Age and parity as determinants of maternal mortality — impact of their shifting distribution among parturients in Sweden from 1781 to 1980

ULF HÖGBERG[1] & STIG WALL[2]

The reduction in maternal mortality in Sweden between 1781 and 1980 is analysed with respect to changes in the distribution of age and parity among parturients over this period. Changes in maternal age contributed to almost 3% of the reduction in mortality over the period 1781–1911 and to 5% between 1911 and 1980. From 1965 to 1980, however, about 50% of the reduction in mortality was caused by a decrease in maternal age. Changes in parity have had the opposite effect. Maternal deaths attributable to the risk factors of age and parity increased from 46% during the 19th century to 80% from 1951 to 1980.

In Sweden, age and parity are the major biological determinants of maternal mortality rate, with the optimum child-bearing age being 20–29 years. The risk of maternal mortality as a function of age can be represented by a J–shaped curve, with the risk of death for pregnant women younger than 20 years or older than 29 years being 2 to 6 times that of women in the optimum age group. Women at the upper age limit of fertility are more likely to develop complications, such as haemorrhage, toxaemia, or prolonged labour, during pregnancy and parturition (*1–3*).

The industrial countries have recently experienced a dramatic decline in maternal mortality rates, coinciding with recent demographic changes — the drastic fall in birth rate and changes in the age and parity distributions of parturients. Previous studies have been inconclusive in their analysis of the effect of these changes on maternal mortality (*4–8*). The present study analyses the effect of changes in age and parity distributions of parturients on mortality rates and describes the role of age and parity as risk factors contributing towards maternal death.

MATERIALS AND METHODS

Since 1749, official statistics have been kept in Sweden on the distribution of births as a function of

[1] Department of Obstetrics and Gynaecology, University Hospital, S-901 85 Umeå, Sweden. Requests for reprints should be sent to this author.

[2] Associate Professor, Department of Social Medicine, University Hospital, Umeå, Sweden.

maternal age (*10–12*). [a] Data on maternal mortality as a function of age are, however, less complete: during 1774–91 at 5-year age intervals,[a] 1911–20 at 10-year age intervals, and 1922–80 at 5-year age intervals (*13*).

For the period 1973–80 the statistics were based on the number of births (*12*), but prior to this the number of confinements was used. This discrepancy is, however, unimportant for the analysis (*14*).

Secular analysis of causes of death is associated with several sources of error. It was not until 1860 that the medical profession became responsible for issuing death certificates in Sweden; before then, the clergy had had the duty of registering the cause of death. The reliability of these statistics has been discussed previously (*15–18*). Indirect maternal deaths may have been included in the official statistics during the 18th and 19th centuries (*19*); however, deaths from abortions and ectopic pregnancies probably were not. Nevertheless, even in modern vital statistics indirect maternal deaths are sometimes erroneously reported as direct maternal deaths (*20*). In the secular analysis described here, no correction has therefore been made for indirect maternal deaths.

The data available in Sweden on the distribution of births and maternal deaths by parity are less complete, and no national figures exist before the 1950s. However, the distribution of births by parity in seven Swedish parishes is available and the data cover 0.27% of all births in Sweden in the 19th

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[a] *Tabellkommissionens Rikstabeller B II a: 1–12.*

century (20). These parishes were not selected as representative samples, but because they provide the only such data available on the situation in Sweden at that time. Nevertheless, the parishes are distributed geographically throughout Sweden and are situated in rural areas, where 90% of the Swedish population lived in the 19th century. Since the distribution of births in the parishes as a function of maternal age does not differ from the national data, we assume that the national distribution of birth by parity follows the pattern in the parishes.

National data on the distribution of births by parity cover 96% of all confinements for the period 1952-60, 75% for 1961-70, and almost 100% for 1973-80 (12, 21, 22).

The distribution of maternal mortality as a function of age was obtained from the maternal death records in Sweden over the period 1951-80. Parity data are available in Sweden for 78% of maternal deaths for the periods 1951-60 and 1961-70, and for 84% for 1971-80. The missing information is assumed to be evenly distributed by age and parity. Since the number of deaths involved is small, the data have been divided into the following subgroups: mothers aged 15-29 and 30-49 years in combination with parity 1, 2-3, or ≥4.

