ORIGINAL ARTICLE

Socioeconomic differences in injury risks in childhood and adolescence: a nation-wide study of intentional and unintentional injuries in Sweden

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Study objective: To measure socioeconomic differences in injuries among different age groups of children and adolescents.
Subjects: Children under 20 living in Sweden between 1990 and 1994 (about 2.6 million).
Method: A cross sectional study based on record linkage between 15 Swedish national registers. Children were divided into four age groups and allocated to four household socioeconomic status groups. Absolute and relative risks were compiled using children of high/intermediate level salaried employees as the comparison group. Four diagnostic groups were considered: fall, traffic, interpersonal violence, and self inflicted injuries.
Results: Injury incidences were relatively low and socioeconomic differences negligible in the 0–4 year olds. Thereafter, significant socioeconomic differences were observed in all diagnostic groups except falls. The highest absolute differences were in traffic injuries, especially among 15–19 year olds, and in self inflicted injuries among 15–19 year old girls. Relative differences were highest in both categories of intentional injuries for the age group 10–14. Social circumstances in the household other than family socioeconomic status affected the social pattern of intentional but not that of unintentional injuries.
Conclusions: Socioeconomic differences in injury risks are not necessarily constant over age. Inequalities are particularly high in absolute terms among adolescents 15–19 years old for traffic injuries and in relative terms among 10–14 year olds for intentional injuries.

Over the past decades, a number of European countries have recorded a significant reduction in overall rates of fatal injuries in childhood and adolescence.[1 2] Whether this reduction applies to children from all socioeconomic groups still remains unanswered. Nevertheless, there is considerable evidence of inequalities in childhood injury risks across social groups.[3–12]

In addition, there is little literature concerning how socioeconomic patterns vary at different ages during childhood and adolescence, as most previous studies have dealt with rather wide age categories. Likewise, possible variations by injury groups with increasing age are rarely addressed. Those questions require investigation because there is some evidence that socioeconomic differences for some types of injuries are reduced at early school ages.[13]

The current study addresses this question, taking into account four types of injuries with documented socioeconomic differences[10 11]: traffic related, falls, violence related, and self inflicted. The aim is to measure the extent of socioeconomic differences in both absolute and relative terms by age group.

METHODS

Creation of the dataset

This cross sectional study is based on a dataset created by record linkage between 15 Swedish national registers. The study base consists of all children and adolescents (0–19) living in Sweden between 1990 and 1994 (approximately 2 661 664). Subjects were identified in the Swedish National Population Register and their sex and age established by record linkage to the national censuses of 1985 and 1990 and the medical register of births.

Register based links between subjects and their parents were made to document socioeconomic status and other characteristics of households and living conditions. Children born in or before 1990 were matched with the adult(s) they lived with (biological parents or not) in the relevant census; those born after 1990 were matched with their biological mother and her living companion (where applicable), most often the child's biological father. Although we were unable to establish whether children born after 1990 were living with their biological mother, other Swedish data show that this is so for 97% of children aged 0–18 in 1993–94.[14]

Subjects who could not be linked to a parent (4.3%) were excluded, as were children with parents who did not reside in Sweden in 1990—that is, when social characteristics were identified in the census (0.9%), and those who died during 1990. The total is 2 523 730 subjects, representing 94.8% of the study population.

Children's socioeconomic status was established using the highest ranking parent, as attributed by Statistics Sweden in the census of 1990. In Sweden, socioeconomic status is a measure of social class, based on occupation.[15 16] To place a family's socioeconomic status within the social hierarchy,[17] four categories were considered: high and intermediate level salaried employees, low level salaried employees, skilled workers, and unskilled workers. Children from the other socioeconomic statuses (about 10%) were excluded on grounds that they could not be positioned within the social hierarchy.

