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Maternal social characteristics and mortality from injuries among infants and toddlers in Estonia

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Abstract

Background – Injuries are a major cause of ill health among children, with a social gradient in child injuries documented in many countries. We investigated how maternal socio-demographic characteristics affect injury mortality among Estonian infants and toddlers.

Methods – A population-based study using linkage of data from the Estonian Medical Birth Registry with Mortality Database. 148,521 children born 1992-2002 were followed for injury mortality (ICD-9 E800-E999) from birth to third birthday. Associations of maternal age, education, marital status, nationality, place of residence, and child's birth order and multiplicity with risk of injury death were studied in logistic regression.

Results – Maternal age (<20 years compared to ≥ 30 years OR=2.12; 95% CI: 1.00-4.51), education (basic compared to secondary or higher OR=3.22; 95% CI: 2.12-4.87), marital status (single, divorced or widowed compared to married OR=2.74; 95% CI: 1.53-4.91), nationality (other compared to Estonian: OR=2.00; 95% CI:1.32-3.02), birth order (fourth or higher compared to first: OR=6.66; 95% CI: 3.42-12.99), and multiple birth (twin or triplet compared to singleton: OR=3.12; 95% CI: 1.44-6.73) affected the risk of injury death among infants (<1 year). Among toddlers (1–2 years), boys were at higher risk than girls (OR=1.75; 95% CI: 1.15-2.66) and low mother's education (basic compared to secondary or higher OR=2.08; 95% CI: 1.28-3.37) and high birth order (fourth or higher compared to first: OR=7.88; 95% CI: 3.90-15.90) increased the risk of injury death.

Conclusions – Maternal socio-demographic characteristics are associated with injury mortality among infants and toddlers. Substantial variation in injury mortality rates within Estonia suggests potential for prevention.

Introduction

Injuries and poisoning, often labelled as “external causes” (shortly “injuries”), are a leading group of causes of death and a major cause of disability and ill health among children.[1] Child injuries often occur in the home environment and are generally considered to be preventable.[1,2] The social structure in a society has important impact on child injuries[3,4], with a demonstrated effect of socioeconomic development on reduction of injury mortality rates among 1–4 year-old children.[5] On the other hand, periods of socioeconomic deprivation, politically and socially instable environments and unemployment tend to be associated with increased risk of injuries.[6,7]

Estonia has undergone fast structural changes during the transitional period after the collapse of the Soviet Union in 1991[4], which has affected the Estonian economy and public health and led to high unemployment rate, decreasing domestic product (GDP), and a decrease in both birth rate and life expectancy.[8] At the same time, family policy has remained relatively generous in Estonia, with parents having the right to parental leave until their child’s third birthday.[9] Increasing ethnic[10] and educational differences[11] in adult mortality rates, and mortality from injuries in particular, have been described in Estonia during the period of transition after 1991. For example, the number of deaths per 100 000 due to alcohol intoxication increased in Estonia during

1990–1994, from 3.6 to 13.2 among women and from 19.3 to 44.3 among men.[7] There is a well described social patterning of alcohol drinking, and heavy and binge drinking in particular, in the Estonian population.[12,13] Large social inequalities in infant survival have been previously described for the period of transition in Estonia.[8]

Child injury mortality in Europe

Injuries contribute substantially to the East-West gap in childhood death rates in Europe.[14,15] The magnitude of child (0–4 years of age) mortality from injuries in European countries is shown in Figure 1. Very high injury mortality rates are found in several former communist countries of Eastern Europe. In 2000–2002, the average mortality rate among Estonian boys was 44.8 per 100 000, i.e. almost ten times higher than the corresponding rate in Sweden (4.7 per 100 000). The injury mortality rate for Estonian girls was considerably lower, 28.8 per 100 000, but still more than ten times higher than in Sweden (2.7 per 100 000).

Insert Figure 1 here.

Socioeconomic factors and injuries

A social gradient in child injury mortality has been documented in a number of middle and high income countries including the United Kingdom[16], Greece[17] and the Czech Republic[18]. Individuals living in poverty may be particularly vulnerable to injuries, because of their higher exposure to risky situations, unsafe environments and risky behaviours.[19] Moreover, it is plausible that place of residence influences child injuries, e.g., traffic injuries in urban areas.[6] Other individual social factors that have been found

to increase the risk for child injuries are low maternal education and age at birth, large family size[19], immigration[6] and parity[20].

The objective of the current study was to investigate whether maternal social characteristics are associated with injury mortality in Estonian infants and toddlers.