In order to estimate the impact of changes in age distribution on the maternal mortality rate, the direct method of standardization was used for the periods 1781-85 and 1911-15: the mortality rates for 1911-15 were used in combination with the birth distribution for 1781-85. Data for the 20th century were also standardized using the direct method. Adjusted mortality rates were calculated using the observed age-specific mortality rates for a given period with the age distribution of the common standard population, in this case 1911-15. The adjusted rates refer to the number of deaths that would have occurred in the standard population in this period had the mortality rate of a different period applied. In this way the age distribution remains fixed for the whole period of the study, and the use of standardized mortality rates avoids confounding from age. The difference between the observed and adjusted number of deaths, calculated as described above, is attributable to the different age distributions. We define this difference as the number of "prevented" deaths. The proportion of maternal deaths prevented by the changes in age distribution is defined as the ratio of the prevented and adjusted number of deaths. The ratio of the adjusted mortality rate and the mortality rate of the standard population is referred to as the standardized rate ratio.

Maternal deaths attributable to age and parity as risk factors are defined as all deaths in excess of the lowest risk found in the population (parity 2-3 and

age 15-29 years). The etiological fraction of a certain exposure, e.g., parity and age, is expressed as $(RR - 1)/RR$, where RR is the risk relative to a reference category (23).

RESULTS

The age factor from 1781 to 1911

The proportion of parturients aged 40-49 years decreased in Sweden from 11.7% to 8.5% from 1781 to 1911 (Fig. 1). The crude death rate per 100 000 births in Sweden over the period 1911-15 was 241.0. Given the distribution of births as a function of maternal age for the period 1781-85, we calculated the adjusted death rate as 247.3. The ratio of the observed number of deaths (1642) and the adjusted number (1691) is 0.971, i.e., 2.9% of the reduction in mortality from 1781 to 1911 can be attributed to the change in age distribution of the parturients.

The age factor during the 20th century

In the 18th century, 43% of births involved mothers aged 20-29 years. Today this proportion has increased to 65%, and the proportion of parturients
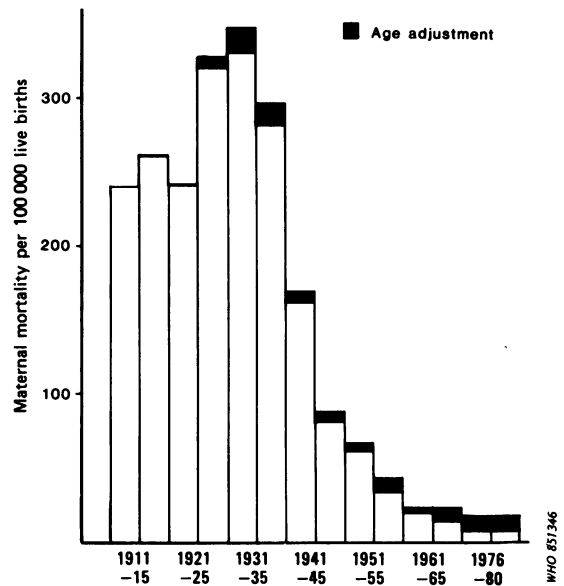

Fig. 1. Distribution of maternal mortality in Sweden at 5-year intervals from 1911 to 1980 (crude death rates and age adjustment after standardization by the direct method).

