Ethnic variations in mortality in pre-school children in Denmark, 1973-2004

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Abstract

The objective of the study was to describe ethnic differences in under-five-years mortality in Denmark according to maternal country of origin. We conducted a large registry-linkage study of all singleton live-born children from mothers born in Denmark and from the ten largest migrant groups (n=1.841.450). Study outcomes were death before the age of five years from all causes combined and the most frequent death causes. Results showed that children of mothers of Turkish, Pakistani, Somali and Iraqi origin had an elevated risk of dying before the age of five compared to offspring of mothers born in Denmark, with hazards ratios (HR) and 95 % confidence intervals (CI) of 1.48 (1.31-1.67), 1.97 (1.68-2.32), 1.70 (1.29-2.25), and 1.92 (1.41-2.62), respectively. Ethnic differences were also observed in the underlying causes of death. Children of mothers born in Former Yugoslavia, Lebanon, Norway, Sweden, Iran, and Afghanistan did not differ in under-five-years mortality from ethnic Danish children. Adjustments for household income did not attenuate the risk estimates. In conclusion, we found excess child mortality in some migrant groups, but not in all. The differences could not be explained by socioeconomic status.

Key words: Child health, Disparity, Ethnic groups, Mortality

Abbreviations

CI: Confidence interval

HR: Hazard ratio

CNS: Central nervous system

ICD: International Classification of Diseases

U5-mortality: Under-five-years mortality

WHO: World Health Organization

Introduction

There have been demonstrated important variations in health and health care among offspring of ethnic minorities.[1] Immigrants represent around 9% of the total Danish population today, and offspring of immigrants constitute a growing proportion of newborns.[2] The ethnic minority population in Denmark is still quite young. Systematic immigration started in the 1960s with a wave of labour migrants from Turkey, Pakistan and Yugoslavia. Although the government put a stop to labour migration in 1973, immigration from low-income countries, primarily from family unification, but also from an influx of refugees from the Middle East, Yugoslavia and Somalia, increased fivefold from 1980 to 2000.

A recent Danish population-wide study demonstrated excess foetal and infant mortality in some ethnic minority groups.[3] Results showed an increased stillbirth and infant mortality rate among ethnic Turkish, Pakistani and Somali children compared with ethnic Danish children, with a doubled risk of death before the child reached their one-year birthday. These results are in concordance with evidence from previous international studies [4-13], where an increased risk of death in infancy was seen for offspring of immigrants. A Dutch register study [10] on ethnic differences in both early and late child mortality (0-15 years) found that Turkish and Moroccan immigrant children had death rates twice as high as native Dutch children. Another Dutch study [14] on early child mortality (0-2 years) found that deaths from hereditary diseases in the first two years of life were four to five times higher among Moroccan and Turkish immigrants. Most studies on ethnic differences have focused on perinatal and infant mortality, whereas research into early childhood (0-5 years) mortality is limited. Under-five-years mortality (U5-mortality) is an often used indicator of the level of child health and overall development according to the World Health Organization (WHO). It is still not sufficiently known why infant mortality and early child health differ between ethnic groups within countries, and a detection of excess deaths due to preventable causes among immigrants could be used to identify areas where health care services or health education for immigrants needs improvement. Systematic differences in the occurrence of death in early life among subgroups of the population should be regarded as unwarranted, and to be able to reduce any excess mortality in some ethnic minority groups one needs to further understand in detail the underlying causes of death and factors that may determine mortality discrepancies. Whether the observed ethnic differences in infant mortality in Denmark also exist when looking into early childhood has not been investigated to date, neither has the underlying causes of death. The Danish population covering registries hold information on country of birth, links between parents and children, a variety of social information on individual level and complete information on serious health

outcomes. Thus providing a unique source to describe and investigate if children of immigrants in Denmark have a higher mortality compared to children born of native Danish parents. This present study seeks to examine ethnic differences in U5-mortality and causes of death in Denmark from 1973-2004 in a population-wide registry-linkage study according to maternal country of birth taking socio-economic factors in to account.

Methods

A large registry-linkage study was undertaken including all live-born singletons in the period from 1973-2004 to mothers born in Denmark (1,754,953) and the ten largest migrant groups; Sweden (6,254), Norway (6,230), Former Yugoslavia (10,109) consisting of Bosnia-Herzegovina, Serbia-Montenegro, Croatia, Macedonia and Slovenia, Somalia (7,058), Lebanon (10,029), Pakistan (10,947), Turkey (25,958), Afghanistan (1,417), Iran (2,956) and Iraq (5,439), comprising a total of n=1,841,450 children. The study database was created by a linkage of population-based registries at the national Danish Statistics Bureau, Statistics Denmark. All the children were followed-up measuring vital status, and in case of death, date of death and main cause of death from linkage to the Civil Registration System and the Danish Causes of Death Registry. Maternal variables (maternal age and parity) were obtained from the Medical Birth Registry and sociodemographic variables on both parents (paternal age, country of origin, taxable income, household size) from linkage to the Population Registry.

