Harsh Social Conditions and Perinatal Survival: An Age-Period-Cohort Analysis of the World War II Occupation of Norway

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ABSTRACT

Objectives. The hypothesis was tested that unfavorable social conditions are associated with poor perinatal survival through direct effects on pregnancy or, more indirectly, through effects on mothers born under such conditions. The occupation of Norway by Nazi Germany was used as a period of social hardship.

Methods. Data from Norwegian vital statistics and the Medical Birth Registry were used to describe perinatal mortality during World War II and also a generation later, among babies born to mothers who had themselves been born during the war. Logistic regression was used to identify a possible cohort effect among mothers born in 1940 through 1944 compared with mothers born before or after that period.

Results. Harsh conditions in Norway during the occupation increased childhood mortality. However, perinatal mortality declined during that period. Likewise, no adverse effect was seen on the survival of babies born to mothers who had themselves been born during the war (odds ratio = 1.00; 95% confidence interval = 0.96, 1.04).

Conclusions. We find no evidence that wartime conditions in Norway impaired perinatal survival, either directly or through an effect on women born during the war. These data underscore how little is known about the ways that social conditions influence perinatal mortality. (*Am J Public Health.* 1994;84:1463–1467)

Introduction

In this century, rates of perinatal mortality have fallen steeply in Norway, as they have in all developed countries. The precise causes of this secular decline are unclear; however, there is general agreement that broad improvements in living conditions, nutrition, and public health have contributed.[1] A similar decline in perinatal mortality took place a century earlier among the European aristocracy, before the era of modern medical care.[2] This supports the hypothesis that social factors make sizable contributions to perinatal survival.[3]

Social conditions may have immediate or delayed influence on perinatal survival. Some factors may act directly, around the time a woman becomes pregnant and gives birth (a period effect). Severe malnutrition is a well-documented example of such an effect.[4,5] Other factors (perhaps including nutrition) may accumulate over the lifetime of the mother (a cohort effect). As a specific type of cohort effect, some authors have hypothesized that a woman's earliest experience as a fetus and young child contributes to her ultimate reproductive success.[6–8] Although all these hypotheses have some plausibility, the usual vital-statistics data offer little basis for preferring one interpretation over another. Without conclusive evidence, the common assumption is that an infant's survival is most strongly affected by conditions prevailing at the time of its fetal development and birth.[9,10]

An historical event may shed light on this issue. In 1940, Norway was invaded and occupied by Nazi Germany. For the next 5 years, the Norwegian population was subjected to severe food shortages and other disruptions. We looked for immediate and delayed effects of those harsh social conditions on perinatal health.

Methods

We drew on two sources of Norwegian perinatal data. One is the published tables of vital statistics, which include annual rates of infant mortality since 1836.[11] We present perinatal and childhood mortality rates for a 50-year period including World War II (1921–1970). Those data are straightforward and require no special analysis.

The second source of data is the Medical Birth Registry of Norway. The Medical Birth Registry comprises all births (including fetal deaths with gestational ages of 16 weeks or more) recorded in Norway since 1967. The annual number of births in the registry has ranged from 50 000 (in 1983) to 69 000 (in 1969), totaling 1.45 million births through 1991. All infant deaths are routinely linked to the birth registry by using the national identification number. The registry includes mother's birth date, from which her birth cohort and age at delivery can be determined.

Mothers with babies in the Medical Birth Registry were themselves born over a range of years that spans World War II. To carry out an analysis of births among