Table 1. Swedish maternal mortality from 1911 to 1980

| Period | No. of maternal deaths/No. of births[a] | | | | No. of maternal deaths | No. of births/5-year period | Mortality rate/100 000 births | | No. of deaths | No. of deaths "prevented" | Proportion of deaths "prevented" (%) |
	15–19 years	20–29 years	30–39 years	≥40 years			Crude	Adjusted			
1911–15	53/4666	603/62093	731/57891	255/11643	1642	681465	241.0	241.0	1642	0	0
1916–20	83/4569	643/58950	701/49521	204/10865	1631	619525	263.3	264.2	1637	6	0.37
1921–25	64/5000	535/55110	584/44853	189/9541	1372	572520	239.6	241.7	1384	12	0.87
1926–30	85/4991	634/48808	670/36547	184/7531	1573	489385	321.4	327.5	1603	30	1.87
1931–35	60/4419	592/45165	614/32075	187/5713	1453	436860	332.6	347.3	1517	64	4.2
1936–40	50/5353	470/44324	541/34645	152/5288	1213	448050	270.7	169.3	1154	–	–
1941–45	36/6028	362/64593	455/46442	112/6085	965	615740	156.7	169.8	1046	81	7.7
1946–50	20/7761	163/67757	241/45024	62/6136	486	633390	76.7	86.4	547	61	11.2
1951–55	14/8013	125/60620	148/36574	34/4663	321	549350	58.4	66.8	367	46	12.6
1956–60	8/9330	54/60657	87/33386	29/3783	178	535780	33.2	43.9	235	57	24.3
1961–65	7/13914	47/68999	40/29867	10/3183	104	579815	17.9	23.3	135	31	23.0
1966–70	3/11037	33/76386	34/19998	6/1881	76	546510	13.9	24.0	131	55	42.1
1971–75	1/8532	14/77464	15/22925	4/1133	34	550270	6.17	13.2	90	56	62.2
1976–80	1/5144	14/62780	16/27377	3/925	34	481130	7.1	12.7	87	53	60.9
Total					11082				11575	552	4.7

[a] The value shown for the number of births is the average annual value over each 5-year period.

Table 2. Maternal mortality rates per 100 000 births by age and parity over the periods 1800–99, 1951–60, 1961–70, and 1971–80

| Age (years) | Parity | | No. of deaths per 100 000 births | | | |
			1800–99	1951–60	1961–70	1971–80
15–29	1		537	42.3	18.5	5.0
	2–3		311	9.9	3.0	3.1
	≥4		163	24.4	11.5	0.0
	Crude rate		395	27.3	11.5	4.0
	Parity adjusted		395	25.9	10.8	3.5
30–49	1		1160	170.5	84.7	22.5
	2–3		636	52.3	18.2	13.1
	≥4		630	72.8	15.5	14.0
	Crude rate		678	78.8	25.2	14.0
	Parity adjusted		678	75.7	22.2	6.2
	1	Crude rate	694	63.3	25.2	7.2
		Age adjusted	694	74.8	35.3	9.6
	2–3	Crude rate	482	27.7	8.2	6.3
		Age adjusted	482	32.1	11.0	8.3
	≥4	Crude rate	585	61.4	14.9	3.9
		Age adjusted	585	67.9	14.9	4.6
Overall crude rate			574	76.0	16.0	6.6
Age and parity adjusted			574	57.2	18.1	7.0
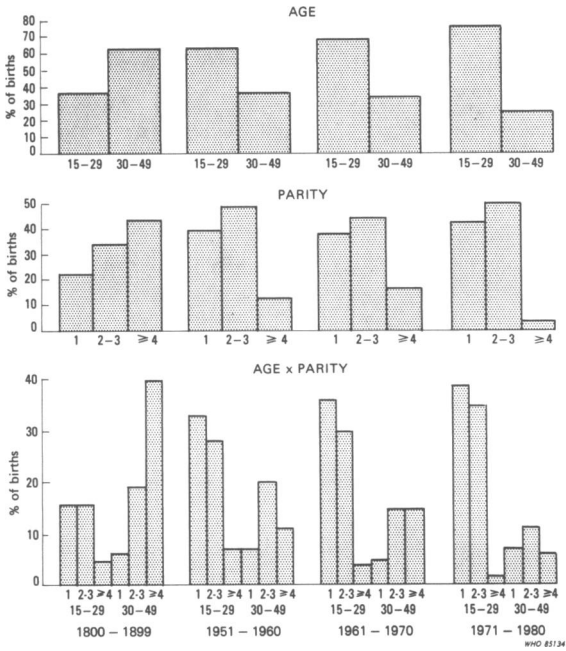
Fig. 2. Distribution of maternal mortality by age (15–29 years, 30–49 years), parity (1, 2–3, ≥4), and age and parity over the periods 1800–99, 1951–60, 1961–70, and 1971–80.