U5-mortality and death causes

U5-mortality from all causes was the primary outcome. All death causes were classified according to the International Classification of Diseases (ICD), ICD-8 from 1973-1993 and ICD-10 from 1994 and onwards. Death cause were divided into; 1) congenital malformations (ICD-8 740-759, ICD-10 Q00-Q99), 2) perinatal causes (ICD-8 760-779, ICD-10 P00-P96), 3) external causes from injuries and accidents (ICD-8 800-990, ICD-10 V01-Y98) and, 4) sudden death from unknown cause or ill defined cause (ICD-8 795-796, ICD-10 R95-96), 5) other causes defined as a combined category of the remaining death causes (e.g. neoplasm, metabolic and inherited causes and causes related to the respiratory, circulatory and digestive system). Congenital malformations were subdivided into; Central Nervous System (CNS) anomalies (ICD-8 740-743, ICD-10 Q00-07), heart and other cardiovascular anomalies (ICD-8 746-747, ICD-10 Q20-28), a combined category of respiratory, digestive, urinary and musculoskeletal anomalies (ICD-8748-756, ICD-10 Q30-45 & 60-79), chromosomal anomalies (ICD-

8 758, ICD-10 Q90-99) and multiple congenital anomalies (ICD-8 759, ICD-10 Q80-89). Perinatal causes were subdivided into; maternal factors for complications of pregnancy, labour and delivery (ICD-8, 760-763, ICD-10 P00-04), disorders related to length of gestation and foetal growth (ICD-8, 777, ICD-10 P05-08), birth trauma, respiratory and cardiovascular disorders (ICD-8 764-769, 772 & 776, ICD-10 P10-15 & P20-29) and other perinatal death causes (ICD-8, 770-771, 773-775 & 778-779, ICD-10 P35-96).

Ethnicity

Ethnicity of the child was defined by maternal country of origin based on the definition used by Statistics Denmark. All births to women born outside of Denmark are referred to as children of the mothers country of birth, and children born to mothers who themselves were born in Denmark as ethnic Danish. All children born of immigrant mothers are descendents denoted as second generation in the country. In this study we regard country of birth as a reasonable approximation for ethnicity.

Explanatory variables

We were primarily interested in the crude risk of early child mortality associated with the different ethnic groups rather than a theoretical defined adjusted population. Despite that, we still wanted to test potential modification by preselected variables (maternal age, paternal age, parity, and household income) based on previous research into child mortality [14 15] and observed variations between the ethnic groups. An adjusted household income was used as a measure of socioeconomic status based on an equivalence function defined by OECD; sum of both parents taxable income divided by the square root of the sum of adults and children in the household taken January 1st prior to the birth year.[16] Household income was categorized into quartiles based on the income distribution of the study population (0-25, >25-50, >50-75, >75-100), corresponding to 0-18348, >18348-24848, >24848-32157, >32157 Euros. Income was however not available from the registries before 1981. Maternal age at the time of birth was categorized into (<25, 25-29, 30-34, and ≥35 years), parity into primiparity, 1 previous birth, and >=2 previous births. Paternal age at the time of birth was categorized into (<25, 25-29, 30-34, 35-39, 40-44, ≥45 years). Ethnicity of the father was defined in relation to the mother as same ethnicity, Danish, different ethnicity, and unknown.

Statistical analysis

Survival analyses with Cox proportional hazards regression model were used to estimate the hazard ratios (HRs) of all-cause and cause-specific U5-mortality according to maternal country of origin. All children contributed with follow up time (person-time at risk) from birth until occurrence of event (death before the age of five), loss to follow-up (emigration) or their fifth birthday. Age was used as the analysis time scale. Children with deaths occurring the same day as they were born were given a minimum person-time of one day. HRs and corresponding 95% confidence intervals (CI) were estimated using ethnic Danish children as the reference group. All estimates were adjusted for year of birth to account for concurrent changes in mortality rates and a varying number of children in the different ethnic groups during the study period. The regression model was also run including maternal age, parity and paternal age separately as covariates to test potential mediation by these variables.