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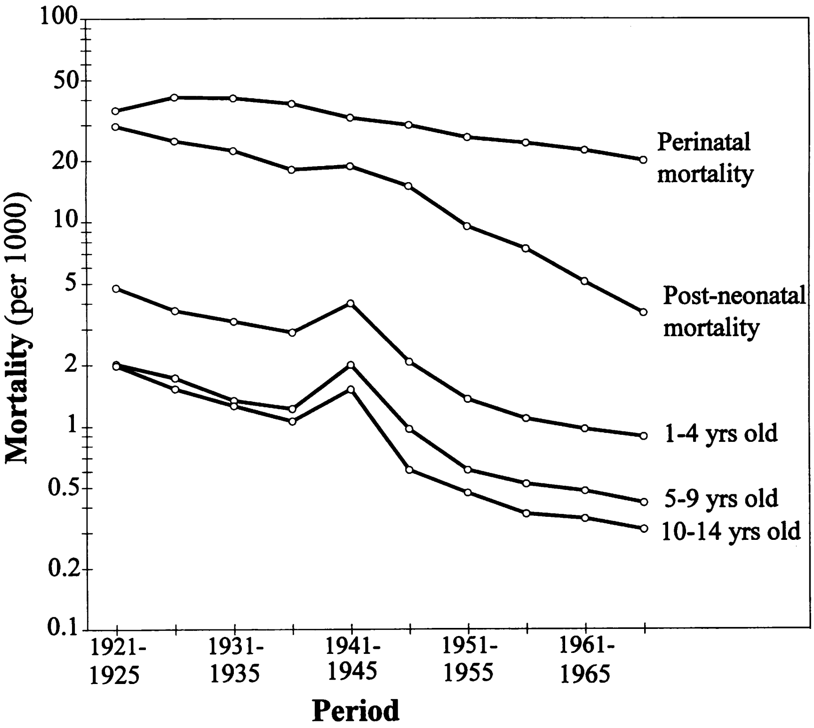


Source. Based on data from Official Statistics of Norway.[11]

FIGURE 1—Perinatal, postneonatal, and childhood mortality, Norway, 1921 through 1970.

the cohort of mothers born during the war, births in the Registry were categorized into 5-year maternal birth cohorts (<1925, 1925–1929, 1930–1934 . . . 1965–1969, 1970–1974, and 1975+), as well as by the year of the baby's birth, also in 5-year time periods (1967–1971, 1972–1976, 1977–1981, 1982–1986, and 1987–1991). Five-year categories for birth periods and maternal birth cohorts define maternal-age groups that correspond approximately—but not precisely—to 5-year categories. This feature of cohort analysis has been clearly described by Case.[12] For example, births in 1967 through 1971 to women born in 1940 through 1944 will be chiefly to women aged 25 through 29 years, but will include some women as young as 23 or as old as 31. Although it is not always discussed explicitly in age-period-cohort analyses, imprecision is inherent in the grouping process. We note this imprecision by designating each maternal-age category according to its central year, for example as "age 27" rather than as "ages 25 through 29."

In the cohort analysis, we first looked separately at stillbirths and at early neonatal deaths (deaths in the first week of life). Results were similar for the two outcomes, and so these two categories of death were combined as perinatal mortality. Rates for mothers younger than 15 or older than 44 years are not included because of instability due to small numbers.

It is a property of age-period-cohort data that when any two of the three variables are fixed, the third is determined. Thus, period and cohort effects are inherently dependent on each other, and no simple solutions are available to separate them.[13] Determination of a possible effect through a specific cohort can be approached as follows. First, we used a logistic regression analysis to model the general effects of birth period and maternal age (as categorical covariates) on perinatal mortality.[14] This simple model provided a reasonable fit to the whole data set ($\chi^2 = 22.8$, 20 *df*, $P = .30$). A single linear (or "drift") term for the period effect reduced the goodness of fit considerably ($\chi^2 = 86.5$, 34 *df*, $P < .01$).[15]

To test for a specific cohort effect in women born during the war, a "dummy" variable was created comprising the five period-age combinations that correspond to the war cohort. This dummy variable includes one data point from each relevant period or, equivalently, one data point from each relevant maternal-age group. The overall effects of age and period were then reestimated for the whole data set excluding the dummy cohort variable. Finally, the possible influence of the war cohort variable (in addition to the effects of age and period) was assessed by likelihood ratio tests.[14] Seen another way, this process estimated a cohort time trend based on all cohorts born before or after World War II, and then measured any deviance of the war cohort from the expected trend. For completeness, the same test was performed separately on each birth cohort.