Changes in the maternal age distribution have therefore been a major cause of the decline in maternal mortality since the 1940s in Sweden (Fig.1).

Parity and age factors during the 20th century

The distribution of maternal deaths per 100 000 births as a function of age and parity over the period 1951–80 is shown in Table 2. The decline in maternal mortality over this period is slightly more pronounced for the primiparous and multiparous groups aged 30–49 years (cf. Fig. 3).
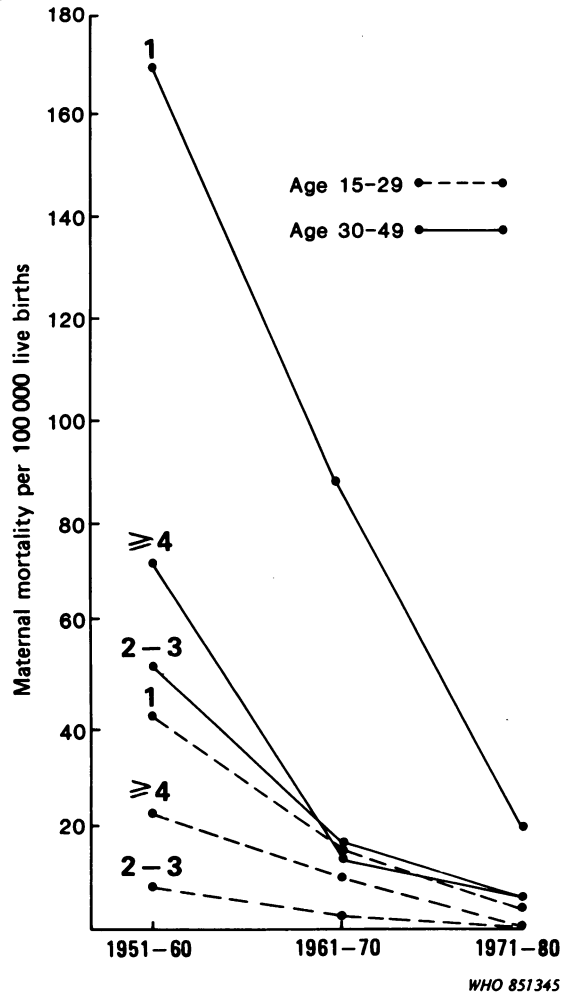
aged ≥40 years has decreased to 1%. The tendency of the majority of births to occur among women of optimum reproductive age is a phenomenon of the last 50 years, being especially marked over the last 20 years. Teen-age pregnancies experienced a transitory increase during the 1950s and 1960s, but in the 1970s, 89% of births occurred among women aged 20–34 years.

To evaluate the effect on maternal mortality of the change in the distribution of births as a function of age during the 20th century, we used the direct method of standardization. Had the age distribution not changed, 11 575 maternal deaths would have been expected over the period 1911–80, in contrast to the 11 081 deaths observed. Thus 552 deaths were "prevented" by a decrease in the average maternal age, i.e., a 4.7% decrease in the number of deaths (Table 1). The relative importance of the age-adjustment factor increased throughout the 20th century. Only 17% of the mortality decline caused by changes in maternal age occurred before the 1940s, but the age factor has been more pronounced since then. The proportion of maternal deaths prevented by the age-adjustment factor was 23% in 1961–65 and 42% in 1966–70, increasing to 67% in 1970–81.

Fig. 3. Trends in maternal mortality in Sweden by age (15–29 years, 30–49 years) and parity (1, 2–3, ≥4) from 1951 to 1980.
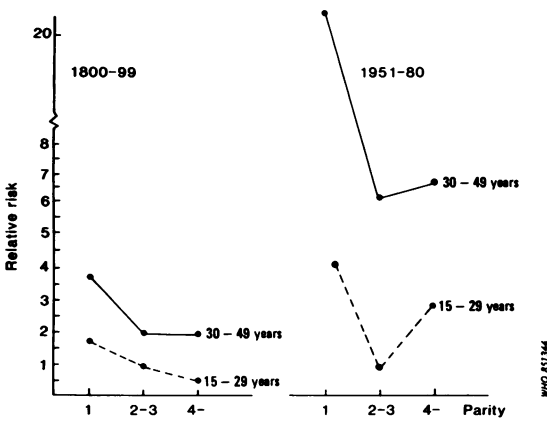
Fig. 4. Comparison of age and parity as risk factors of maternal mortality in Sweden over the periods 1800–99 and 1951–80 (relative risk 1 = age 15–29 years and parity 2–3).