Other social characteristics considered were country of birth of parent(s),[12 18] single parent home,[19–23] and receipt of welfare benefit 1990–94.[24] Country of birth of parent(s) was

Abbreviations: ICD-9, *International Classification of Diseases*, ninth revision; RII, relative index of inequality; SII, slope index of inequality

Table 1 Injury incidence and number of person years. Incidence per 100000 person years, 1990–94*, due to different causes, for various age categories separately, all socioeconomic groups aggregated. Person years by age category, sex, and socioeconomic status

	0–4 years	5–9 years	10–14 years	15–19 years
Injury incidence				
Traffic injury	42.3	148	236	365
% Females	42.9	40.3	41.1	32.9
% Fatal injuries*	3.5	1.1	1.0	3.1
Fall injury	473	496	446	359
% Females	44.4	38.0	39.5	41.3
% Fatal injuries*	–	0.01	0.05	0.14
Self inflicted injury	0.35	0.16	18.9	123
% Females	33.3	75.0	85.0	80.1
% Fatal injuries*	–	–	0.7	3.8
Violence related injury	5.02	3.32	11.3	66.8
% Females	49.2	40.5	31.6	16.7
% Fatal injuries*	12.5	14.3	0.7	1.1
Injuries total	520	647	712	914
% Females	44.3	38.5	41.1	41.2
% Fatal injuries*	0.4	0.3	0.4	1.9
Person years				
Girls				
High and intermediate level salaried employees	414420	463314	486616	534212
Low level salaried employees	159841	151879	154273	174202
Skilled workers	235628	210216	173869	175690
Unskilled workers	210959	195468	170767	181015
Boys				
High and intermediate level salaried employees	439192	491053	513292	559692
Low level salaried employees	168793	159718	160391	180256
Skilled workers	248952	221864	182899	186492
Unskilled workers	221865	205415	179192	188319

*Fatal injuries were only measured for 1991–94; the proportion of fatal injuries is therefore somewhat underestimated.

used as a proxy measure of the ethnic background of the household. Two categories were created—Sweden and outside Sweden—where children with both or the single parent born outside Sweden were placed in the latter category.

Single parent home (yes or no) was attributed to children who lived with a parent who was not cohabiting with another adult. During the study period around 15%–20% of all children in Sweden lived with a single parent and about 30%–50% of these children were born in single parent families.

Finally, a household was regarded as having received welfare benefit (yes or no) if anyone in the household received benefit of any kind, once or more, during the study period (1990–94).

This material was then linked to five annual national hospital discharge registers (1990–94), and to the national causes of death register (for the years 1991–94). Fatal and non-fatal injuries involving at least one night of hospitalisation or death were considered together but, to avoid double registration, any subject with the same diagnosis in both an annual national hospital discharge register and the national causes of death register within two months was excluded from the former register. Child and youth injury mortality is low in Sweden and consequently it appears reasonable to combine fatal and non-fatal injuries.[25] Coverage of the national hospital discharge registers is estimated to be nearly complete, with only a few small private hospitals not providing data. About 4.5% of cases in the registers lack information on either E code or personal identification number.[26]

Injuries were grouped according to the *International Classification of Diseases*, ninth revision (ICD-9)[27 28] into four categories: traffic injuries (E810–E829), falls (E880–E888), violence (E960–E969), and self inflicted (E950–E959).

Table 1 presents injury incidences per 100 000 person years by diagnosis group and age. In the same table person years by sex, age, and socioeconomic status are displayed. A subject living in Sweden a whole year contributed one person year; whereas one who moved from Sweden, or was born or died during any one year, contributed half a year. Person years (denominator) and injuries (numerator) were summed for the five years under study. In total, 63% of the injuries were due to falls, 28% were traffic related, and 5.2% and 3.1% respectively were self inflicted or related to interpersonal violence. Boys suffered relatively more traffic and violence related injuries, and girls more self inflicted injuries. The incidence of intentional injuries is negligible in the youngest age groups.

Data analysis

In the analyses, each diagnosis category presented in table 1 was considered separately and children were grouped into four age categories (0–4, 5–9, 10–14, and 15–19 years).