Household income was not available for the period from 1973-1980 and therefore analysis including household income was conducted on a subset of the study population consisting of children born in the period from 1981-2004. We excluded families with negative incomes or inadequate information on household size (4.3%). These regression models were also run with the covariables included separately. An additional sensitivity analysis restricted to children of mothers in the highest income quartile (75-100 percentile) was conducted.

The distribution of explanatory variables was compared across the ethnic groups by use of Pearson χ^2-test.

To test whether the effect of ethnicity on the risk of U5-mortality (from all causes) varied according to levels of the individual explanatory variables (maternal age, paternal age, parity and household income), effect measure modification between ethnicity and the explanatory variables were assessed by examining the statistical significance of a likelihood ratio test of the difference between the model with and without the interaction terms with all main effects included. To examine the influence of infant mortality on the overall findings, we conducted a sensitivity analysis where we allowed for different effects of ethnicity before and after the first year of follow-up. The proportional hazards assumption was checked by plotting the log cumulative hazards against age for the 11 ethnic groups and by testing if an interaction between ethnicity and log(time) could be observed.

Results

The distribution of the explanatory variables differed significantly across the 11 ethnic groups (Table 1.). Mothers from Turkey, Pakistan, Former Yugoslavia and Lebanon were on average younger than ethnic Danish mothers, whereas the other ethnic mothers were slightly older. Higher parity was seen for the majority of immigrant women. Except for Swedish-, Norwegian-, and Turkish-born fathers, paternal age was higher among immigrants. Paternal country of origin was for the majority identical to the mothers. Except for families of Swedish and Norwegian origin, adjusted household income was clearly lower in immigrant families. During the study period 14,172 children died before the age of five years (Table 2). In total, 32% of all deaths were caused by congenital malformations, 32.4% by perinatal causes, 6.2% by external causes (e.g. from injuries and accidents), 11.2% from sudden deaths of undefined causes and 18.2% from a combined category of the remaining causes of death. Table 2 shows the crude rates, estimated HRs and 95% CIs for U5-mortality, adjusted for birth year, maternal age and parity. Offspring of Pakistani and Iraqi mothers had an almost doubled risk of dying before the age of five years. Somali and Turkish offspring had a 50% increased hazard compared to ethnic Danish children. Offspring of Afghani mothers also had a considerable elevated risk, thus results were based on very few cases. The remaining ethnic minority groups did not reveal any elevated overall U5-mortality. Independent adjustment for maternal age and parity did not change the results noteworthy. Adding paternal age to the model somewhat increased the estimates of Turkish, Pakistani and Iranian offspring, yet slightly decreased the remaining estimates. No effect measure modification was found between ethnicity and either three variables (maternal age, parity or paternal age).

Adjustment for household income slightly attenuated all estimates, yet an increased relative risk remained for offspring of Turkish, Pakistani, Somali and Iraqi-born mothers as in the non-adjusted model (Table 3.). Restriction to offspring born of parents in the highest income category for the whole population (75-100 percentile) increased the relative risk considerably for the Pakistani, Turkish, Somali and Iraqi offspring, and attenuated estimates for Somali-born offspring (results not shown). No effect measure modification was found in these restricted analyses.

Additional cause specific sub-analyses revealed a consistent elevated risk of death from congenital malformations across non-European immigrant children, including Turkish offspring with the exception of Iranians. This was not seen for European immigrant groups. Death from perinatal causes showed a less consistent pattern, but was most elevated for Iraqi and Pakistani offspring. Pakistani and Iraqi offspring also had

the highest risk of death from external cause (traffic accidents and injuries from burning, poisoning and falls), however external causes of death accounted for a very small proportion of all deaths. For the ethnic Turkish, Pakistani and Iraqi offspring we examined the underlying ICD-codes and found that hereditary disorders account for 1/3 of all deaths from the category of other death causes (results not shown). Children of non-European immigrants appeared to be at consistently lower risk of sudden death, whereas offspring of Norwegians had an excess risk, although the numbers were small. Except for offspring of Former Yugoslavians, an increased risk of death from the combined category of other causes of death (e.g. neoplasm, metabolic and inherited causes and causes related to the respiratory, circulatory and digestive system) was observed for all minority groups. No violation of the proportional hazards assumption was noted from visual inspection of the log cumulative hazard plot, and a global test of proportionality was fulfilled. Moreover excluding deaths within the first year of age did not chance the findings.

