of triplets was 30.2 per 1000. For twins the corresponding figure is 16.2 and for singletons 5.1. In comparison with the corresponding Swedish data, these figures are rather high (cf. Figure 1 and Table 1).

Discussion

Several countries have kept the common definition of stillbirth with a minimum of 28 weeks of gestation, but the alternative limits (mainly 22 or 24 weeks) chosen vary from country to country. These changes usually cause small cusps in the time series of the SBRs (Figure 3). In addition, we stress that the disagreement concerning the redefinitions causes difficulties when one wants to compare different countries. Furthermore, the time for the reform must be considered when temporal comparisons within a country are studied.

In Finland such a redefinition was performed in 1987. The new definition is that a stillborn is a newborn which is born dead after a pregnancy lasting 22 weeks or longer or with a birthweight of at least 500 g. The data for 1986 and before cover only cases where the pregnancy has lasted 28 weeks or longer (Statistics Finland, 1994, p. 106). The effect of this change can be observed in Figure 3 as a marked upward step of about 1.5 per mille units in the graph and after that the decreasing trend in the SBR continues.

In England and Wales a similar change was performed in 1992. The *Still-Birth Act 1992* redefined stillbirths from October 1, 1992, to also include losses between 24 and 27 weeks gestation. We have noted that, at least for some countries in the Commonwealth (e.g., England and Wales), the officially published data take this change into consideration and the number of stillbirths according to both definitions are presented for some years following the redefinition. The effect of the new SBRs definitions in England and Wales showed only a small temporary jump upwards in the time series (Figure 3). We have obtained information (Statistics Sweden, 2003) supplied by Dr H. Gidebäck that no such change has been made in Sweden.

Clarke (1786; referred by Golding, 1990, p. 68) noted that the risk of stillborn twins was twice that of singletons. Bulmer (1970), considering England and Wales from 1939 to 1957, stated that the SBR is about twice as high in twins, about three times as high in triplets, and four times as high in quadruplets. Golding (1990) noted that as the perinatal death rate in singletons has been reduced, the ratio of multiple to singleton rates has increased considerably, being as much as 5 to 6. In addition, he stated that there is, in the literature, no clear pattern or trend with time in the relationship between twin and singleton death rates.

In recent papers, increases in the twinning rates (TWRs) have been registered (Fellman & Eriksson, 2005b). The rise in the rate of multiple maternities since the mid-1970s is most often attributed to subfertility treatments, particularly in the case of triplets and multiple births of higher order. Ovulation-inducing

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drugs that can cause superovulation, and assisted conception techniques such as in vitro fertilization (IVF) where more than one embryo is transferred, may lead to multiple maternities. The rate of triplet and higher order multiple maternities rose during the 1980s, around the time when IVF treatment began (cf. Figure 4).

Although subfertility treatments have obviously influenced the rates of multiple maternities, the effect of the mother's age should not be overlooked, particularly in DZ twinning (Wood, 1997). However, Eriksson and Fellman (2004) showed that only around 50% of the temporal variation in the TWR can be explained by maternal age.

In Figure 4 we present the secular trends in the TWR and the triplet rate for Sweden, 1869 to 2001. In order to improve the comparisons, the triplet rate has been transformed according to Hellin's law. In comparison with Hellin's law, before 1970 there is a deficit of triplet maternities and after 1970 there is an accentuated surplus. However, triplets and higher order multiple maternities are still rare and represent less than 2% of all multiple maternities.

Twin or higher multiple pregnancies are the most frequent and most serious iatrogenic complication of artificial reproduction techniques (ART; Evers, 2002). Multiple gestations are associated with both emotional and financial burdens for both parents and society and the attendant prematurity is associated with increased mortality and morbidity, for both mothers and fetuses. When fertility specialists succeeded in inducing the conception of three or even more fetuses, they claimed success. Six to 9 months later, the beleaguered intensive care team held a different view (Hall & Keith, 2003). Recently, a radical new way of measuring the success of IVF clinics has been proposed. The goal is to prevent twin and higher multiple gestations and to minimize the number of prematures and stillbirths (Min et al., 2004). They also suggest the establishment of a new definition of a successful outcome in ART as appropriate and that the delivery of a single healthy baby per ART cycle initiated is the most relevant standard of success.

It has been estimated that one embryo transfer is more cost effective than two embryo transfers when all costs associated with multiple gestations are taken into consideration (Martikainen et al., 2001; Wølner-Hanssen & Rydhstroem, 1998).

Recent time trends have shown an increasing number of ART procedures in Sweden as well as an increasing effectiveness reported as delivery rate per procedure. In addition, among induced confinements there is a declining multiple pregnancy rate. In the beginning of the 1990s, triplets or higher-order pregnancies accounted for about 5% of deliveries, whereas in 2000 to 2004 it is close to zero; similarly, the twinning rate has gone down from approximately 30% to 20% over the same period (Nygren, 2002). The Swedish registers of congenital malformation and of cancer constitute the largest follow-up of ART children (Bergh et al., 1999). The main conclusion was that the increased rate of multiple pregnancies, mostly twins, carries with an increased risk of prematurity and consequent increases in perinatal mortality and morbidity. The report concluded that the high rate of multiple pregnancies (including twins) must be reduced or eliminated. Recent results of randomized trials that applied a mild stimulation protocol with strict cancellation criteria showed reasonable pregnancy rates per cycle (13%–34%) and no multiple pregnancies (Cohlen, 2005).

Sweden's birth and death rates in 1985 were among the lowest in the world, with only 11.8 births and 11.3 deaths per 1000 population. Infant mortality was quite low, at 6.8 per 1000 live births, and life expectancy at birth, 1981 to 1985 was very high, 76.6 years for males 82.7 for females. These population statistics reflect the high living standard in Sweden. The gross national product (GNP) per capita in Sweden, which has grown consistently, was in 1985 among the highest in the world, being about USD 12,000.

In general, the stillbirth rate decreases as the quality of care throughout pregnancy improves in a population. Findings in Finland indicate that increased educational levels have the greatest effect on decreases in the SBRs and infant death rates (Notkola & Valkonen, 1989). In Sweden a relatively high proportion of infant mortality was caused by congenital malformations, a cause of death with a probable weak relation to social status (Haglund et al., 1993).

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