Injury incidences were measured for boys and girls separately and computed per 100 000 person years. Thereafter, two summary measures of injury risk distribution, the slope index of inequality (SII) and the relative index of inequality (RII), were computed. Weighted least square regression was used to estimate slopes,[29 30] using the SAS package (version 6.12). The two measures reflect experiences of the entire study population, by contrast with the relative risk of socioeconomic groups in relation to a reference group. Both measures involve calculating the injury incidence of each socioeconomic group and ranking them by socioeconomic status, and take into account the population size of the groups. SII scores provide information about the potential gain in population safety, in absolute terms, if all socioeconomic groups had the risk of the group with the highest socioeconomic status. The RII measures the relative inequality for the population as a whole, comparing the least privileged groups with the most privileged, taking into account the association between injury risk and socioeconomic status in every group.

A series of regressions were performed to calculate relative risks of injury according to socioeconomic status with 95% confidence intervals. Logistic regression using the SAS

Table 2 Incidence per 100000 person years, 1990–94, by age group, diagnostic category, and socioeconomic group

	Traffic		Falls		Self inflicted		Violence	
Household socioeconomic status	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
0–4 years								
High and intermediate level salaried employees	33.1	39.2	400	482				
Low level salaried employees	33.2	39.1	403	486				
Skilled workers	34.8	47.0	451	538				
Unskilled workers	38.9	50.9	474	542				
Total	37.3	46.9	432	512				
5–9 years								
High and intermediate level salaried employees	102	133	398	578				
Low level salaried employees	123	163	383	597				
Skilled workers	133	190	385	636				
Unskilled workers	145	216	378	627				
Total	122	172	387	599				
10–14 years								
High and intermediate level salaried employees	178	227	361	514	21.2	4.68	3.08	7.99
Low level salaried employees	207	273	361	509	34.4	4.99	3.24	19.3
Skilled workers	188	296	379	538	32.8	4.92	8.63	14.8
Unskilled workers	213	332	357	515	53.9	10.1	13.5	22.3
Total	199	272	361	527	33.0	5.55	7.36	15.1
15–19 years								
High and intermediate level salaried employees	210	369	304	413	156	37.3	12.36	82.9
Low level salaried employees	246	479	322	415	169	39.9	18.37	103
Skilled workers	277	571	291	406	196	42.4	20.49	131
Unskilled workers	308	601	295	401	286	60.5	32.04	141
Total	245	478	304	412	202	48.0	19.62	112

Table 3 Scores of slope index of inequality (SII) and relative index of inequality (RII) with regard to injuries from different causes, 1990–94, by age group. Boys and girls are handled together

Age group (years)	Traffic		Falls		Self inflicted		Violence	
	SII	RII	SII	RII	SII	RII	SII	RII
0–4	–12.22	0.289	–98.77	0.209				
5–9	–92.97	0.629	–28.96	0.058				
10–14	–103.2	0.437	–17.32	0.039	–23.27	1.229	–16.95	1.495
15–19	–255.0	0.700	–13.57	0.038	–88.56	0.718	–57.60	0.862

package (version 6.12) was employed. High and intermediate level salaried employees were treated as the reference group. Both crude and adjusted relative risks were compiled. Relative risks were adjusted for country of birth of parent(s), single parent home, and receipt of welfare benefits (1990–94). Boys and girls were considered together after testing for, and not finding, a modification effect of sex on socioeconomic pattern (results not presented).

RESULTS

In table 2 injury incidences per 100 000 person years are presented according to socioeconomic status, diagnosis, age group, and sex. Whereas the incidence of fall injuries is relatively constant across age groups, that of the other groups increases with age. Consequently, absolute socioeconomic differences within diagnostic groups increase from the youngest age category to the oldest one.

Fall injury is the most frequent diagnosis in all instances except for boys 15–19, where traffic injuries dominate. The largest absolute differences between children with the lowest and the highest socioeconomic status are found in the oldest age groups, for both boys and girls. For boys, traffic injuries show the greatest variation, while for girls, the group with the largest absolute socioeconomic status difference is self inflicted injury.