Results

Mortality rates for Norwegian infants and children from 1921 through 1970 are shown in Figure 1. Mortality is on a log scale to accommodate the wide range of rates. Death rates declined in all categories by at least 50% during the time period. The most striking effects of World War II were among children over 1 year of age. Within each age category of childhood mortality, the death rate increased by at least a third and then fell in the next time period to below prewar levels. These patterns were consistent for both boys and girls and for deaths due to accident as well as illness (data not shown). For postneonatal mortality (deaths between 1 month and 1 year of age), the overall decline was interrupted only slightly during the war years. There is no evidence for any effect of World War II on the decline of perinatal mortality (stillbirths plus deaths in the first week of life).

Table 1 presents data from the Medical Birth Registry on births among mothers who were born from 1920 through 1974, the same general time period as Figure 1. Data are sorted by age of the mother, birth cohort of the mother, and period of the birth. Columns correspond to maternal age, horizontal rows show the mother's birth cohort, and diagonals (lower left to upper right) show the time period during which the index birth occurred. Table 2 presents perinatal death rates (per 1000) within the same groups. Declining mortality rates are apparent with advancing period and cohort. Risk is elevated among the youngest and oldest mothers.

TABLE 1—Distribution of Live Births Plus Stillbirths, by Maternal Age, Cohort of Maternal Birth, and Period of Index Birth, Norway, 1967 through 1991

Period of Index Birth	Maternal Age, y 17	22	27	32	37	42	Maternal Birth Cohort
						9 770	1925–1929
					25 781	4 724	1930–1934
				51 254	16 670	2 977	1935–1939
			98 423	47 155	15 508	3 390	1940–1944
		120 478	106 019	52 697	20 032	4 726	1945–1949
	29 602	97 420	90 432	56 831	26 019		1950–1954
	26 191	78 933	95 039	75 251			1955–1959
1967–1971	17 717	67 487	106 161				1960–1964
1972–1976	13 971	70 006					1965–1969
1977–1981	12 410						1970–1974
1982–1986							
1987–1991							

Note: Horizontal rows show mother's birth cohort, and diagonal rows (lower left in the first column of the table to the last column under "Maternal Age") show the period during which the index birth occurred.

TABLE 2—Perinatal Mortality per 1000 Live Births and Stillbirths within Categories of Maternal Age, Cohort of Maternal Birth, and Period of Index Birth, Norway, 1967 through 1991

Period of Index Birth	Maternal Age, y 17	22	27	32	37	42	Maternal Birth Cohort
						43.2	1925–1929
					30.7	36.2	1930–1934
				23.4	28.7	27.5	1935–1939
			20.6	20.3	21.2	20.6	1940–1944
		21.5	17.9	15.1	17.3	24.8	1945–1949
	25.2	17.9	14.4	14.3	17.8		1950–1954
	22.8	14.6	11.7	13.4			1955–1959
1967–1971	16.9	12.8	11.4				1960–1964
1972–1976	17.8	11.7					1965–1969
1977–1981	14.7						1970–1974
1982–1986							
1987–1991							

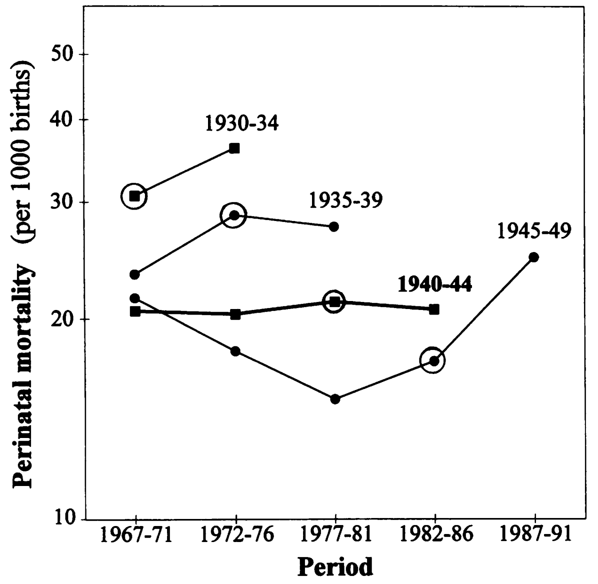
Note: Horizontal rows show mother's birth cohort, and diagonal rows (lower left in the first column of the table to the last column under "Maternal Age") show the period during which the index birth occurred.

