Maternal education and risk of offspring death; changing patterns from 16 weeks of gestation until one year after birth

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Introduction

It is well known that individuals with low income and low education have higher mortality than individuals with high income and high education. Public health care, however, may decrease social inequalities in mortality, as all individuals, independent of income and personal resources, are given the same rights to health care. Infant mortality is one indicator of population health status, and high infant mortality is associated with low social and economical status of the family or the country. Also stillbirth rates are reported to differ by social and economical conditions. Improvement of health care is likely to have played a major role in reducing fetal and infant mortality. If public health care is important in reducing social inequalities in offspring mortality, we would expect the inequality in mortality to be lowest in term pregnancies and during the hospitalization after birth. In this period, the offspring is most carefully monitored.

Our aim was to examine whether social disparity in offspring mortality varies during pregnancy or during infancy. Therefore, among all births in Norwegian women during 1999–2004, we estimated fetal death rates by duration of pregnancy and perinatal mortality by time after birth. In this period, all women living in Norway and their infants use the public health care service extensively. Our results may suggest that health care that is equally available to all citizens, reduces social disparities in mortality.

Methods

Design

We performed a population-based follow-up study by using data from three Norwegian nationwide registries: the Medical Birth Registry, the Education Registry, and the Central Person Registry.
Study population
The study population was identified through the Medical Birth Registry of Norway to which all births after 16 weeks of gestation are compulsory reported. The Medical Birth Registry comprises information about the mother, the delivery and the newborn child.

In Norway, antenatal, obstetric and infant health care is a part of the public health care program and is offered to all women free of charge. Almost 100% of pregnant women follow the public antenatal health care program from early pregnancy, and the frequency of examinations increases towards the date of term pregnancy. Also, close to 100% of pregnant women in Norway deliver in a public hospital. The length of hospital stay after delivery is usually 4 days, but may be longer depending on the mother’s and the child’s health. Routine clinical examinations of newborns are performed in the hospital shortly after birth and in the infant health care program.

Our study population comprised all births in Norway after 16 weeks of gestation during the period 1999 through 2004 (n = 349,408). We excluded all women whose parents were not born in Norway (n = 45,238), as information on educational level was lacking or insufficient for a large proportion of these women. We also excluded pregnancies without information on length of gestation at birth (n = 2,135). Pregnancies recorded to last >43 weeks were excluded (n = 331), as gestational length was miscoded in some of these pregnancies. We could not with certainty determine which were miscoded, and therefore we excluded all. In addition, we excluded pregnancies without information on maternal educational level or other study factors (n = 4,041), leaving a sample of 297,663 pregnancies for the data analyses.

Study factors
Gestational age at birth was based on estimations of term date at routine fetal ultrasonographical examinations in pregnancy week 17–19. If this examination was not performed (for 3.2%), gestational age at birth was calculated from the date of last menstrual period.

Information on vital status at birth was obtained from the Medical Birth Registry. Information on infant death and offspring age at death was obtained by linkage to the Central Person Registry by using the woman’s and her child’s unique person identification number.

Information on maternal education was obtained by linkage to the Education Registry. All educational institutions in Norway report yearly individual data to the Education Registry. Hence, individual information about the educational level of the mother when the baby was born could be obtained. The mothers’ educational level was categorized into three groups: compulsory school only (9–10 years or less), upper secondary education (12–13 years) and university/college education only. For each offspring age period, we calculated adjusted excess mortality (adjusted odds ratio minus one), for offspring of mothers with less than university/college education.

The study was approved by the Regional Committee for Medical and Health Research Ethics (Reference number 603-07276a 1.2007.2366).

Results
Among all mothers, 42.0% had university/college education and 18.3% had compulsory school education only (table 1). The fetal death rate was highest in week 16–22, and lowest in week 23–28. Beyond week 36, there was found little variation in fetal death rate (week 37: 0.16%, week 38: 0.14%, week 39: 0.12%, week 40: 0.12%, week 41: 0.15%, week 42: 0.15%, week 43: 0.10%).