Data and Methods

Data

For every newborn in Estonia, detailed birth data have been collected in the Estonian Medical Birth Registry since 1992. The birth registration form is filled in at a maternity ward and/or postnatal ward and contains information on the mother and the infant. The quality and completeness of the Estonian Medical Birth Registry is considered to be good.[21] Birth records from 1992–2002 (149 318 live births) were linked to the Estonian Mortality Database by a unique personal identification number. Over the study period, three different classifications of causes of death were in use in Estonia: abridged Soviet classification based on ICD-9 in 1992–1993, ICD-9 in 1994–1996, and ICD-10 in 1997–2005. To ensure uniformity, underlying causes of death were recoded to ICD-9 in the Mortality Database. Injury deaths analysed in the study included ICD-9 codes E800–E999.

The linkage was not successful for 1.3% (25 cases) of all deaths, and for 6.4% (15 cases) of injury deaths, recorded in children until the third birthday. Twelve of the unlinked injury deaths were homicides at age 0–1 day without any information on the mother and without recorded place of residence. Birth records with missing data on social characteristics (797 births and one death) were excluded from the analysis. Two age

groups were studied separately – infants (<1 year of age) and toddlers (1–2 years of age).

Maternal social characteristics

Maternal education was used as an indicator of socioeconomic status, and classified into two categories: secondary or higher, and basic. Mother's marital status was categorized as married, cohabiting, and other (single, divorced, widowed), and mother's nationality as Estonian and non-Estonian (mainly Russian). The mother's place of residence was classified into two groups: five largest **Estonian** cities (Tallinn (the capital of Estonia), Tartu (a University City), Narva, Kohtla-Järve and Pärnu) and other. Birth order (based on the number of mother's deliveries) of the child was analysed as first, second, third, and fourth or higher, and the gender of the child (boy or girl) was taken into account. Maternal age was analysed in three categories (<20, 20–29, ≥30 years), and multiplicity as singleton birth and multiple birth.

Methods

Logistic regression models using Stata statistical package were performed to estimate the differences in risk of injury death between different socio-demographic groups. Crude and fully adjusted (for gender of the child, maternal education, marital status, nationality, maternal age, multiplicity, birth order of the child and place of residence) odds ratios (OR) for injury death (vs. alive) with 95% confidence intervals (CI), are reported.

The study was approved by Tallinn Medical Ethics Committee.

Results

A total of 148 521 live births (99% of all births) were included in the analysis, and there were 122 injury deaths registered among infants. There were 146 832 infants who survived their first year of life and among these, 97 injury deaths were observed before the third birthday. The largest number of injury deaths among infants (91 cases) and toddlers (40 cases) was caused by submersion, suffocation and foreign bodies.

The dominant maternal characteristics of live born children were: secondary education (37.7%), married (53.1%), Estonian nationality (71.8%), 20–29 years of age (63.8%), singleton pregnancy (98.0%), first born child (49.4%) and living in rural areas (54.6%) (Table 1).

Insert Table 1 here.

Determinants of injury death among infants

Cumulative overall mortality rate was 1 137 per 100 000 and cumulative injury mortality rate 82 per 100 000. Injury deaths constituted 7.2% of all deaths in this age group. However, when excluding neonatal deaths (0–27 days), injury deaths accounted for 17.9% of all deaths in postneonatal period.

Boys had somewhat higher injury mortality odds than girls (Table 1). Educational level of the mother influenced strongly infant injury mortality, but the effect of education decreased after adjustment. Infants of cohabiting or single mothers had more than twofold statistically significant excess of injury mortality risk compared to children of married mothers. Infants of non-Estonian mothers had twice as high risk of injury death than those of Estonian mothers. A statistically significant effect of place of residence on the

injury mortality risk was observed in the crude model, however, this association became not significant on further adjustment. Infants of young mothers (<20 years) had a twofold risk of death from injury compared with infants of mothers aged 30 or more years.

Multiplicity and birth order were strongly associated with injury mortality risk (adjusted ORs 3.12, 95% CI 1.44-6.7 for multiple compared to singleton birth and 6.66, 95% CI 3.42-12.99 for fourth or higher compared to first born).

Determinants of injury death among toddlers

In toddlers, 41.3% of all deaths were due to injuries. Cumulative overall mortality rate was 160 per 100 000 and cumulative injury mortality rate 66 per 100 000.