Discussion

Findings from this study showed ethnic differences in U5-mortality and underlying death causes in Denmark during the period from 1973-2004. Overall, Pakistani, Somali, Iraqi and Turkish offspring had an increased risk of dying before the age of five years compared to ethnic Danish offspring. The majority of deaths were due to congenital malformations and perinatal causes, the two death causes accounting for the majority of deaths in the infant period. However, excluding deaths within the first year of life did not change the findings. This suggests that the observed ethnic differences in early child mortality are not driven by differences in infant mortality alone. Ethnic disparities were also found in external causes and other causes of death, although these results were based on a small number of cases. Ethnic differences previously found in infant mortality in Denmark seem to pertain in the first 5 years of life.

Despite the limited amount of studies on this research topic, our findings are comparable to results from a Dutch study on ethnic differences in early and late child mortality (0-15 years) [10], finding Turkish and Moroccan children with twice as high a death rate as native Dutch children. In the 1-4 year old children hereditary disorders and external causes largely contributed to the ethnic differences. In our study, Pakistani offspring also had an excess risk of death from external causes primarily comprised of drowning, burning, falls and traffic accidents. Some of the other minority groups also showed elevated point estimates, however external causes only accounted for a very small number of all deaths, and results should be interpreted carefully. The

aforementioned Dutch study showed that one quarter of the ethnic children actually died during visits to the mother's country of origin. No information on whether the child deaths occurred during home country visits where available in our dataset and underlying causes of this observation requires further investigation. Our examination of the underlying ICD-codes suggested that hereditary disorders made up about a 1/3 of all events among other death causes. This is similar to Schulpen et al.[10, 14] who found that inherited congenital conditions were one of the main causes of the excess risk of mortality among Turkish and Moroccan preschool children. It has been show that advanced paternal age is associated with an increased rate of congenital malformations and other severe diseases (e.g. childhood cancer).[15] Despite higher paternal ages of immigrant fathers in our study, we did not find that differences in paternal age could explain the observed differences. It has also been suggested that a higher frequency of malformations and inherited disorders in some ethnic minorities could be explained by consanguine marriages.[17] A study on early mortality and consanguinity in India and Pakistan revealed that U5-mortality was significantly increased for children of first cousins compared to non-cousins.[18] Consanguinity is the most plausible explanation for the excess death from inherited disorders in our study. Unfortunately, consanguine relations have not been registered in Denmark. Nonetheless, in Norway data on familial relationships are systematically registered for all births, and results from a large registry study [17] on consanguinity and birth defects showed that 28% of birth defects could be attributed to consanguinity in Pakistani offspring. Registration in Norway has showed that 40% of second generation Pakistani, 17% of second generation Turkish and 7% of second generation Somali children have consanguine parents [3], but the proportion has been decreasing over time.[19] It is likely that a similar pattern could be present in Denmark. Nevertheless, interpretation of the data without direct information on consanguinity still remains on tentative grounds. We found that Turkish and Pakistani offspring had a higher risk of dying from CNS anomalies. Offspring of Lebanese, Somali and Former Yugoslavians also had a substantial elevated risk, yet sub-analysis should be interpreted carefully due to a substantial reduced number of cases. A study from the United Kingdom found that infants of Pakistani mothers had an excess risk of dying from CNS anomalies compared with infants of mothers born in the United Kingdom.[20] A Dutch study [21] found less knowledge of the prophylactic effect of folic acid among non-western compared to western women. In Denmark, it has been shown in 2005 that less than 20% of all pregnant women follow the official recommendations on periconceptional folic acid supplementation.[22] Whether a further ethnic gradient exists is still unknown, yet periconceptional use of folic acid could be a possible explanation,

which would suggest that folic acid supplementation campaigns targeted towards immigrant women might help eliminate the ethnic disparities.

Pakistani and Iraqi offspring had a significantly increased risk of dying from perinatal causes. Timely and adequate antenatal care is an acknowledged method for preventing adverse birth outcomes [23], and could be an explanation for part of the excess perinatal mortality. An increased risk of suboptimal pregnancy care in ethnic minority groups has been found in previous studies.[24, 25] Almost all health care services in Denmark are free of charge for all residents, and all women irrespective of ethnic origin should have free access to prenatal care at any hospital. Despite this, a recent Danish study[26] found lower attendance rates at free preventive child care examinations among immigrant children, an unfortunate trend that may also be present in the use of antenatal care among immigrant women. No recent studies have looked at this in a Danish setting. A Dutch study however showed that the first antenatal care visit often occurred later among immigrant women when compared to ethnic Dutch women.[27] Lack of knowledge of or negative attitudes towards prenatal screening and/or pregnancy termination could have an effect on death rates from congenital malformations and perinatal causes. A study in United Kingdom found that Pakistani women held more positive attitudes to prenatal testing, but less favourable attitudes to termination when compared to women from the majority population.[28] Further research into the use of antenatal care, screening and diagnostic among immigrant women in Denmark is required to understand if these mechanisms are important.