The crude odds ratio for fetal death decreased by increasing maternal educational level (table 2). In term pregnancies, however, the association was weak. In pregnancy weeks 23–28, compulsory education only gave an odds ratio for fetal death of 1.84 (95% CI 1.24–2.74), using mothers with university/college education as the reference. In pregnancy weeks 37–43, the odds ratio was 1.15 (95% CI 0.88–1.49). For mothers with upper secondary education, the corresponding odds ratios showed weaker associations, but a

Table 1 The number of offspring and deaths according to offspring age and maternal educational level

<table>
<thead>
<tr>
<th>Maternal education</th>
<th>Compulsory school</th>
<th>Upper secondary school</th>
<th>University/college</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Offspring</td>
<td>Deaths</td>
<td>Percent deaths</td>
</tr>
<tr>
<td>In pregnancy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16–22 weeks</td>
<td>54,369</td>
<td>161</td>
<td>0.30</td>
</tr>
<tr>
<td>23–28 weeks</td>
<td>54,208</td>
<td>44</td>
<td>0.08</td>
</tr>
<tr>
<td>29–36 weeks</td>
<td>54,164</td>
<td>79</td>
<td>0.15</td>
</tr>
<tr>
<td>≥37 weeks</td>
<td>54,085</td>
<td>85</td>
<td>0.16</td>
</tr>
<tr>
<td>After birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤1 week</td>
<td>54,000</td>
<td>121</td>
<td>0.22</td>
</tr>
<tr>
<td>1 week–1 month</td>
<td>53,879</td>
<td>48</td>
<td>0.09</td>
</tr>
<tr>
<td>1 month–1 year</td>
<td>53,831</td>
<td>97</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Included are offspring of all pregnancies in Norwegian women during 1999–2004.
similar pattern. Adjustment for the other study factors attenuated the odds ratios, but still we found a weaker association of maternal education with fetal death in term pregnancies as compared with in pregnancies before term (table 2).

Infant mortality was highest in the first week after birth (table 1). However, the association of infant death with maternal education was weak in the first week and increased thereafter (table 3). For infants of mothers with compulsory school only, the estimated crude odds ratio of death was 1.29 (95% CI 1.03–1.61) in the first week after birth. The crude odds ratio was 2.35 (95% CI 1.57–3.52) in the 2nd through 4th week after birth, and it was 2.76 (95% CI 2.06–3.71) during the 2nd through 12 month after birth. Adjustment for gestational age at birth and the other study factors attenuated the association, but still we found the weakest association of maternal educational level with infant death the first week after birth (table 3).

Before pregnancy week, the fetal mortality was >60% higher in offspring of mothers with compulsory school only as compared with mothers with university/college education (figure 1). At term (weeks 37–43), the excess mortality was 22%. After birth, the excess infant mortality in the first week was 89%, and it was 132% during the 2nd through 12th month. Adjustment was made for gestational age at birth.

Discussion

In this study of all offspring of Norwegian women during the years 1999–2004, the association of offspring death by maternal educational level varied by offspring age. In term pregnancies and in the first week after delivery, there was little difference in the risk of death by maternal educational level. However, before pregnancy week 37 and in the 2nd through 12th month after birth, offspring of mothers with low education had higher mortality.

Births and vital status at birth are reported by law to the Medical Birth Registry of Norway, and deaths after birth are reported to the Central Person Registry. Thus, we believe all births and all offspring deaths are included in our study. Induced abortions after pregnancy week 16 were separately reported to the Medical Birth Registry from 1999 and thereafter. To avoid misclassification of induced abortions as fetal deaths, we therefore included births after 1999 only. Also, from 1999, the expected term date, as estimated by fetal ultrasonographical examination, was routinely used for calculation of gestational age at birth at the Medical Birth Registry. We had complete information on maternal education and infant death through 2004 only. The lack of data for the most recent years is due to the tedious process of updating national registries. Also the linkage between registries took time to ensure accurate information on maternal educational level at the time of birth. We have, however, no reason to believe that our results are not valid beyond 2004.

