The heavier the better? Birthweight and perinatal mortality in different ethnic groups

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Background
Mother’s ethnicity is associated with her baby’s birthweight and risk of perinatal mortality. Given the close relation between birthweight and perinatal mortality, we explored whether ethnic differences in birthweight explain ethnic differences in perinatal mortality.

Methods
Data on all births to mothers born in Norway (808,658), Pakistan (68,544), Vietnam (32,832) and North Africa (14,611) from 1980 to 1995 were obtained from the Medical Birth Registry of Norway. The associations between birthweight and perinatal mortality among ethnic groups were analysed using univariate and multivariate methods.

Results
Mean birthweights were low for Vietnamese and Pakistani mothers (3202 g, 3244 g) and high for Norwegian and North African mothers (3530 g, 3559 g). Mean birthweights were largely unrelated to perinatal mortality, which was lowest for Vietnamese (8.2/1000, 95% CI: 5.1–11.3) and highest for Pakistanis (14.9/1000, 95% CI: 12.0–17.7). Intermediate perinatal mortality rates were found among Norwegians (9.5/1000, 95% CI: 9.3–9.7) and North Africans (9.6/1000, 95% CI: 4.6–14.6). Further comparison of weight-specific mortality rates between the two largest ethnic groups showed the low birthweight paradox, where among low-weight births, perinatal mortality was lower among Pakistani than among Norwegian babies. However, adjustment to a relative birthweight scale (units of standard deviations from population-specific mean value) revealed higher rates of weight-specific mortality among Pakistanis across the entire range of birthweights. Multivariate adjustment for relative birthweight and other factors did not change these results.

Conclusions
Differences in perinatal mortality between the ethnic groups were not explained by differences in mean birthweight. Paradoxical differences in birthweight-specific mortality rates could be resolved by adjustment to a relative scale.

Keywords
Perinatal mortality, birthweight, ethnic groups

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Low birthweight (<2500 g) is associated with increased risk of morbidity and mortality in the newborn. The prevalence of low birthweight is widely used as an indicator of health in a population. However, there are several causes of low birthweight. When mechanisms that retard general growth and development come into play, the consequences may be different than when low birthweight reflects a smaller body size norm in a specific population. Rooth showed that low birthweight defined as values less than two standard deviations below the mean value could vary by as much as 350 g between different populations. The substantial variation in birthweight limits the value of low birthweight as an indicator of health in clinical evaluations of the newborns and in epidemiological studies. The Wilcox and Russell approach, an extension of Rooth’s method, resolved this problem by converting birthweight values to a relative measure that is re-scaled according to the group-specific distribution of birthweight.
Several environmental and biological factors influence mortality. These include socioeconomic conditions, maternal cigarette smoking, the quality of health care, and consanguinity. A higher risk of perinatal mortality in offspring of immigrants from the Indian subcontinent and North Africa has been observed in Norway and other European countries. It has been discussed whether an increase in birthweight of infants born to Asian women in Britain would lower perinatal mortality in babies of Asian origin.

We studied the effect of differences in birthweight on the risk of perinatal death among ethnic groups in Norway. To adjust for ethnic differences in body size distribution the method of relative birthweight was used.

Methods
Subjects
The Medical Birth Registry of Norway contains information on all live births and fetal deaths after 16 weeks of gestation. All single births from 1980 to 1995 with gestational age \( \geq 22 \) weeks or birthweight \( \geq 500 \) g to women born in Norway (808 658), Pakistan (6854), Vietnam (3283) and North Africa (1461 from Morocco, Tunisia and Algeria) were studied. Ethnic groups were defined according to the mother's country of birth. Linkage to Statistics Norway secures an accurate categorisation of ethnic group. Nearly all mothers were married to men with the same country of origin. Many of the immigrants have attained Norwegian citizenship, but for simplicity they will be referred to as Pakistani, Vietnamese and North Africans. A relatively larger proportion of the immigrants was living in the capital compared to ethnic Norwegians. Approximately 80% of the Pakistanis and North African mothers were living in Oslo compared with 11% of the Norwegians and 20% of the Vietnamese.

Variables
Perinatal deaths included any stillbirth or death of a live birth within the first week of life. The World Health Organization's criterion of fetal death (gestational age \( \geq 22 \) weeks or birthweight \( \geq 500 \) g) was applied. The data were also analysed after inclusion of all births from 16 weeks of gestation in the analyses. The results from these analyses were commented upon in the text, but were not included in the Tables. Birthweight was the child's weight at birth in grams measured by a trained health worker immediately after the delivery. Maternal age at the time of the delivery was categorised into \( <25, 25-34, \geq 34 \) years. Parity was classified as \( p0 \) (first birth), \( p1 \) (second birth) and \( p2+ \) (third or higher birth order). Information on maternal education was categorised as 0–9, 10–12, 12 years, or missing information.