Our results showed a reduced risk of sudden death, primarily from sudden infant death syndrome in most of the non-European immigrant children when compared to ethnic Danes. These findings are contrary to a Dutch study on childhood mortality were sudden infant death syndrome rates for Turkish offspring was twice as high as for Dutch infants.[29] Our findings are, however, in line with a Norwegian study by Kyle et al. [30], who found a similar lower risk of sudden infant death syndrome among offspring of Asian immigrants. Offspring of Norwegian mothers on the other hand had twice as high a risk, which is in line with the fact that Norway had the highest incidence in the sudden infant death syndrome epidemic.[31] Our data showed a similar trend for Norwegian children living in Denmark. However, inferences from these results should be made with caution due to very small number of cases.

Some studies argue that socio-economic inequalities and not ethnicity can explain ethnic health disparities, while other studies advocate differently.[32] Except for the Norwegian and Swedish group, inclusion of household income in the regression model slightly attenuated all relative risk estimates for all groups, yet the overall picture stayed

the same, not supporting that the observed disparities simply should be explained by differences in socioeconomic status. This is different from the findings of Bos *et al.* [33] in the Netherlands, were deaths rates were substantially influenced by socioeconomic status. The difference may be due to the choice of socioeconomic marker as adjusted household income may not sufficiently capture differences in socioeconomic status. In a previous Danish study [3] on ethnic differences in stillbirth and infant mortality, findings were not attributable to ethnic differences in socioeconomic position as defined by both household income and maternal education. A Dutch study [14] also found ethnicity to be a more important predictor of perinatal and infant mortality than socioeconomic status, followed by maternal age and parity. Results from restriction to the highest income category (75-100 quartiles) substantially reduced the group sizes, yet still showed elevated relative risks for offspring of Iraqi, Pakistani and Turkish mothers. Only a small part of the 1981-2004 population had missing or inadequate information on household income, and any missing data is regarded as being independent of outcome status. Moreover, very good agreement was found between findings in the 1973-2004 and 1981-2004 study populations.

The use of ethnicity as an epidemiological variable is controversial, and whether maternal country of birth is an adequate measure of ethnicity is debatable. It is a commonly used definition, and while it is crude it has the strength of being easy to measure and stable over time. Some argue that self-reported ethnicity may be the most appropriate measure ahead of race and religion [34], but country of origin was the only available variable in Danish registries. It should be noted that the association between (our definition of) ethnicity and the risk of U5-mortality does not itself establish causality. We tested the influence of each of the mediating variables (age, parity and socioeconomic status), but stress the fact that the mediator-adjusted estimates do not necessarily carry a causal interpretation. When adding mediators into models we are making two assumptions. The first assumption is that there is no interaction between ethnicity and the putative mediators.[35] [36] This was assessed as part of the model check and was not violated. The second assumption is that that there are no uncontrolled factors affecting both the mediator and the outcome. [37] This assumption is unlikely to be met, so it is possible that some bias of unknown direction is introduced when intermediary variables are included in the regression models.

This study included all live-born singletons in Denmark in the period from 1973-2004. The underlying data source of this article is the Danish Civil Registration System, which contains data on all births and death causes including a variety of socio-demographic variables. This makes the possibility of selection bias unlikely. This

offers a unique opportunity to conduct a population wide study that includes large enough ethnic groups to investigate the proposed research question. According to Statistics Denmark country of birth is reliably measured, and hence not considered to contribute with any bias. For a small part of the mothers, country of origin was however discordant over time and in these cases we used the country of origin updated by January 2007. This may be due to a reorganization of the population statistics in July 2007, most probably of no importance. The Danish Causes of Death Registry contains data from all death certificates issued in Denmark (100% coverage), fully updated until the end of 2004. Up till 4 causes of death can be ascribed each case, only one is the primary underlying death cause based on the conclusion of the individual attesting doctors, potentially vulnerable to some misclassification. Yet, there is no reason to assume that registration of death causes should be misclassified systematically according to ethnicity.

It should be noted that the association between our definition of ethnicity and the risk of U5-mortality does not itself establish causality. We ran models testing the individual influence of fundamental modifying variables (age, parity, socioeconomic status), yet unknown within-country variations and unaccounted for modification by unavailable or unknown variables may be inherent in the results.