The same pattern is observed for scores of SII in table 3, where SII and RII scores are presented for boys and girls together. Traffic injuries have the highest SII score for all age groups, except 0–4 years, and the highest score is in age group 15–19 years. This means that the absolute gain (in injury reduction) of moving from the lowest to the highest socioeconomic status would be greatest for this diagnosis and for that age group. Since violence related injury incidence is relatively low, absolute socioeconomic differences are also rather small.

RII scores show the greatest relative inequalities in violence related and self inflicted injuries, especially among 10–14 year olds. For the oldest age group, the scores are high for traffic injuries as well as for both categories of intentional injuries.

Both crude and adjusted relative risks by socioeconomic status are shown in table 4. Crude relative risks for 0–4 year olds show small socioeconomic status differences, for both traffic and fall injuries. When adjusted, relative risks lose statistical significance for traffic injuries. For fall injuries, they decrease slightly but remain significantly higher for children of both skilled and unskilled worker families.

Table 4 Relative risks (RRs) and confidence intervals of injury from different causes, 1990–94, by age group and socioeconomic status. Boys and girls are handled together

Household socioeconomic status	Traffic	Falls	Self inflicted	Violence
0–4 years				
Crude RRs				
High/intermediate employees	1.0	1.0		
Low employees	1.00 (0.81 to 1.24)	1.01 (0.95 to 1.07)		
Skilled workers	1.14 (0.95 to 1.36)	1.12 (1.07 to 1.18)		
Unskilled workers	1.25 (1.04 to 1.49)	1.15 (1.09 to 1.22)		
Number of injuries	1078	12061		
Adjusted RRs*				
High/intermediate employees	1.0	1.0		
Low employees	0.97 (0.78 to 1.19)	0.99 (0.93 to 1.05)		
Skilled workers	1.04 (0.87 to 1.24)	1.08 (1.03 to 1.14)		
Unskilled workers	1.03 (0.85 to 1.25)	1.08 (1.02 to 1.14)		
Number of injuries	1031	11584		
5–9 years				
Crude RRs				
High/intermediate employees	1.0	1.0		
Low employees	1.22 (1.09 to 1.36)	1.01 (0.95 to 1.07)		
Skilled workers	1.38 (1.25 to 1.51)	1.05 (1.00 to 1.10)		
Unskilled workers	1.54 (1.40 to 1.69)	1.03 (0.98 to 1.09)		
Number of injuries	3734	12531		
Adjusted RRs*				
High/intermediate employees	1.0	1.0		
Low employees	1.18 (1.06 to 1.32)	0.99 (0.93 to 1.05)		
Skilled workers	1.32 (1.20 to 1.45)	1.03 (0.98 to 1.08)		
Unskilled workers	1.36 (1.23 to 1.51)	0.98 (0.92 to 1.03)		
Number of injuries	3578	12083		
10–14 years				
Crude RRs				
High/intermediate employees	1.0	1.0	1.0	1.0
Low employees	1.19 (1.09 to 1.29)	0.99 (0.94 to 1.06)	1.52 (1.12 to 2.06)	2.05 (1.35 to 3.11)
Skilled workers	1.20 (1.11 to 1.30)	1.05 (0.99 to 1.11)	1.46 (1.08 to 1.96)	2.10 (1.41 to 3.14)
Unskilled workers	1.35 (1.25 to 1.46)	1.00 (0.94 to 1.06)	2.47 (1.91 to 3.19)	3.22 (2.25 to 4.61)
Number of injuries	5724	10813	459	275
Adjusted RRs*				
High/intermediate employees	1.0	1.0	1.0	1.0
Low employees	1.14 (1.05 to 1.24)	0.97 (0.92 to 1.04)	1.16 (0.85 to 1.59)	1.76 (1.16 to 2.69)
Skilled workers	1.17 (1.08 to 1.27)	1.03 (0.97 to 1.09)	1.14 (0.84 to 1.54)	1.69 (1.13 to 2.54)
Unskilled workers	1.23 (1.14 to 1.34)	0.94 (0.88 to 1.00)	1.29 (0.97 to 1.73)	2.00 (1.36 to 2.94)
Number of injuries	5531	10471	439	260
15–19 years				
Crude RRs				
High/intermediate employees	1.0	1.0	1.0	1.0
Low employees	1.26 (1.18 to 1.34)	1.03 (0.97 to 1.10)	1.08 (0.96 to 1.22)	1.28 (1.10 to 1.49)
Skilled workers	1.47 (1.38 to 1.56)	0.97 (0.91 to 1.04)	1.23 (1.10 to 1.38)	1.59 (1.38 to 1.84)
Unskilled workers	1.57 (1.48 to 1.67)	0.97 (0.91 to 1.04)	1.79 (1.63 to 1.98)	1.82 (1.58 to 2.09)
Number of injuries	9479	9343	3207	1738
Adjusted RRs*				
High/intermediate employees	1.0	1.0	1.0	1.0
Low employees	1.24 (1.16 to 1.32)	1.01 (0.95 to 1.08)	0.94 (0.83 to 1.06)	1.15 (0.98 to 1.35)
Skilled workers	1.46 (1.37 to 1.55)	0.96 (0.90 to 1.02)	1.00 (0.90 to 1.13)	1.38 (1.19 to 1.60)
Unkilled workers	1.52 (1.43 to 1.62)	0.94 (0.88 to 1.01)	1.13 (1.02 to 1.26)	1.29 (1.11 to 1.50)
Number of injuries	9188	9091	3077	1654