Norway practises compulsory notification of births. A personal identification number is used to establish linkage with the Population Registry and with the Cause of Death Registry. These procedures ensure complete ascertainment of births as well as infant deaths and prevent selection bias regarding birth information in the Birth Registry. The quality of the information on birthweight, maternal age and parity is quite high, with a minimal amount of missing values (0–0.6%) across groups. Information on birth order might be less reliable among the immigrants as deliveries in the mother's former country of residence might not be noted. Information on maternal educational level is obtained from the National Education Registry in Statistics Norway. Information on the maternal educational level is considered to be reliable for ethnic Norwegians and was missing for only 2.2%. Among immigrant groups information on maternal educational level may be less reliable and was missing for a large proportion (36–62%).

Statistical analysis
Analyses of frequencies and cross-tables were used to estimate the mean birthweight and the proportions of low birthweight and perinatal mortality in ethnic groups. Relative risks of perinatal death across groups were calculated using logistic regression and approximated by odds ratios (OR). Measures of uncertainty for proportions and OR were computed as 95% CI. The model introduced by Wilcox and Russell was used to analyse birthweight-specific mortality. The predominant distribution is estimated by fitting a normal curve to the main birthweight distribution. Birthweight was converted to a relative scale (z-score) based on the population-specific mean and standard deviation of the predominant distribution.

Results
Birthweight
Mean birthweights differed between the populations (Table 1). The highest (3559 g) occurred in the North African group, while the lowest (3202 g) was found among the Vietnamese. The standard deviations were approximately the same among Norwegians, Pakistanis and North Africans (590). Among the Vietnamese the standard deviation was smaller (475 g) with more births clustered around mean birthweight. Compared with Norwegians, the proportion of infants weighing \( <2500 \) g was significantly larger among the Pakistanis and the Vietnamese. Among the North Africans the proportion of low birthweight was smaller than among ethnic Norwegians, but this result did not reach significance.

Birthweight and perinatal mortality
Perinatal mortality per 1000 births was 9.5 among Norwegians, 14.9 among Pakistanis, 8.2 among the Vietnamese, and 9.6 among North Africans (Table 2). Thus, the lowest perinatal mortality and the lowest mean birthweight were combined in the Vietnamese group. The poor correlation between birthweight and perinatal mortality between the groups is also illustrated by Figure 1. Of particular importance is that the lowest rate of perinatal mortality was found in a group with a substantial proportion of low birthweight infants.

Table 1 Mean birthweight and percentage of low birthweight by ethnic group, Norway 1980 to 1995

<table>
<thead>
<tr>
<th>Ethnic groups</th>
<th>No. of births</th>
<th>Mean SD (g)</th>
<th>Low birthweight (&lt;2500 g) % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>808 658</td>
<td>3 530 590</td>
<td>3.9 (3.8–3.9)</td>
</tr>
<tr>
<td>Pakistan</td>
<td>6854</td>
<td>3 244 590</td>
<td>7.5 (6.9–8.1)</td>
</tr>
<tr>
<td>Vietnam</td>
<td>3283</td>
<td>3 202 475</td>
<td>4.9 (4.2–5.7)</td>
</tr>
<tr>
<td>North Africa</td>
<td>1461</td>
<td>3 559 586</td>
<td>3.2 (2.3–4.2)</td>
</tr>
</tbody>
</table>

a Based on mother's country of birth.
Even though total perinatal mortality rate was significantly higher among the Pakistanis than among Norwegians there was a trend towards lower perinatal mortality in the Pakistani group for babies weighing 2500 g (Table 2). After inclusion of all births from 16 weeks of gestation in the analyses this difference reached significance. Birthweight-specific mortality rates for Norwegian and Pakistani babies are presented in Figure 2. This Figure demonstrates the low birthweight paradox. Specifically, the Pakistani mortality figures are lower or equal to the Norwegian figures for small babies, but higher for babies weighing >3000 g (Figure 2A). After converting birthweight values into the relative scale, perinatal mortality rates were higher among Pakistanis than among Norwegians along the entire range of birthweights (Figure 2B).

The effects of the covariates on perinatal mortality are presented in Table 3. Model 1 includes simple OR within each category. In these analyses the data from all groups were combined. Due to the substantially larger Norwegian sample the associations shown in this Table are representative for ethnic Norwegians, but not necessarily for the immigrants. Separate analyses for each group (data not shown) showed similar patterns of crude estimates among the immigrants and among Norwegians for maternal age, parity, and absolute and relative birthweight. However, for the maternal education level no clear association was found to perinatal mortality among the immigrants. Due to the large number with missing maternal education data among the immigrants all adjustments were performed with a dummy for missing values.