The decline in perinatal mortality seen in Figure 1 has continued throughout the subsequent 25 years covered by the registry. Figure 2 shows perinatal mortality among four birth cohorts of women, arranged by the time period in which their pregnancies occurred. Two cohorts were born before World War II, one was born during the war, and the fourth was born immediately after. There is a general pattern of decreasing mortality within each successive cohort, although this pattern is complicated by maternal age. In any given year, women from different birth cohorts also differ in age. As an illustration of this, the perinatal mortality for mothers in the 37-year age group is circled on each cohort curve. Figure 3 shows the cohort curves for all birth cohorts arranged by mother's age.

Our hypothesis was that the babies of women born in 1940 through 1944 would have higher perinatal mortality than that predicted from the cohorts of mothers born before and after the war. We used an analytic approach that tested whether the experience of the war cohort differed from the overall pattern of steadily improving mortality in successive cohorts. After modeling the general effects of age and period, the odds ratio for the war cohort was 1.00 (95% confidence interval = 0.96, 1.04). Thus, we found no evidence that being born during World War II impaired women's ability to bear healthy infants.

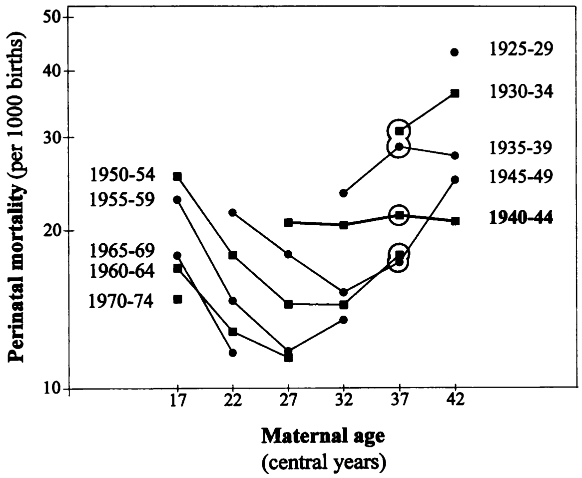
We carried out the same analytic procedure on the other birth cohorts represented in the registry. Odds ratios for these cohorts ranged from 0.99 to 1.02, with tight confidence intervals due to the large number of births within each cohort. The reproductive success of each cohort of mothers is what would be predicted by the observed mortality trends associated with period and age.

Of course, this analytic approach cannot distinguish the relative contributions of period and cohort to perinatal mortality; it shows only that when taken one at a time, no single maternal cohort deviates from the pattern set by all other cohorts in the sample. Another limitation of this test is that it does not consider



Note. Circles indicate mortality for mothers with a central age of 37 years.
Source. Based on data from the Medical Birth Registry of Norway.

FIGURE 2—Cohort-specific perinatal mortality for selected maternal cohorts, by period, Norway, 1967 through 1991.



Source. Based on data from the Medical Birth Registry of Norway.

FIGURE 3—Cohort-specific perinatal mortality, by maternal age, Norway, 1967 through 1991.

ways in which mortality patterns *within* cohorts might differ. For example, the war cohort (1940–1944) has a relatively flat pattern of perinatal mortality with advancing age compared with other cohorts. The meaning of this pattern, if any, is unclear.

Discussion

Perinatal mortality is continuing to decline in many countries, which is an expression of improvements in social and other factors that determine perinatal risk. Within this pattern of general improvement, large differences in perinatal mortality by socioeconomic status persist. How important are social conditions around the time of pregnancy or conditions earlier in the life of the mother? Norwegian data allow both factors to be studied in relation to the hardship of World War II. During World War II, the Norwegian population suffered not only deprivation of food and other essentials, but also punishment for resistance to German occupation. Many were imprisoned, and war-related deaths are estimated at about 10 000.

We looked for wartime effects on perinatal mortality during that time and also a generation later, when women born during the occupation themselves gave birth. Data for the latter group of births are not routinely available; vital statistics do not link the mother's age with survival of her infant, and so perinatal outcomes for maternal birth cohorts must be constructed from other sources. The Medical Birth Registry of Norway provides the mother's age linked with perinatal mortality for a recent 25-year period and includes many mothers born during World War II.