If the maternal age distribution for 1800–99 is taken as the standard population, the fraction of deaths prevented by the age factor is 17.8% for the period 1951–80, 4% less than the value calculated using the age distribution for 1911–15 as the standard population (Table 1).

Important changes in the distribution of births by parity occurred in the 20th century in Sweden. The proportion of primiparous pregnancies increased from 23% in 1899 to about 45% in 1980, but the proportion of pregnancies among women aged ≥30 years remained approximately constant at 5.7%; however, the proportion of multiparous pregnancies (≥4 deliveries) decreased from 43% in 1899 to 5% in 1980 (Fig. 2). The effect of the changes in the distribution of births by parity on maternal mortality is dichotomous: on the one hand there is a tendency towards fewer multiparous pregnancies, but, on the other, there is a tendency towards an increasing proportion of primiparous pregnancies among women aged 15–29 years, with a constant proportion of primaparous pregnancies among women aged 30–49 years. However, the effect of the primiparous pregnancies outweighs that of the decreasing number of multiparous pregnancies (Table 2, Fig. 2 and 3).

The adjusted number of deaths calculated for the period 1951–80 using the parity distribution for 1800–99 was 52 (etiological fraction 7.0%), resulting from a reduction in the proportion of multiparous parturients. The proportion of maternal deaths prevented between 1951 and 1980 by the combined effects of the changes in age and parity distributions was 16.7%, which is almost the same proportion

prevented by changes in age alone (17.8%). The proportion of deaths prevented by the combined effect was especially pronounced in the period 1951–60, during which 66% of the total deaths prevented from 1951 to 1980 occurred. The changes in the age and parity distributions operate interactively since 150 deaths were prevented by the change in the combined distribution, while only 110 were prevented by their separate effects.

Age and parity as risk factors

By identifying the group exposed to the least risk of death during the 19th century (age 15–29 years, parity 2–3), maternal deaths caused by the increasing risk of age and parity can be calculated. In this way the etiological fraction of maternal mortality was 46% in Sweden during the 19th century. This fraction increased to 77% of maternal deaths over the period 1951–80. In other words, the relative importance of age and parity is greater today than in the 19th century. The risk difference between the age groups 15–29 and 30–49 years was 3-fold during the 19th century, but 21-fold during 1951–80 (Fig. 4).

DISCUSSION

Changes in the death-cause registration over the period 1780–1980 in Sweden may have had a bearing on the results reported here. However, any bias resulting from this should have been more pronounced during the 18th and 19th centuries when the impact of the age-factor analysis of the official statistics was lowest. Furthermore, the analysis of the age factor from the seven parishes gave results that were comparable to the official statistics in the 19th century. This indicates that the secular parity changes were also not biased.

Parity

For the assessment of obstetric management and evaluation of medical techniques there is a need for studies of the effect of biological determinants on the outcome of pregnancy (24). It has been suggested that multiparity is associated with a higher level of risk than primiparity. Our results indicate that shifts in the parity distribution of parturients have had a negative influence on the decline of maternal mortality. However, the combined effect produced by changes in maternal age and parity counteracts that of changes in parity alone.

Age

The risk of maternal mortality as a function of age can be represented graphically by a J-shaped curve,

with a higher risk of mortality at the extreme ages of fertility. The trough of the curve is shallower, i.e., less pronounced, in countries with high birth rates. One possible explanation for this may be that in countries with low birth rates the parturients are predominantly in the age group 20–34 years, whereas older women belong to a high-risk group that is susceptible to intercurrent diseases and has less access to health services (26). Maternal mortality is therefore increased by parturients of the socioeconomic high-risk group who are in the upper reproductive age category (27, 28).