*Adjusted for country of birth of parent(s), single parent home, and receipt of welfare benefits.

At 5–9 years, crude relative risks disappear for fall injuries and become more pronounced for traffic injuries. A socioeconomic gradient appears for the latter, that is not much altered when adjusting for other social factors. Children of unskilled worker families show a 36% greater risk compared with those from the reference group.

For 10–14 year olds, differences in socioeconomic status are found in all diagnosis groups but falls. The steepest gradient in relative risks is observed for violence related injuries, with a more than threefold higher risk for children from unskilled worker families. This is followed by self inflicted injuries and, to a lesser degree, traffic injuries. When adjusted, the relative risks decrease slightly for traffic injuries and considerably for intentional injuries. For self inflicted injuries, no statistically significant relative risks remain.

Adolescents aged 15–19 from both skilled and unskilled worker families have about a 50% greater risk of a traffic injury than the reference group, considering both crude and adjusted risks. Regarding violence related and self inflicted injuries crude relative risks show that adolescents from all other socioeconomic groups have an excess risk. Adjustments for other social circumstances results in a reduction in relative risks of all groups in the case of violence related injuries and a loss of significance in most groups for self inflicted injuries.

DISCUSSION

Some findings are in line with those of earlier studies dealing with socioeconomic differences in injury risks in children and youth. There are, indeed, considerable socioeconomic gradients in injury risks during that period of life.[10–12] It should not come as any surprise that the relative differences between socioeconomic groups are more important in the case of violence related injuries among adolescents than for unintentional ones.[10 11]

Yet some findings are new and put in a brighter light the avoidability of socioeconomic differences in injury risks, at

least in early childhood. Our results show that, in Sweden, there are negligible differences in fall and traffic related injury risks between socioeconomic groups among preschoolers. This contrasts with most evidence that suggests that socioeconomic differences in injury risks are great in early childhood.[10 11] Earlier Swedish studies, based exclusively on mortality data, also point to socioeconomic gradients in injury risks.[3 19] The lack of inequality is likely to be a reflection of social policies by which high quality living has been made accessible to families from all social groups, combined with concerted efforts to combat structural determinants of childhood injury risks by—for example, various housing and safety regulations.[31]

From the age of 5–9, however, fall and traffic related injuries follow different trajectories. Whereas socioeconomic gradients in fall injuries never become significant, differences in traffic injuries increase with age. Also, traffic injuries show the greatest inequalities in absolute terms, reaching a peak in the age groups 10–14 and 15–19. Results from other studies conducted by our research group suggest that this can be explained by the increasing share of traffic injuries involving motorised vehicles with increasing age, and more pronounced socioeconomic differences for that diagnosis group.[32 33] It is worth emphasising that, in our data, large absolute differences also exist among girls in the case of self inflicted injuries.