The confidence intervals around our estimates were wide, as the number of deaths within sub-groups was limited. Despite the uncertainty around each estimate, we found a consistent trend, with the most pronounced U-shaped association of mortality according to offspring age in the women with the lowest education. Unfortunately, we had no information on the causes of offspring death in our study.

For some women, in particular women who experienced fetal death early in pregnancy and before the routine ultrasonographical fetal examination had been performed, length of gestation was estimated from date of last menstrual period. We believe, however, that different methods of estimating term date have not biased our results, as there is little difference in term date between the two methods of estimation.

Beyond pregnancy week 37, the number of ongoing pregnancies and thereby at risk of fetal death, decreases rapidly. However in ongoing pregnancies, the fetal death rate is known to increase by length of gestation. Therefore, we estimated the fetal death risk in

<table>
<thead>
<tr>
<th>Maternal education</th>
<th>16–22 weeks</th>
<th>23–28 weeks</th>
<th>29–36 weeks</th>
<th>≥37 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal education</td>
<td>Total number</td>
<td>Crude OR</td>
<td>Adjusted OR</td>
<td>Crude OR</td>
</tr>
<tr>
<td>Compulsory school</td>
<td>297,012</td>
<td>1.58 (1.32–1.93)</td>
<td>1.76 (1.42–2.18)</td>
<td>1.84 (1.40–2.42)</td>
</tr>
<tr>
<td>Upper secondary school</td>
<td>633</td>
<td>1.60 (1.22–1.94)</td>
<td>2.04 (1.60–2.60)</td>
<td>2.34 (1.79–3.03)</td>
</tr>
<tr>
<td>University/college</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
</tbody>
</table>

Associations are estimated as crude and adjusted odds ratio (OR) with 95% confidence intervals. Included are all pregnancies in Norwegian women during 1999–2004.
each week beyond week 37, but in our population we found no trend of increasing risk by pregnancy week.

The level of education is higher in Norwegian women than in many other populations of childbearing women. We believe, however, that the difference in maternal educational level may be used as a proximate for social disparity, independent of the absolute educational levels in the population. We are not aware of any other studies that have examined whether the association of educational level with offspring mortality varies by offspring age.

**Interpretations**

In general, offspring death is linked to low social class. We found little educational disparity in offspring mortality in term births and in the neonatal period. In this period, there is high intensity of scheduled contacts with the public health care as compared with other periods in offspring life. It is therefore likely that our finding is a result of health care interventions. The absolute risk of offspring death is highest in term pregnancy and in the week after birth. In this time period of offspring life, however, the temporal decline in offspring mortality has been largest. Thus, our finding also suggests that low social disparity in offspring death is important for the achievement of low perinatal mortality rates.

We do not have individual data on participation in public antenatal health care, but virtually all mothers follow the program. The recommended number of routine health care visits involves six clinical examinations from pregnancy week 8 to 36 and one examination per week beyond week 36. The infant is examined by midwife or doctor immediately after birth, and infants with reduced vitality are referred to neonatal units. Also, routine clinical examination is performed in all infants before discharge from the maternity ward, usually by a pediatrician and usually 4 days after birth. Within 2 weeks after discharge from the maternity ward, the mother and infant are entitled to a home visit by a public health nurse. About 75% of all mothers in Norway receive such visits. Visits after 6 weeks are mainly for vaccination purposes.

Unfortunately, we had no information on the causes of death in our data. The causes of offspring death may vary by offspring age. For instance, very preterm delivery and accidents may cause offspring death. Such deaths are associated with low social status, but may not be preventable by health care.