Boys had significantly higher injury mortality odds than girls (Table 2). Low maternal education was associated with elevated injury mortality risk. Neither mother's marital status nor nationality were statistically significantly associated with injury death among toddlers. There was a suggestion of an increased risk of injury death among toddlers of young mothers, however, the association was not statistically significant. Similar to the associations observed for infants, the effect of place of residence was statistically significant in univariable analysis but became substantially weaker and statistically not significant on adjustment. Toddlers of high birth order (≥ 4) were at almost eight times higher risk of injury death compared to first born children.

Insert Table 2 here

Type of injury deaths for boys and girls in infants and toddlers

When comparing the specific injury death causes among boys and girls in infants and toddlers, we noted substantial variation (Table 3). Injuries caused by submersion, suffocation and foreign bodies constituted three quarters of injury deaths among infants, for both boys and girls. Half of deaths among toddler boys were caused by the same type of injuries (mostly drownings), while toddler girls had the largest proportion (26%) of injury deaths due to accidents caused by fire and flames.

Insert Table 3 here

Discussion

Main findings

This is the first detailed study addressing maternal socioeconomic factors as determinants of injury death among infants and toddlers in Estonia. We found that maternal education and birth order of child had strong effect on injury mortality among both infants and toddlers. Children of mothers with basic or lower education had more than twofold increased risk for injury mortality. High birth order (≥ 4) was associated with more than sixfold injury mortality excess. Mother's marital status, nationality, age and multiplicity increased injury mortality risks significantly among infants. Among toddlers, these factors were not equally significant.

Strengths and limitations

Population-based register data from the Estonian Medical Birth Registry and the Estonian

Mortality Database are considered to be of reasonable quality. Consistency checks and comparisons of birth and death records did not indicate problems that could seriously bias the results. A relatively small and stable proportion of missing data on exposure variables suggest that this study provides valid estimates of social variation in injury mortality among children. Personal identification numbers were available for all live births, and the follow-up was almost complete. The cases of death that we were unable to link to the Medical Birth Registry data included a large proportion of intentional injuries in infants aged 0-1 days, and the overall rate of mortality from intentional injuries is thus likely to be underestimated in our study. A range of social characteristics of mothers, who are the primary caretakers of children in the Estonian context, was available for the analysis. On the other hand, we lack, unfortunately, information of the father's social characteristics which may also influence infant and toddler injury mortality. There are some general issues in measuring socioeconomic position in pregnant women and mothers of young children, and it is likely that some of the indicators used in our analyses are subject to misclassification. It is also possible that e.g. marital status, place of residence or education of mothers could have changed between pregnancy and the third birthday of the index child. Some young mothers might not have completed their education at the time of the birth of the index child, but it was not practical to obtain additional information on later educational achievement within this study. In the absence of paternal or family socioeconomic characteristics, we do believe that our analysis provides valuable evidence on large social inequalities in injury mortality in early childhood. The statistical power of this study was not sufficient for analysis of time trends in the strength of social effects on child injury mortality, and we could not analyse social determinants

of specific types of injury deaths either.

Consistency with previous studies and interpretation of results

Social gradients in injury mortality among infants and toddlers have been found in earlier studies conducted in the Nordic countries[22–24], other European countries[2,17] and in the United States.[20,25,26] Children from working class homes had higher injury mortality, compared to non-manual class children in Sweden and Finland.[22–24] Social gradient in infant deaths from injuries was also found in another transition country, the Czech Republic in 1990s.[18] Our results are thus consistent in showing a strong social patterning of infant injuries in Estonia in 1992–2005. They also elaborate on earlier findings of strong social gradient in all-cause infant mortality in Estonia.[8] Factors such as access to emergency care could mediate the increased risks for injury mortality among infants living in rural areas as well as among the disadvantaged socioeconomic groups. About 30% of the Estonian population were living in rural areas in 1999.[4] The largest (university) hospitals are located in the Estonian cities.[4] Although health services are provided free of charge for children in Estonia[4], quality of care may differ between hospitals as well as between socioeconomic groups.[27]

Toddlers of mothers with basic education compared to secondary or higher, had twofold risk of injury death, and infants of mother with basic education had three times higher risk of injury death. These results are remarkably consistent with an earlier study in the United States.[20] Educational level is an important mechanism by which the labour market position in adulthood is achieved[28] and can be considered as a proxy for occupational class and material conditions of the family. It is also plausible that maternal

education is closely associated with parental knowledge, skills, access to information or attitudes to risk taking. Moreover, as argued by Heyman[29], mothers with low education are also likely to be disadvantaged in terms of the extent and quality of social networks, access to quality child care or adequate supervision that could all impact on young children's risk of injury.

