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Background. This study examines whether the association between maternal educational level and postneonatal death has changed over time.

Methods. All single survivors of the neonatal period in Norway in three periods, 1968–1971, 1978–1981 and 1989–1991 were studied. There were 582,046 births and 1717 postneonatal deaths. Logistic regression analyses were applied.

Results. There has been an increasing inverse relationship between maternal educational level and postneonatal mortality in recent years. There was no statistically significant association between educational level and postneonatal mortality in the late 1960s. In the second period (1978–1981) the association is statistically significant for first-born children. In the third period (1989–1991) postneonatal mortality for first-born and later-born children was associated with maternal educational level, with adjusted odds ratios of 2.5 and 2.1 respectively. The overall level of education has increased tremendously, and the proportion of women with the lowest level of education has decreased from 56.3% to 10.7% in the period under study.

Conclusions. The underlying causes of changes in the impact of educational level are hard to determine and are indicative of the complexity of using maternal educational level as an indicator of social status over time. Possible mechanisms by which certain variables may covary with educational level, and thus have an adverse effect on postneonatal mortality, are discussed. The fact that the inverse association between educational level and postneonatal mortality has increased over time should be a matter for concern. It may indicate that the growth of the welfare state has not reached all segments of the population.

Keywords: time trends, postneonatal mortality, maternal educational level

Previous investigations show an association between sociodemographic factors and pregnancy outcomes.1-4 If the mortality during the first year of life is reduced by better social and economic conditions, it is to be expected that socio-economic development over recent decades has brought a reduction in infant mortality in the western hemisphere.5 In Norway in 1936–1940 the infant mortality rate was 39.4, in 1946–1950 31.1, in 1956–1960 19.9, in 1966–1970 13.9, in 1976–1980 9.0 and in 1986–1990 7.9 per 1000 live births.6

Compared with other countries, infant mortality in Norway is low and social inequalities are relatively small.7 Therefore, a study of the association between sociodemographic factors and infant mortality requires large datasets. The present study is based on registry information covering a period of 20 years. Data from the Medical Birth Registry of Norway have been linked to the Census data by the personal ID-number. The resulting dataset, which includes both medical and social variables, provides a unique opportunity to study the association between sociodemographic factors and deaths in the first year of life at an individual level.

A number of studies have unequivocally shown that the nature and magnitude of the association between infant mortality and socio-economic status is not stable but can vary over time.5,8 In recent decades there have been considerable changes in women’s lifestyle, for example there has been a marked increase in level of education and participation in the labour force.9 On this background, we have examined whether the association between maternal educational level and postneonatal mortality has changed over time.
MATERIAL AND METHODS

Study Population
The Medical Birth Registry of Norway (MBR) covers all livebirths and fetal deaths in Norway since 1967 with a gestational age of 16 weeks or more. Since 1890 censuses have been performed every tenth year in Norway. The Population and Housing Census 1970, 1980 and 1990 comprise all people who are registered as residents in Norway in those years. More detailed information about the registers is published elsewhere. The official national personal identification system allowed linkage between MBR and the Censuses. Thus, information on medical and social variables was established in one linked dataset.

A total of 659,174 infants (stillbirths and livebirths with gestational age of 16 weeks or more) were registered in the three periods under study. We have restricted our study to single born neonatal survivors with gestational age of 28 weeks or more; a total of 582,046 births. The first period (1968–1971) has 245,985 births, the second period (1978–1981) has 182,120 births and the third period (1989–1991) has 153,941 births. The periods comprise births approximately 2 years prior to and one year after the census. Because of some linkage problems, births in 1988 were not linked to the 1990 Census.

Variables
The dependent variable was postneonatal death (deaths from 28 days to the end of the first year of life). The independent variables were parity, maternal age, marital status and maternal educational level in years. The completeness of reported deaths and the data quality regarding maternal educational level are highest in the postneonatal period. In addition, the timing of infant deaths may reflect social conditions. Postneonatal mortality is usually due to environmental (or exogenous) factors. The independent sociodemographic variables can be regarded as risk factors for postneonatal mortality. Parity, maternal age and marital status were reported in MBR, and maternal level of education was reported in the Census.