The crude risk of perinatal death was 1.6 for Pakistanis, 0.9 for the Vietnamese and 1.0 for North Africans relative to Norwegians. Model 2 and model 3 shows the inter-ethnic risk estimates after adjusting for absolute and relative birthweight categories. By using absolute birthweight categories the inter-ethnic risk estimates of perinatal death changed substantially showing lower risk for Pakistanis compared to Norwegians, while after adjusting for relative birthweight the risk estimates of perinatal death remained largely unaltered. A model (including births to Norwegians and Pakistanis) specifying an interaction term between ‘country of origin’ and ‘absolute birthweight categories’ was compared to a model where the interaction was between ‘country of origin’ and ‘relative birthweight categories’. The interaction was significant ($P = 0.03$) in the model containing the absolute birthweight values, but was not significant ($P = 0.66$) when the relative birthweight values were used.

The risk estimates of perinatal death remained largely unaltered after adjusting for maternal age, parity, maternal education level and relative birthweight (Model 4). After including all births from 16 weeks gestation in our analyses, the relative risk estimates of perinatal death were essentially unchanged for Pakistanis and Vietnamese. Among the North Africans it increased slightly from 1.0 to 1.2.

Secular trends in perinatal mortality in the population groups were also analysed. There was a slight trend among the Norwegians towards better outcome during the 15-year period. Among the immigrants no clear trend could be observed. After adjusting for 5-year periods, the inter-ethnic risk estimates for perinatal death remained unaltered.

Discussion

Main findings

We compared birthweights and perinatal survival of ethnic groups in Norway. Birthweight differences between these groups were not clearly related to perinatal mortality. Although mean birthweight varied by as much as 350 g between the groups, it could not explain ethnic group differences in perinatal mortality.

Methodological considerations

The results presented in the Tables included births with birthweight $>500$ g or gestational age $>22$ weeks. Due to new
therapeutic possibilities, births of very low gestational age have received increasing attention in modern obstetrics. Perinatal deaths between 16 and 22 weeks of gestation represent a mixed group comprised of therapeutic abortions, late spontaneous abortions and missed abortions. After including all births from 16 weeks gestation in our analyses, the relative risk estimates of perinatal death were essentially unchanged for Pakistanis and Vietnamese. Due to a larger proportion of fetal deaths <22 weeks or birthweight <500 g among the North Africans, the relative risk increased from 1.0 to 1.2 in this group. There is evidence that lethal malformations are more common in offspring of consanguinely related parents. Consanguinity is prevalent in the Pakistani and North African group in Norway. Thus, therapeutic abortions may be more common in these groups. Therapeutic abortions are less likely to be noted in the Birth Registry. To the extent that this introduces a bias, the differences in perinatal mortality between ethnic groups that were revealed in this study are underestimated.

The groups included represent the largest immigrant groups in Norway. The number of births to immigrants in Norway is relatively small and represents a limitation for epidemiological studies. This is particularly relevant to the North African group. Moroccan, Tunisian and Algerian subjects represent an ethnic homogeneous group and their data have been pooled to obtain larger numbers.

The analytical approach introduced by Wilcox and Russell offers a refined tool to study the relation between birthweight and perinatal mortality. Birthweight-specific (500 g categories) mortality was analysed for Norwegian and Pakistani babies (Figure 2A). These weight-specific mortality rates were then adjusted to a relative birthweight scale (standard deviations from mean value) as shown in Figure 2B. With this procedure the effect of ethnic group differences in birthweight is separated from other effects on mortality. These differences were also examined using an alternative analytical strategy based on logistic regression showing a significant interaction term between country of origin and absolute birthweight, as opposed to the interaction term between country of origin and relative birthweight categories which was not significant. These results confirm the importance of using the relative strategy to compare birthweight and perinatal mortality in different ethnic groups as is suggested by Figure 2 or Models 3 and 4 in Table 3.

**Birthweight and perinatal mortality**

The significantly elevated mortality among the Pakistanis is attributable, in part, to the larger proportion of small births. In addition, the higher weight-specific mortality along the entire spectrum of adjusted birthweights for Pakistani infants shown in Figure 2, indicates an increased risk regardless of birthweight.