We were able to find no evidence that Norway's experience during World War II affected perinatal survival, either immediately or through indirect effects on mothers born during the war. These data do not contradict previous reports of increased perinatal death associated with maternal starvation. Maternal malnutrition appears to impair perinatal survival when caloric intake falls below a certain threshold,[5] and extreme malnutrition was rare in Norway. However, the disruption and distress that accompanied German occupation are unquestioned, and the absence of measurable effects on perinatal mortality raises several possible interpretations.

1. Deaths may have been incompletely registered during this period, especially fetal or early infant deaths. By 1940, the registry of perinatal deaths had been routine in Norway for a century. We know of no evidence to suggest that registration deteriorated during the war; still, that possibility cannot be ruled out. Underregistration of deaths might have contributed to the absence of a direct war effect on perinatal mortality; it would not account for the absence of an effect a generation later.

2. Pregnant women and infants may have been relatively protected from the hardships of the occupation. It is difficult to reconstruct all aspects of this disrupted period of history, now a half-century in the past. Norway was not self-sufficient in food production; during the blockade of imports in 1942 through 1945, severe undernutrition and frank malnutrition were commonplace.[16] Pregnant women and infants probably did not suffer the worst; however, deprivation was widespread. Young children were not spared, as suggested by their mortality rates (Figure 1). Childhood growth retardation and delay of menarche during this time have been documented.[17,18] Because conditions were most severe in the last part of the war, we carried out additional analyses in 3-year groupings, separating the 1940 through 1942 cohort from the 1943 through 1945 cohort. Results were unchanged; no cohort effect was apparent in either group.

3. To produce a cohort effect on reproduction, hardship may have to come

later in childhood, or be sustained over a longer time. Logistic regression analysis of data from cohorts of women who were born before the war (and thus were older children at the time of the war) showed no evidence of adverse effects on their later reproduction. Possible effects of more prolonged deprivation cannot be evaluated with these data.

4. War conditions may have discouraged some high-risk women from becoming pregnant, thus concealing adverse wartime effects on those pregnancies that actually occurred. Maternal age at delivery did not change in Norway between 1935 through 1939 and 1940 through 1944.[9] Furthermore, Norwegian age-specific fertility rates were actually higher during the war than in the previous 5-year period.[9] Thus, we find no gross evidence of self-selection for pregnancy related to the war. The influence of more subtle selection among women who became pregnant is difficult to assess.

5. Perinatal mortality may be too crude an end point; period or cohort effects may be detectable only among less drastic outcomes such as fertility or fetal growth. Fertility or fetal growth effects may occur[19] but are not directly relevant to the present analysis. The object here was to explore connections between social conditions and perinatal survival.

Some additional data are available from Holland, which also had severe wartime experience. Parts of Holland suffered extreme deprivation during the German occupation. Famine occurred in some regions between October 1944 and May 1945. Pregnant women who were starved in their first trimester experienced increased rates of stillbirth, whereas those who were starved late in pregnancy had increased rates of infant death in the first 3 months of life.[5] Subsequent cohort effects on perinatal survival of babies born to these Dutch women have been suggested but are not well documented.[20] Unlike the experience in Norway, national rates of postneonatal mortality in Holland jumped sharply during the war to more than double the prewar level.[21] However, national rates of perinatal mortality declined for Holland, as they did in Norway.[21]

Maternal age, birth period, and maternal birth cohort are not isolated variables, of course. For instance, maternal age is correlated with parity, and parity is in turn affected by desired family size and selective fertility,[22] which change with time. These and other variables may be relevant to the interpretation of period and cohort effects, but they are beyond the scope of the present analysis.

In conclusion, we looked for increases of perinatal mortality specifically related to the occupation of Norway by Nazi Germany during World War II. Whereas mortality increased for children during the war, there was only a slight effect on postneonatal deaths and none on perinatal deaths. We found no evidence that women who were born during the war suffered later consequences in their ability to bear viable infants. Our inability to detect wartime effects underscores how little we understand the ways in which social factors act on perinatal mortality. □

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