Marital status was divided in two groups, married and unmarried. Those who were registered as widows, separated or divorced have been excluded (first period 0.7%, second period 1.8%, third period 1.0%). The MBR started to register cohabitation in June 1982. Cohabiting mothers have been included with married mothers. Unmarried mothers are women who have never been married. Educational level in years was grouped into three levels, those who have completed elementary school education (0–9 years of schooling), those with high school education (10–12 years of schooling) and those with any formal post high school education (13 or more years of schooling). Those with unknown education have been excluded from the analyses (first period 0.8%, second period 2.7%, third period 3.5%).

Statistical Methods
Since parity is associated with sociodemographic factors and has been shown to be associated with infant mortality, we have chosen to study first-born and later-born children separately. Postneonatal mortality rates are expressed as deaths per 1000 infants surviving the neonatal period. Thus, only neonatal survivors, those actually at risk of postneonatal death, were included in the denominators. The association between maternal educational level in years and the outcome variable was studied by logistic regression analysis. The subgroup having the lowest mortality was used as reference, with an odds ratio value of 1.00. Adjusted odds ratios (OR) were obtained by using all the independent variables in the model, and 95% confidence intervals are given for the adjusted OR. We also included interactions in a logistic model.

RESULTS
Table 1 shows the frequencies of maternal age, marital status and maternal educational level in years for first-born and later-born children in the three periods 1968–1971, 1978–1981 and 1989–1991. The number of teenage mothers decreased, and the number of mothers older than 30 years increased in the study period. Regarding marital status, the number of unmarried mothers was much higher for first-born children than for mothers of later-born children. There has been a considerable and consistent decline in the proportion of less-educated mothers. The decline was present in all the three periods both for first-born and later-born children.

Table 2 shows the number of infants surviving the neonatal period and the number of postneonatal deaths by sociodemographic factors. The postneonatal mortality rates per 1000 infants surviving the neonatal period by maternal age, marital status and maternal educational level in years are shown in Table 3. The rates declined for first-born children from 2.5 per 1000 to 2.1 per 1000, and from 3.6 per 1000 to 3.0 per 1000 for later-born children. Later-born children have a higher overall postneonatal mortality rate than first-born children.

Offspring of the youngest mothers have the highest postneonatal mortality rates. Generally, the lowest rates were found in the oldest age group. The lowest
postneonatal mortality rates were found for married mothers both for first-born and later-born children in the whole period under study. For later-born children the unmarried mothers in the first and the third period have the highest postneonatal mortality rates (7.8 and 8.2 per 1000). The association between maternal educational level in years and postneonatal mortality appeared linear in the whole period. The rates are highest for births in the least educated group, somewhat lower for mothers with a medium level of education and lowest for mothers with >12 years of education. However, in the first period (1968–1971) there are only small differences between the three education categories.

<table>
<thead>
<tr>
<th>Year of birth</th>
<th>First-born mortality rate</th>
<th>Later-born mortality rate</th>
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</thead>
<tbody>
<tr>
<td><strong>Sociodemographic factors</strong></td>
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<tr>
<td><strong>Maternal age</strong></td>
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<tr>
<td>&lt;20</td>
<td>3.5</td>
<td>5.3</td>
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<td>20–30</td>
<td>2.3</td>
<td>2.2</td>
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<td>&gt;30</td>
<td>2.4</td>
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<tr>
<td><strong>Marital status</strong></td>
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<tr>
<td>Unmarried</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Married</td>
<td>2.3</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Education (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>2.6</td>
<td>4.1</td>
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<tr>
<td>10–12</td>
<td>2.5</td>
<td>2.3</td>
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<tr>
<td>&gt;12</td>
<td>2.3</td>
<td>1.3</td>
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<tr>
<td><strong>Total</strong></td>
<td>2.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Table 4 shows the crude and adjusted OR for first-born and later-born children by maternal educational level in years, and 95% confidence intervals of the adjusted OR. Singleborn with gestational age 28 weeks or more. Norway, 1968-1971, 1978-1981, 1989-1991