Although socioeconomic conditions are well-known determinants of perinatal mortality, maternal educational level was not associated with perinatal mortality in any of the immigrant groups. Similar findings have been reported in other studies. Educational level may be an inadequate measure of socioeconomic resources among immigrants as they are more likely to be in the lower grades of all occupations, independent of educational level. In the current study, the large amount of missing information on maternal education level among the immigrants clearly means that education is a poor adjustment for social position in these groups.

Marriage between close relatives increases the risk of stillbirth and infant mortality. Previous studies have shown that

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**Figure 2** Birthweight-specific mortality before (A) and after (B) adjustment to a relative birthweight scale for Pakistani and Norwegian births, Norway 1980–1995
approximately 40% of the Pakistanis in Norway are married
to a first cousin or a closer relative. Evidence suggests that
the high frequency of consanguineous marriages contributes
importantly to perinatal mortality among Pakistanis in Norway.
However, other factors may also come into play. Compared to
Europeans, a larger number of perinatal deaths among Asian
women in Leicestershire, UK, was associated with avoidable
factors relating to antenatal care. Recent research from the
US and Britain has revealed a clear socioeconomic gradient for
each ethnic group, with poor people having poorer health and
higher mortality rates. The patterns for white and ethnic minor-
ity groups were very similar. The authors concluded that the
strongest evidence implicated socioeconomic inequalities as the
key determinants of ethnic inequalities in health.

The highest mean birthweight was found in the North
African group. High birthweights of North Africans have been
explained by maternal diets with high carbohydrate and low
protein content. After including all births from 16 weeks
gestation in the analyses there was a trend towards increased
risk of perinatal death for this group compared to ethnic
Norwegians. Thus, the highest mean birthweight and a trend
towards increased risk of perinatal death were combined in the
North African group. Similar findings among North African
immigrants have been reported from studies performed in
Belgium.

The lowest mean birthweight combined with the lowest
perinatal mortality was found among the Vietnamese. This may
be reflective of the smaller standard deviation observed for this
group, with more births clustered close to the mean weight. The
world’s lowest infant mortality rates are reported from Asian
countries such as Singapore and Japan. This suggests that
the lower birthweight among Asian populations poses no

<table>
<thead>
<tr>
<th>Country of origin</th>
<th>Model 1(^a) Crude Odds ratio (95% CI)</th>
<th>Adjusted for absolute birthweight Odds ratio (95% CI)</th>
<th>Adjusted for relative birthweight Odds ratio (95% CI)</th>
<th>Adjusted for maternal age, parity, education level and relative birthweight Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>Pakistan</td>
<td>1.58 (1.30–1.93)</td>
<td>0.92 (0.75–1.14)</td>
<td>1.59 (1.29–1.98)</td>
<td>1.48 (1.18–1.87)</td>
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<td>Vietnam</td>
<td>0.87 (0.60–1.27)</td>
<td>0.64 (0.43–0.96)</td>
<td>0.92 (0.62–1.38)</td>
<td>0.89 (0.60–1.34)</td>
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<tr>
<td>North Africa</td>
<td>1.01 (0.60–1.72)</td>
<td>1.12 (0.63–2.00)</td>
<td>1.19 (0.67–2.10)</td>
<td>1.15 (0.65–2.05)</td>
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<thead>
<tr>
<th>Maternal age, years</th>
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<th>Model 4</th>
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<td>25–34</td>
<td>0.87 (0.83–0.91)</td>
<td>0.94 (0.89–1.00)</td>
<td>1.12 (1.02–1.22)</td>
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<tr>
<td>&gt;34</td>
<td>1.30 (1.21–1.40)</td>
<td>1.23 (1.16–1.30)</td>
<td>1.44 (1.35–1.55)</td>
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<th>Parity</th>
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<td>1.00</td>
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<td>p1</td>
<td>0.84 (0.80–0.89)</td>
<td>1.23 (1.16–1.30)</td>
<td>1.44 (1.35–1.55)</td>
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<tr>
<td>p2+</td>
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<td>1.24 (0.94–1.62)</td>
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<thead>
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<th>Education, years(^b)</th>
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<th>Model 3</th>
<th>Model 4</th>
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<td>0–9</td>
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<td>1.00</td>
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<td>10–12</td>
<td>0.78 (0.74–0.83)</td>
<td>1.01 (0.95–1.08)</td>
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<td>0.60 (0.56–0.65)</td>
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<td>0.97 (0.84–1.12)</td>
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<table>
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<th>Birthweight, g</th>
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<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
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<td>&lt;2500</td>
<td>115.12 (106.37–124.58)</td>
<td>117.23 (108.04–127.19)</td>
<td>117.23 (108.04–127.19)</td>
<td></td>
</tr>
<tr>
<td>2500–3500</td>
<td>3.04 (2.79–3.31)</td>
<td>3.08 (2.82–3.37)</td>
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<td>3501–4500</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>&gt;4500</td>
<td>1.24 (0.95–1.61)</td>
<td>1.24 (0.94–1.62)</td>
<td>1.24 (0.94–1.62)</td>
<td></td>
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<tr>
<th>Relative birthweight(^b)</th>
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<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
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<tr>
<td>&lt;–2SDD</td>
<td>88.50 (81.01–96.68)</td>
<td>88.50 (81.01–96.68)</td>
<td>81.01 (81.01–96.68)</td>
<td>91.68 (83.83–100.26)</td>
</tr>
<tr>
<td>&lt;2SDD–0SD</td>
<td>2.46 (2.24–2.71)</td>
<td>2.46 (2.24–2.71)</td>
<td>2.46 (2.24–2.71)</td>
<td>2.54 (2.31–2.80)</td>
</tr>
<tr>
<td>0SD– +2SDD</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>&gt;+2SDD</td>
<td>1.15 (0.80–1.66)</td>
<td>1.15 (0.79–1.66)</td>
<td>1.15 (0.79–1.66)</td>
<td>1.11 (0.77–1.61)</td>
</tr>
</tbody>
</table>