Is has been suggested that economic migrants may have better health than e.g. refugees.[38] The immigrant population of this study consisted of a wide range of different migrant types, from labour workers, to family unifications and refugees, however no specific pattern of health outcomes with immigration type was seen. We find no clear cut explanations for the observed ethnic differences, they may be related to both pre- and post immigration exposures, cultural assimilation, language competences, religious convictions, notions and practices of health and use of health care services. Future research should focus on unravelling further underlying causes, and more importantly preventive measures should be taken to reduce these observed disparities in early child mortality.

Conclusion

Significant excess early child mortality was found for ethnic Turkish, Pakistani, Somali and Iraqi offspring compared to the ethnic Danish majority. The remaining ethnic minority groups did not show any excess early child mortality. Our results do not support the supposition that socioeconomic status may be the underlying explanation behind the observed ethnic differences in early child health in Denmark.

Contributors

GSP and AMNA conceived the study idea. GSP performed the statistical analyses, and drafted the manuscript. AMNA and LHM supervised the study, assisted in analysis and interpretation of the data, revised the manuscript critically at several occasions and contributed with important intellectual content. All authors listed in the manuscript has seen and approved the submitted version and takes full responsibility of the manuscript.

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Table 1| Explanatory factors stratified by maternal country of birth, Denmark 1973-2004.

	Ethnicity†								
	Danish	Turkish	Pakistani	Fr. Yugoslavian	Lebanese	Somali	Swedish	Norwegian	Iraq
N live births	1.754.953	25.958	10.947	10.109	10.029	7.058	6.254	6.230	5.53
Sex (%)									
Boys	51.3	50.9	50.7	51.1	51.1	51.1	52.1	51.1	51.8
Girls	48.7	49.1	49.3	48.9	48.9	48.9	47.9	48.9	48.2
Maternal age (%)									
<25	26.2	53.6	37.4	43.8	46.9	20.4	21.2	19.4	28.4
25-29	39.2	26.9	35.0	30.8	28.9	37.2	32.7	37.0	32.9
30-34	25.3	13.4	18.7	17.5	16.4	29.8	30.6	29.7	24.1
≥35	9.3	6.1	8.9	7.9	7.8	12.6	15.5	13.9	16.4
Parity (%)									
Primiparity	53.0	37.8	32.3	43.5	25.8	21.3	53.7	52.7	33.7
1	34.6	31.8	28.6	36.1	24.3	23.4	33.4	33.4	30.7
2+	12.4	30.4	39.1	20.4	49.9	55.3	12.9	13.9	35.6
Paternal ethnicity (%)‡									
Same as maternal	92.0	95.2	89.6	83.7	85.4	84.2	4.1	4.8	88.8
Danish	0.0	0.8	0.9	8.1	0.6	1.2	82.0	82.3	1.2
Different	3.1	1.4	3.1	3.1	11.9	3.2	6.5	5.9	7.4
Paternal age (%)									
<25	12.0	31.5	11.9	17.9	11.3	5.2	9.9	9.0	4.9
25-29	32.8	31.5	27.1	31.3	28.6	17.1	27.3	29.5	14.2
30-34	32.0	19.5	26.7	25.9	28.2	29.5	32.6	32.3	29.0
35-39	15.1	10.3	17.9	14.3	18.8	22.4	17.8	17.2	27.8
40-44	4.8	3.9	8.5	5.3	7.6	10.3	7.0	6.6	15.1
≥45	1.8	1.8	5.2	1.8	5.4	5.4	3.0	3.3	6.6
Missing	1.5	1.5	2.7	3.5	2.3	9.9	2.3	2.2	2.4

Household income (%)§		*1.301.310*	*23750*	*9.039*	*8.860*	*10.015*	*7.045*	*4.274*	*4.657*	*5.53*
				HR† for U5-Mortality						
0-25 percentile		20.7	46.4	65.4	33.2	71.1	70.9	35.1	39.0	63.1
25-50 percentile	Live birth	23.5	30.4	17.7	29.5	20.8	15.7	17.0	16.0	25.0
50-75 percentile		25.4	14.9	8.2	19.9	4.7	5.8	18.9	17.5	6.5
75-100 percentile		26.5	5.9	4.9	13.3	1.5	2.1	23.4	22.2	2.8
Missing information	1,754,953	3.9	13,412	2.4 7.6	3.8 1.00	4.1 1.00	1.0	5.5 1.00	5.6 5.3	1.00 2.6

		Child deaths	Mortality rates	Adjusted for year of birth	Adjusted for maternal age†	Adjusted for parity§	Adjusted for paternal age¶

*p-value for χ^2-test (categorical variables).

† Ethnic group, by maternal country of birth.

‡ Paternal country of birth.