<table>
<thead>
<tr>
<th>Education (years)</th>
<th>First-born</th>
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<tbody>
<tr>
<td></td>
<td>Crude OR</td>
<td>Adjusted OR</td>
<td>95% CI</td>
<td>Crude OR</td>
<td>Adjusted OR</td>
<td>95% CI</td>
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<tr>
<td>&lt;10</td>
<td>1.1</td>
<td>1.2</td>
<td>0.9–1.6</td>
<td>1.2</td>
<td>1.1</td>
<td>0.8–1.6</td>
</tr>
<tr>
<td>10–12</td>
<td>1.1</td>
<td>1.1</td>
<td>0.8–1.5</td>
<td>1.1</td>
<td>1.1</td>
<td>0.8–1.6</td>
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<tr>
<td>&gt;12</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td>1.0</td>
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<td>1978-1981</td>
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<tr>
<td>&lt;10</td>
<td>3.2</td>
<td>1.5</td>
<td>1.1–1.9</td>
<td>1.3</td>
<td>1.1</td>
<td>0.8–1.5</td>
</tr>
<tr>
<td>10–12</td>
<td>1.9</td>
<td>1.1</td>
<td>0.9–1.4</td>
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<td>1.0</td>
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<td>1989-1991</td>
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<tr>
<td>&lt;10</td>
<td>2.7</td>
<td>2.5</td>
<td>1.8–3.4</td>
<td>2.7</td>
<td>2.1</td>
<td>1.4–3.1</td>
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<tr>
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<td>2.1</td>
<td>1.6</td>
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<td>1.5</td>
<td>1.3</td>
<td>0.9–1.8</td>
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<td>&gt;12</td>
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* Adjusted for maternal age and marital status.

Table 4 shows the crude and adjusted OR for first-born and later-born children by maternal educational level in years. Maternal education shows no association in the first period (1968-1971), either for first-born or later-born children, after adjusting for maternal age and marital status by logistic regression. In the second period (1978-1981) there is a significant difference between the lowest and the highest educational level for first-born children. For later-born children in the second period, there is no association between educational level and postneonatal mortality. Maternal educational level remained significantly associated with postneonatal mortality both for first-born and later-born children in the third period when maternal age and marital status were adjusted for. For mothers in the lowest educational group, the adjusted OR are...
more than doubled (first-born OR = 2.5, later-born OR = 2.1).

To test if the observed trend toward a greater impact of maternal education on postneonatal mortality actually reaches statistical significance, data for all three periods were combined. Interaction terms between periods (scored 1,2,3 as a linear covariate) and maternal education (linearly) were then entered in the logistic regressions after controlling for the main effects of secular trends (i.e. period) and maternal education, using maternal age and marital status as covariates. Our results show that the interaction terms do indeed contribute significantly to the equation; for first-born children the increase in the model $\chi^2$ was 7.793 (d.f. 1, $P = 0.0052$) and for later-born children 7.559 (d.f. 1, $P = 0.0060$). These findings indicate that there has been a statistically significant (linear) trend toward a closer association between maternal education and postneonatal mortality over the last decades.

In addition we included interaction terms between maternal educational level and the other sociodemographic factors in the multiple logistic regressions. For later-born children the interaction between maternal age (>30 years of age) and educational level was significant ($\chi^2 9.458$, d.f. 2, $P = 0.0088$).

Because of the overall increase in level of education among women in our study population, the marginal distributions of education are radically different for the three periods, and effect parameters may be difficult to compare. Therefore, to check if our finding of a stronger association between education and postneonatal mortality holds up with comparable marginal distributions, an effort was made to standardize the scale of education. The scale was dichotomized into low and high education, choosing the median value in each time period as the cutoff point. For the first period (1968–1971), the OR for postneonatal death, comparing mothers with low education to mothers with high education, was 0.9 ($P = 0.55$) for first-born children and 1.1 ($P = 0.55$) for later-born children. For the second period (1978–1981) the OR was 1.5 ($P = 0.03$) for first-born children and 1.0 ($P = 0.90$) for later-born. In the last period (1989–1991) the OR were 1.4 ($P = 0.07$) for first-born and 1.5 ($P = 0.002$) for later-born children.

DISCUSSION

The purpose of this study was to analyse the development of the association between maternal education level and postneonatal mortality over time. This study has demonstrated a decline in postneonatal mortality and a considerable and consistent decline in the proportion of mothers with low educational level. Our main finding is that the inverse association between educational level and postneonatal mortality has increased over time.

When comparing different variables over time the possibility of differences in registration and coding practices should always be considered. However, all the variables have been consistently classified by MBR or by the Norwegian Central Bureau of Statistics. Thus, it is unlikely that the variations found by us can be explained by changes in coding or classification.

Education is an indicator of both class and status, it is correlated with income and occupation and it is often used as a proxy for socio-economic grouping.20,21 Using educational level as a social indicator is meaningful for international comparisons and is easily implemented because of its simplicity.21-23 However, the theoretical meaning of education is different from that of income and occupation, and it is not always clear what these variables actually measure.24 Furthermore the importance of education relative to other social indicators may have changed over the last decade.25 The differences between the first and the third period in this study might reflect this complexity.