It is also important to consider common behavioural risk factors among the parents, such as alcohol abuse and smoking, as recently suggested by Estonian authors.[30] Maternal smoking is associated with an increased risk for fires and injuries from fire burns.[6] About 20% of Estonian women were daily smokers in 2004.[31] Women with low education were likely to be frequent smokers. Children are at risk from both violence and negligence of drunken parents,[19] and in Russia, alcohol intake was estimated to be a main trigger of up to 85% of injuries and violence.

A higher risk of injury death associated with higher birth order is consistent with findings of several previous studies.[20,26,32,33] We speculate, as others[26,33], that the main reason behind the increased risk in children of high birth order is lack of supervision. It has been reported that sibling supervision increases the risk of injury in a Canadian study.[33] Sibling supervision is also common among Estonian infants and toddlers.

There is a well documented gender difference in injury mortality, and boys have generally higher mortality rates from injuries than girls.[4,18] In our study, statistically significant gender difference was seen among toddlers, but not in infants, a finding consistent with a study of American children.[20] Although it is plausible that some of the gender difference might be related to parenting practices, it is interesting to note that a

cross-cultural study on Estonian and Finnish mothers and fathers found no differences in child-rearing values due the gender of the child or maternal educational level.[34] This suggests that Estonian boys and girls are not intentionally reared differently due to gender.

In Sweden, immigrants had higher rates in injuries, compared to native born and the injury rates differed among immigrant groups.[6] In our study, the effect of nationality was only observed among infants. After adjustment for other maternal characteristics, infants of non-Estonian mothers had twofold injury mortality increase, compared to infants of Estonian mothers.

The most common causes of deaths among infants were inhalation and ingestion of food causing suffocation and accidental mechanical suffocation, while accidental drowning and submersion, accidents caused by fire and flames and transport accidents were more frequent among toddlers. Drowning and transport injuries being more common among toddlers were also found in a previous Estonian study.[30] Moreover, we found that drowning was the leading injury death cause among toddler boys, while injuries caused by fire and flames were the leading injury death cause among toddler girls. These findings indicate that it is important to develop injury prevention strategies that consider both age and gender differences in the aetiology of injuries deaths.

Child abuse is recognised as an important issue in Estonia with a suspected link to parental socio-economic pressures[35] and there have been initiatives against child abuse in Estonia, focusing on prevention and family preservation.[36] A recent report on injury prevention in the Baltic States[37] acknowledges an existing injury prevention program in Tartu, and advocates more high-risk group targeted prevention and long-term

prevention programs with country-wide coverage.

Conclusions

Maternal socioeconomic characteristics are strongly associated with injury mortality among infants and toddlers in Estonia. There is substantial variation in injury mortality rates among infants and toddlers from different social groups within Estonia, suggesting important opportunities for prevention and for reduction of the overall high injury mortality rate in the country. There is an urgent need for better understanding of the specific causes and mechanisms leading to injuries and injury deaths in Estonian children that would facilitate implementation of new effective prevention strategies. There are a large number of intervention strategies with proven effectiveness in other European countries.[38,39] These need to be translated into the local contexts[40] and further evaluated with respect to their impact on social inequalities[41,42] in order to bridge the gaps and reduce the burden of injury mortality among children in Estonia.

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What is already known on this subject?

Injuries are a major cause of disability and ill health among children and a social gradient in child injury mortality has been documented in a number of middle and high income countries.

Increasing ethnic and educational differences in mortality from injuries in adults and large social inequalities in infant survival have been previously described in Estonia during the period of transition after 1991.

What does this study add?

Lower maternal education and high birth order increase the risk of infant and toddler injury death. Higher risks were also found for low maternal age, unmarried marital status, non-Estonian nationality and multiplicity of pregnancy among infants. Toddler boys had higher injury mortality than toddler girls.

Table 1 Number of live births, number of deaths from injuries and odds ratios (OR) for death from injuries (vs. alive) in infants (<1 year) born in Estonia 1992–2002, by socio-demographic characteristics.