Antenatal screening for preeclampsia and technology for diagnosing fetal distress are offered to all women in Norway with increasing intensity near term, and obstetric interventions are most prevalent in term pregnancies. Low offspring birth weight and
impaired fetal growth are associated with increased risk of offspring death at any length of gestation, and also with low maternal education. Thus, low birth weight may be a mediator of fetal death in women with low education. Because fetal growth restriction is more likely to be diagnosed in term pregnancy than before term because of the many scheduled health care visits at term, fetal deaths linked to low birth weight may be prevented at term by induction of birth. Immediately after births and the first day thereafter almost all mothers and infants are hospitalized, and the infants that fail to thrive are likely to be identified and treated. Because offspring of women with low education have an increased risk of death, they are likely to benefit the most from the frequent contact with health care and thereby adequate intervention.

Before term and after the first week of life, the absolute risk of offspring death is relatively low, and the number of scheduled contacts with health care is low. We believe that one reason for the higher disparity of offspring death by maternal education in this period may be that diagnosis of offspring symptoms and preventive interventions largely depend on the mother. Mothers with high education are probably more able to respond to signs of illness than mothers with low education. Our results, therefore, indicate that more closely follow-up in pregnancy and for a longer time after birth could further diminish social disparity in offspring mortality.

Conclusion

In this study from Norway, offspring of women with low education had the highest mortality. In term pregnancies and in the week after birth, however, there was little difference in offspring mortality by maternal educational level. All pregnant women and their offspring are offered continuous public health care services at term and shortly after birth. Thus, the lack of social disparities around the time of birth may be interpreted as effect of the public health care system, as effective interventions to reduce mortality are available.

Acknowledgement

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Conflicts of interest: None declared.

Key points

- Social disparity in perinatal mortality has been reported in several studies.
- We found little difference in offspring mortality by maternal education in term pregnancies and in the first week after birth in Norway during the years 1999–2004.
- However, before pregnancy week 37 and in the months 2–12 after birth, there was excess mortality in offspring of mothers with compulsory school only, using university/college education as the reference.
- Maternal health care is available to all inhabitants in Norway free of charge and is most extensively used in term pregnancy, during delivery and in the first week after birth. Thus, our results may suggest that health care, equally available to all citizens, reduces social disparities in mortality.

References

Social and economic inequalities in induced abortion in Spain as a function of individual and contextual factors

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Background and objectives: The socioeconomic position of women who have an induced abortion has been explored extensively, but without taking contextual factors into account. The objective was to describe socioeconomic inequalities in the rate of induced abortion in Spain in 2001, jointly evaluating the effects of both regional and individual socioeconomic characteristics. Methods: A cross-sectional study using a multilevel approach was carried out among women who were resident in Spain in 2001, considering the hierarchical structure of relevant factors. Analyses were carried out at the individual and regional level. We fit Poisson regression models to calculate adjusted relative risks (aRR) of induced abortion and 95% confidence intervals (CIs). Results: The estimated abortion rate was 6.26 per 1000 women aged 20–49 years. Induced abortion was more frequent among younger women (aRR = 1.55 for women aged 20–24 years, compared with those aged 25–34 years) and those with less than primary education (aRR = 2.25 compared with women with university studies). Women residing in regions with lower public spending on non-university education (aRR = 0.83, 95% CI: 0.70–0.98) and a higher percentage of non-European Union immigrants (aRR = 1.06, 95% CI: 1.02–1.10) were also more likely to have had an induced abortion. Conclusions: Socioeconomic inequalities in the practice of induced abortion in Spain exist not only at the individual level but also at the regional level. The prevention of unintended pregnancy should be approached using a global political strategy aimed at changing contextual and individual factors that contribute to unintended pregnancy.

Introduction

An important requisite for women’s active participation in society is their recognized right to determine whether and when to have children. In general, women spend most of their reproductive life (an average of 30 years) trying to avoid pregnancy rather than trying to become pregnant. Contraception is widely used in European countries, although with clear variations between countries. Condoms and oral contraceptive pills are the most frequently used methods of contraception and both rely on consistent use to be...