§ Children born in the period from 1981-2004 (n=1.378.833). Household income is equal to; (sum of parents income/√sum of adults and children in the household). Quartiles are based on the income distribution of the study population, corresponding to; (0-18348, >18348-24848, >24848-32157, >32157).

Table 2 | Hazard ratios (HR) and 95% confidence intervals (95% CI) of U5-mortality by maternal country of birth, Denmark 1973-2004.

Turkish	25,958	266	10.2	1.48 (1.31-1.67)	1.38 (1.22-1.56)	1.46 (1.29-1.65)	1.66 (1.48-1.8
Pakistani	10,947	150	13.7	1.97 (1.68-2.32)	1.91 (1.63-2.25)	1.92 (1.63-2.26)	2.22 (1.85-2.6
Former Yugoslavian	10,109	63	6.2	1.07 (0.83-1.37)	1.00 (0.79-1.29)	1.06 (0.83-1.36)	0.96 (0.72-1.2
Lebanese	10,029	66	6.6	1.07 (0.84-1.37)	1.00 (0.79-1.28)	1.03 (0.81-1.32)	1.08 (0.84-1.3
Somali	7,058	55	7.8	1.70 (1.29-2.25)	1.68 (1.27-2.22)	1.64 (1.24-2.17)	1.57 (1.18-2.1
Swedish	6,254	47	7.5	0.98 (0.73-1.30)	0.98 (0.73-1.30)	0.97 (0.73-1.30)	0.95 (0.66-1.3
Norwegian	6,230	52	8.3	1.11 (0.85-1.46)	1.12 (0.85-1.47)	1.11 (0.85-1.46)	0.96 (0.67-1.3
Iraqi	5,439	40	7.4	1.92 (1.41-2.62)	1.86 (1.36-2.53)	1.89 (1.38-2.58)	1.73 (1.26-2.3
Iranian	2,956	19	6.4	1.08 (0.69-1.69)	1.06 (0.68-1.67)	1.08 (0.69-1.69)	1.18 (0.75-1.8
Afghani	1,417	7	4.9	1.97 (0.94-4.13)	1.88 (0.89-3.95)	1.92 (0.92-4.03)	1.86 (0.89-3.9

Mortality rates are per 1000 live births.

			HR† for U5-Mortality

* Ethnic group, by maternal country of birth.

† All HR's are adjusted for year of birth.

‡Adjusted for maternal age (<25, 25-29, 30-34, >=35).

§Adjusted for parity (primiparity, 1 child, >=2 children).

¶ Adjusted for paternal age (<25, 25-29, 30-34, 35-39, 40-44, ≥45).

Table 3 | Hazard ratios (HR) and 95% confidence intervals (95% CI) of U5-mortality from all causes by maternal country of birth, restricted to children with known household income during the period from 1981-2004.

	Live birth Death causes*	Child deaths	Mortality rates	Adjusted for year of birth	Adjusted for maternal age‡	Adjusted for parity§	Adjusted paternal a
Ethnic group*							
Danish	1.251.098	8.278	6.6	1.00	1.00	1.00	1.00
Turkish	22.956	222	9.7	1.48 (1.29-1.69)	1.34 (1.17-1.53)	1.45 (1.27-1.66)	1.59 (1.39
Pakistani	8.584	113	13.2	2.11 (1.76-2.55)	2.01 (1.67-2.42)	2.05 (1.70-2.47)	2.22 (1.84
Former Yugoslavian	8.458	46	5.4	1.00 (0.75-1.35)	0.93 (0.70-1.25)	1.00 (0.75-1.34)	1.05 (0.77
Lebanese	9.760	64	6.6	1.03 (0.80-1.32)	0.94 (0.74-1.21)	0.99 (0.77-1.27)	1.17 (0.91
Somali	6.614	47	7.1	1.55 (1.16-2.10)	1.51 (1.14-2.02)	1.49 (1.12-1.99)	1.84 (1.37
Swedish	4.012	24	6.0	0.93 (0.62-1.39)	0.94 (0.63-1.40)	0.93 (0.62-1.38)	0.91 (0.60
Norwegian	4.376	30	6.9	1.07 (0.74-1.52)	1.08 (0.75-1.54)	1.06 (0.74-1.52)	0.92 (0.61
Iraqi	5.355	38	7.1	1.74 (1.26-2.39)	1.65 (1.20-2.27)	1.71 (1.24-2.35)	2.03 (1.46
Iranian	2.846	18	6.3	1.05 (0.66-1.66)	1.03 (0.65-1.64)	1.05 (0.66-1.67)	1.22 (0.77
Afghani	1.370	7	5.1	1.86 (0.89-3.90)	1.75 (0.83-3.67)	1.82 (0.87-3.81)	2.21 (1.05

Mortality rates are per 1000 live births.