Characteristic	No of live births	Deaths from external causes		
		No	Crude OR (95% CI)	Adjusted OR (95% CI)*
Gender of child				
Boy	76505	68	1.19 (0.83–1.70)	1.19 (0.83–1.71)
Girl	72016	54	1	1
Mother's education				
Secondary or higher	125616	65	1	1
Basic	22905	57	4.84 (3.39–6.91)	3.22 (2.12–4.87)
Mother's marital status				
Married	78838	38	1	1
Cohabiting	55900	65	2.42 (1.62–3.60)	2.28 (1.50–3.48)
Other	13783	19	2.88 (1.66–4.99)	2.74 (1.53–4.91)
Mother's nationality				
Estonian	106592	83	1	1
Non-Estonian	41929	39	1.20 (0.82–1.75)	2.00 (1.32–3.02)
Mother's age (years)				
<20	18158	22	1.49 (0.86–2.59)	2.12 (1.00–4.51)
20–29	94712	71	0.92 (0.60–1.41)	1.50 (0.93–2.44)
≥30	35651	29	1	1
Multiplicity				
1	145595	115	1	1
≥2	2926	7	3.18 (1.48–6.82)	3.12 (1.44–6.73)
Birth order				
1	73359	37	1	1
2	47102	36	1.52 (0.96–2.40)	2.40 (1.44–4.00)
3	17332	26	2.99 (1.81–4.93)	5.24 (2.89–9.49)
≥4	10728	23	4.29 (2.55–7.22)	6.66 (3.42–12.99)
Place of residence				
5 largest cities†	67432	38	1	1
other	81089	84	1.84 (1.25–2.70)	1.27 (0.83–1.95)

* Adjusted for all other variables included in the table.

† Tallinn, Tartu, Narva, Kohtla-Järve and Pärnu.

Table 2 Number of children alive at age of one year, number of deaths from injuries and odds ratios (OR) for death from injuries(vs. alive) in toddlers (1–2 years), born in Estonia 1992–2002, by socio-demographic characteristics.

Characteristic	No of children	Deaths from external causes		
		No	Crude OR (95% CI)	Adjusted OR (95% CI)*
Gender of child				
Boy	75537	63	1.75 (1.15–2.66)	1.75 (1.15–2.66)
Girl	71295	34	1	1
Mother's education				
Secondary or higher	124316	63	1	1
Basic	22516	34	2.98 (1.97–4.53)	2.08 (1.28–3.37)
Mother's marital status				
Married	78017	44	1	1
Cohabiting	55250	41	1.31 (0.86–2.01)	1.21 (0.77–1.89)
Other	13565	12	1.57 (0.83–2.97)	1.56 (0.79–3.07)
Mother's nationality				
Estonian	105486	76	1	1
Non-Estonian	41346	21	0.70 (0.43–1.14)	0.98 (0.58–1.64)
Mother's age (years)				
<20	17906	16	1.12 (0.61–2.08)	2.10 (0.90–4.90)
20–29	93753	53	0.71 (0.45–1.12)	1.27 (0.75–2.15)
≥30	35173	28	1	1
Birth order				
1	72612	30	1	1
2	46613	31	1.61 (0.97–2.66)	2.17 (1.24–3.80)
3	17085	10	1.42 (0.69–2.90)	2.00 (0.90–4.45)
≥4	10522	26	6.00 (3.55–10.15)	7.88 (3.90–15.90)
Place of residence				
5 largest cities†	66682	30	1	1
other	80150	67	1.86 (1.21–2.86)	1.23 (0.77–1.97)

* Adjusted for all other variables included in the table.

† Tallinn, Tartu, Narva, Kohtla-Järve and Pärnu.

Table 3 Number of deaths from injuries in infants (<1 year) and toddlers (1–2 years), born in Estonia 1992–2002.

Cause of death	Infants				Toddlers			
	Boys		Girls		Boys		Girls	
	No	%	No	%	No	%	No	%
Transport accidents (E800–E848)	2	2.9	3	5.6	10	15.9	4	11.8
Accidental poisoning (E850–E869)	3	4.4	0	–	0	–	5	14.7
Accidental falls (E880–E888)	2	2.9	1	1.9	3	4.8	3	8.8
Accidents caused by fire and flames (E890–E899)	2	2.9	3	5.6	10	15.9	9	26.5
Accidents due to natural and environmental factors (E900–E909)	0	–	0	–	2	3.2	0	–
Accidents caused by submersion, suffocation and foreign bodies (E910–E915)	51	75.0	40	74.1	32	50.8	8	23.5
<i>Accidental drowning and submersion (E910)</i>	0	–	4	7.4	25	39.7	5	14.7
Other accidents (E916–E928)	6	8.8	3	5.6	2	3.2	2	5.9
Homicide (E960–E969)	2	2.9	3	5.6	3	4.8	3	8.8
Injury undetermined whether accidentally or purposely inflicted (E980–E989)	0	–	1	1.9	1	1.6	0	–
Total	68	100	54	100	63	100	34	100

Legend figure 1

Figure1 Mortality rates (per 100 000) from injuries in selected European countries, age 0–4 years, 2000–2002. Source: WHO (Health for All database).

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