\(^a\) With a dummy for missing values.
\(^b\) Population-specific z-scores (values from the predominant distribution of birthweight within each group).
\(^c\) Simple odds ratios within each category.
\(^d\) The various factors have been adjusted for one another.
obstacle to achieving superior infant survival. A recent study from Norway reported low risk of perinatal complications and the lowest frequency of caesarean section (10.1%) in the Vietnamese group.24 Lower levels of perinatal mortality among Vietnamese immigrants have also been found in the US and has been explained by reduced exposure to maternal cigarette smoking.25 However, cigarette smoking is also rare among Pakistani and North African mothers. This suggests that other unfavourable conditions play a stronger role for infant survival in these groups.

The results presented in this study could be biased by an internal selection in the immigrant groups. Generally, the most disadvantaged groups in a country are not able to migrate. The majority of North Africans and Pakistanis came to Norway as labourers from lower middle class strata in villages or small cities in their native countries. The Vietnamese, however, came to Norway as political refugees. They were to a larger degree represented by people from more advantageous socioeconomic positions than the other groups. The better health profile among the Vietnamese might be a result of such selection.

Preterm births
Gestational age is another important factor in perinatal mortality. The notification of gestational age in the Birth Registry is based on the mother’s last menstrual period. The proportion of preterm infants (<37 weeks) was substantially greater in all immigrant groups and was largest among the Vietnamese (10.6%). Furthermore, mean gestational age was shorter: 5 days among the Pakistanis, 3 days among the North Africans, and 4 days among the Vietnamese (data not shown). These differences persisted when the analysis was restricted to infants born at term. Shorter duration of gestation among African-Americans compared to Caucasian mothers has also been reported from the US.26 This raises the question of whether the criterion for preterm delivery ought to be the same in all ethnic groups. However, misclassification of gestational age has been reported to be more frequent in some ethnic groups and might explain these results.

The heavier the better?
Clarke et al. reported low perinatal mortality among Asian women in Britain during the period 1976–1985.13 However, this was not accompanied by a clear higher level of birthweight in children born to Asian women.16,17 This suggested that the reduction in perinatal mortality could not be ascribed to increased birthweights.17

In the present study perinatal mortality rates were higher among the Pakistanis compared to Norwegians regardless of birthweights, and the lowest rate of perinatal mortality co-occurred with the lowest mean birthweight among the Vietnamese. These findings confirm that heavier is not always better. It is clear, that at least when comparing ethnic groups, mean birthweight is a poor predictor of perinatal mortality. Birthweight differences do not contribute to the substantial differences in perinatal mortality by ethnicity in Norway. Future research should focus on other biological and environmental factors to explain ethnic differences in perinatal mortality.

Acknowledgements
We want to thank the Norwegian Foundation for Health and Rehabilitation and the Norwegian Women's Public Health Association for funding the study. We also wish to express our gratitude to an unknown reviewer for detailed and very useful comments.

KEY MESSAGES

- Birthweight and perinatal survival were compared between ethnic groups in Norway using data from the Norwegian Medical Birth Registry.
- Mean birthweights and perinatal mortality varied considerably among the ethnic groups, but there was no clear relationship between birthweight and the risk of perinatal death.
- Birthweight differences do not seem to contribute to the poor outcomes among certain ethnic groups.
- Our findings suggest that future research should focus on other biological and environmental factors to explain ethnic differences in perinatal mortality.

References