Data from Sweden are consistent with a trend towards an increase in the relative mortality risk by age at a time when total mortality in the country is declining. Swedish data also deviate from the classic J-shaped curve, since teenagers benefit more than other age groups from medical services (25). This also confirms earlier suggestions that the effect of increasing age is the most difficult risk factor to minimize (9).

Evaluations of the epidemiological effect on maternal mortality of the shift towards younger parturients is more difficult. In several countries national or regional data have been analysed in an attempt to estimate the impact of birth distributions by age and parity on maternal mortality. For example, in Australia no relationship was found between birth rate and maternal mortality in the early part of the 20th century (5). However, in the USA changes in the age and parity distribution have had an influence on maternal mortality over the period 1919–69 (6). In Scotland changes in maternal age and parity over the period 1939–46 had no effect on maternal mortality (8). Finally, in the Netherlands, 7% of the total decline in maternal mortality from 1950 to 1965 can be attributed to a shift towards younger mothers (7).

Our results show that 27% of the reduction in maternal mortality rate over the period 1951–80 in Sweden can be attributed to changes in the age distribution of the parturients. These results are comparable to those obtained from studies on infant and perinatal mortality, which indicate that 25–50% of the reduction in mortality is caused by a shift towards younger mothers and fewer births per mother (27, 28). However, in Sweden only 9% of the reduction in perinatal mortality during 1953–75 can be attributed to demographic influences (14).

In conclusion, our results indicate that before the 20th century changes in maternal age played only a small part in reducing maternal mortality, but that since the 1930s the effect of maternal age has become increasingly significant: over the last 15 years as much as 50% of the reduction in maternal mortality in Sweden can be attributed to this factor. In contrast, changes in the parity distribution have had the opposite effect; however, the combined effect of maternal age and parity counteracts that of parity alone.

ACKNOWLEDGEMENTS

RÉSUMÉ

AGE ET PARITÉ EN TANT QUE FACTEURS DÉTERMINANTS DE LA MORTALITÉ MATERNELLE — IMPACT DE L'ÉVOLUTION DE LEUR DISTRIBUTION CHEZ LES PARTURIENTES EN SUÈDE, DE 1781 À 1980

Entre 1781 et 1980, le taux de mortalité maternelle a baissé de façon spectaculaire en Suède, coïncidant avec une réduction du nombre moyen d'enfants mis au monde par femme, qui est passé de 4,9 à 1,4. L'article analyse l'effet des modifications de la distribution des parturientes par âge et parité sur le taux de mortalité et décrit les tendances séculaires des distributions de l'âge et de la parité en tant que facteurs de risque contribuant aux décès liés à la maternité.

On ne dispose pas de données sur les décès maternels en Suède en fonction de l'âge et de la parité pour l'ensemble de la période d'étude. Par exemple, tous les décès maternels ont été enregistrés entre 1951 et 1980, mais on ne dispose que de données partielles sur le nombre total de naissances au 19ème siècle. On a examiné les éventuels biais pouvant fausser l'analyse des données. L'impact des modifications de la distribution par âge sur le taux de mortalité maternelle a été calculé au moyen de la méthode de standardisation directe, qui a également été utilisée pour examiner l'effet

conjoint de l'âge et de la parité sur ce taux.

De 1781 à 1980, la proportion de parturientes de 35 ans et plus est passée de 32% à 7%. Entre 1781 et 1911, les modifications de la distribution des parturientes par âge pouvaient expliquer presque 3% de la baisse du taux de mortalité, et 5% entre 1911 et 1980. Toutefois, entre 1965 et 1980, environ 50% de la réduction du taux de mortalité maternelle était due à une diminution de l'âge maternel moyen. Au cours des deux siècles de la période d'étude, la proportion des multipares (femmes ayant donné naissance à 4 enfants ou plus) est passée de 43% à 5%, alors que la proportion de primipares s'est élevée de 23% à 45%. Les modifications de la parité au cours de la période d'étude ont eu pour effet d'augmenter le taux de mortalité mais, globalement, les modifications des distributions par âge et selon la parité ont conduit à une réduction de la mortalité maternelle. La proportion des décès maternels attribuables aux facteurs de risque âge et parité est passée de 46% au 19ème siècle à 80% au cours des 30 dernières années.

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