Among sociologists there has been considerable dispute about how women should be classified in the social class structure.24 In a previous investigation we pointed out how important it is to use both the family and the individual as units of analysis.1

Medical advances have occurred parallel to socio-economic changes in our society.26 When exogenous causes, often linked to living conditions like housing, clothing, standards of hygiene and the nutritional status of infants, were controlled, it was assumed that excess mortality due to social deprivation would disappear.27 However, this did not happen.

Maternal educational level has consistently been shown to be an important determinant of postneonatal mortality.1,28,29 For a better understanding of this phenomenon it is important to look for possible mechanisms, i.e. variables that may be related—directly or indirectly—to educational level and impact adversely on postneonatal mortality. Living conditions, lifestyles, occupational status, power and financial resources of the family or the household, psycho-social stress and the use of medical care have been suggested in the literature.30-33

Cigarette smoking is a known risk factor which varies inversely with social class.21 Kleinman and Madans have shown that women of low educational attainment were more likely to smoke prior to pregnancy, less likely to have stopped smoking during pregnancy and more likely to be heavy smokers than women of higher educational attainment.34 Thus, smoking may act as an
intermediate variable in the pathway between educational level and postneonatal mortality. Unfortunately, we have no information on smoking in our dataset. However, in an earlier study, we showed birthweight differences between different educational groups that could largely be attributed to smoking behaviour. Nevertheless, even when controlling for smoking, significant differences in birthweight between the lowest and the highest maternal educational levels were still present.

Postneonatal mortality also covaries with other characteristics, such as maternal age and marital status. Therefore we have adjusted for these variables to control for the influence of possible confounders. However, the excess in postneonatal mortality in lower educational levels persists even after these factors are adjusted for. A Swedish study showed that social differentials in infant mortality could be explained by more smoking among mothers with low education, younger age and higher parity for age. Women of higher education are more likely to comply with medical advice during pregnancy and to make better use of health care services. Robitaille and Kramer have shown that participants in antenatal courses in Montreal, where such services are mostly available free of charge, tend to be of higher educational attainment than non-participants. Educational level might be inseparable from the mother's attitudes, beliefs, and expectations concerning herself and her child. In addition, highly educated mothers probably have more resources available to deal with negative reproductive patterns. Bourdieu discusses how education is closely linked to legitimate, cultural capital. Thus, education may effectively discriminate between differences in lifestyles, health-related habits, coping resources, coping styles, and illness behaviour in ways which affect the pregnancy outcome.

It is apparent that the overall nature of the association between educational level and postneonatal mortality has changed over the years—not statistically significant in the late 1960s, becoming stronger in the late 1970s, and becoming a pronounced and statistically significant inverse relationship between educational level and postneonatal mortality in the late 1980s.

However, the main task here is to understand the underlying determinants of changes in the impact of educational level over time. In the first period (1968–1971) there is no elevated risk associated with a low level of education. In the late 1960s married women had a rather loose attachment to the labour market. Marriage, house and children were their main preoccupation. Since the majority of mothers had little education (63.0%), work outside the home was not common and most mothers were married (94.2%); perhaps their partner's educational level was the best indicator of actual socio-economic position during this period. In the 1960s (as well as in the 1980s) there was also a correlation between the spouses' status.

During the 1980s the overall level of education gradually increased and so has the importance of education for employment opportunities. It is probably more problematic for a person nowadays to have a low educational level than previously.

In the 1980s there was a marked increase in women's participation in the labour force. Today nearly the same proportion of women and men are employed, and 50% of mothers with small children worked full time in 1991. In the last period (1989–1991) only 12% of mothers did not continue their education beyond the elementary level. This is a very different risk group compared to the mothers with limited education in the 1960s. When assessing these results one must take into account the changing distribution of educational level at various time periods. In the first period more than half of the women giving birth had less than 10 years of education, whereas only 12% were at this level in the last period. These groups are therefore not easily comparable across time. However, even when educational level is standardized, our results show that educational level has a stronger association with postneonatal mortality in the last period.

The results of the present study are of political and scientific interest in that the growth of the welfare state has not eliminated mortality differentials across groups defined by educational attainment.

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REFERENCES


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