* Ethnic group, by maternal country of birth, restricted to children with known information on household income during the period from 1981-2004 (n=1.326.038).

† All HR's are adjusted for year of birth.

‡ Adjusted for maternal age (<25, 25-29, 30-34, >=35).

§ Adjusted for parity (primiparity, 1 child, >=2 children).

¶ Adjusted for paternal age (<25, 25-29, 30-34, 35-39, 40-44, ≥45).

‖ Adjusted for household income (quartiles; 0-25, 25-50, 50-75, 75-100) based on the distribution of the study population.

	Congenital malformations		Perinatal causes		External causes		Sudden death, unknow cause	
	Cases	HR (95% CI)†	Cases	HR (95% CI)†	Cases	HR (95% CI)†	Cases	HR (95% CI)†
Ethnic group*								
Danish	4292	1.00	4394	1.00	841	1.00	1536	1.00
Turkish	82	1.43 (1.15-1.17)	63	1.11 (0.86-1.42)	11	1.05 (0.58-1.90)	13	0.62 (0.36-1.07)
Pakistani	44	1.76 (1.31-2.37)	36	1.43 (1.03-1.98)	11	2.32 (1.28-4.21)	4	0.44 (0.17-1.18)
Fr. Yugoslavian	27	1.06 (0.70-1.62)	15	1.07 (0.70-1.63)	4	1.06 (0.40-2.84)	11	0.78 (0.35-1.75)
Lebanese	22	1.37 (0.94-2.00)	22	0.79 (0.47-1.31)	4	1.19 (0.44-3.18)	6	1.47 (0.81-2.67)
Somali	25	2.08 (1.40-3.09)	12	1.05 (0.59-1.85)	2	1.02 (0.25-4.09)	2	0.43 (0.11-1.72)
Iraqi	11	1.26 (0.69-2.27)	15	1.79 (1.08-2.98)	3	2.08 (0.67-6.50)	0	-
Norwegian	14	0.93 (0.55-1.57)	14	0.91 (0.54-1.54)	4	1.36 (0.51-3.62)	10	1.86 (1.00-3.46)
Swedish	14	0.90 (0.53-1.51)	11	0.68 (0.38-1.23)	5	1.60 (0.67-3.86)	6	1.08 (0.49-2.42)
Iranian	6	1.03 (0.46-2.30)	7	1.23 (0.59-2.59)	1	0.99 (0.14-7.05)	1	0.45 (0.06-3.23)
Afghani	3	1.60 (0.52-4.98)	2	1.12 (0.28-4.49)	0	-	0	-

Table 4 | Hazard ratios (HR) and 95% confidence intervals (95% CI) of cause specific U5-mortality by maternal country of birth, Denmark 1973-2004.

* Ethnic group, by maternal country of birth.

†HR adjusted for birth year.

‡Death causes: Congenital malformations, ICD-8 740-759, ICD-10 Q00-99. Perinatal causes, ICD-8 760-779 ICD-10 P00-96. External causes (injuries and accidents), ICD-8 800-999 ICD-10 V01-Y98. Sudden death from unknown or ill-defined causes, ICD-8 795-796 ICD-10 R95-96. Combined category of other death causes, ICD-8 000-739, ICD-10 A00-N99 & R00-R94.

- Insufficient number of cases.

Appendix

Table 1. Hazard ratio and 95 % CI of U5-mortality by ethnic groups, stratified by sex. Denmark 1973-2004.

Ethnic group	Boys*	Girls*
Danish	1.00	1.00
Turkish	1.47 (1.25-1.73)	1.50 (1.25-1.81)
Pakistani	1.72 (1.37-2.16)	2.32 (1.84-2.91)
Former Yugoslavian	0.90 (0.63-1.28)	1.30 (0.92-1.82)
Lebanese	0.95 (0.67-1.34)	1.23 (0.88-1.74)
Somali	1.50 (1.01-2.23)	1.96 (1.32-2.91)
Swedish	0.78 (0.51-1.19)	1.25 (0.84-1.85)
Norwegian	1.10 (0.77-1.58)	1.13 (0.74-1.71)
Iraqi	1.61 (1.02-2.53)	2.34 (1.52-3.60)
Iranian	0.88 (0.46-1.69)	1.35 (0.72-2.50)
Afghani	1.46 (0.47-4.52)	2.66 (0.99-2.50)

*Adjusted for calendar time