One final finding is that control for single parent home, country of birth of parent(s), and receipt of welfare benefit (1990–94) does not markedly change the socioeconomic pattern of unintentional injuries, but reduces considerably the relative risks of intentional ones, especially self inflicted. This applies to both age groups where intentional injuries were considered (10–14 and 15–19) but it is even more striking in 15–19 year olds.

Single parent home, as a proxy measure of family type—and disruption—is a recognised risk factor for unintentional injuries in preschool children[10 23] and it is also known to be a risk factor for various forms of intentional injuries—for example, non-fatal physical abuse.[20 22] A single parent home is also associated with an increase risk of mortality among Swedish children aged 0–18.[19]

Country of birth of parent(s) was used as a proxy for ethnic and cultural background of the household and was considered because people from different countries may vary with regard to care seeking behaviour and access to medical care.[10 18 19] The two categories retained—both, or the single parent(s) born outside Sweden or at least one parent born in Sweden—are not sensitive enough to highlight possible differences among different family constellations. Other sources of information would be needed to study ethnic background more thoroughly.

Receiving welfare benefits can be seen as a proxy measure for behaviour problems in the family—for example, alcohol/drug abuse and criminality, both of which have been shown to effect intentional injuries, such as violence towards children.[24 34 35] Welfare benefits can also be regarded as a proxy for economic stress and thereby serve as a mediator, not only a confounder. Earlier studies have shown that, in Sweden, receipt of welfare benefits is not greatly related to economic stress, in part because of the design of the welfare system.[36] It is worth mentioning, however, that during the study period (1990–94), Sweden was facing an economic recession that did not exist during previous studies. Therefore, the likelihood of economic stress, combined with family problems cannot be rejected.

Limitations

One set of limitations has to do with problems in determining the household of some children—and thereby, possible misclassification of socioeconomic status and other social characteristics—in two instances. The first is that of children born after 1990 who were linked to their biological mother, with no guarantee that it was with her that the child lived. The second is children and adolescents who lived as much in the home of their mother as with their father, but for which only one household was identifiable, since children are registered at a single address. In the worst case, this could imply that some children have been attributed a different socioeconomic status than they should. But the number of children affected is so low that it cannot significantly alter the main results.[14]

Also, for a small proportion of the children, information on socioeconomic status could not be obtained, although it is difficult to see how this would affect the findings. A priori, there is no reason to expect any systematic bias in the population register used with regard to any particular socioeconomic group. This also applies to possible misclassifications of socioeconomic status of head of household on the part of Statistics Sweden.

Another limitation arises from the possibility of inaccuracies in the classification of the subjects as injured or not, to the detriment of children from families from lower socioeconomic groups. Misclassifications of that kind may occur because of under-reporting by the subjects themselves (differential access to medical care or in care seeking)[10] or because of differences in hospital staff's propensity to keep an injured patient at the hospital at least one night.[11] Though there is no evidence of the latter in Swedish settings,[37] the occurrence of any of those biases, which the data at hand cannot reveal, may have lead to an underestimation of absolute and relative injury risks among lower socioeconomic groups. Conversely, there would be an overestimation of their risk if hospital staff tend to keep injured patients from those groups to a greater extent.

There is also the possibility of more or less systematic "errors" in diagnosis, in particular regarding intentional injuries, involving children with lower socioeconomic status.[38 39] The importance of such a bias is difficult to assess. At worst, this would result in an over-estimation of the risk of intentional injuries in children from lower socioeconomic groups.

In addition, differential injury severity might constitute confounding. We do not know if injuries tend to be more serious in lower socioeconomic groups than in higher ones, in countries like Sweden.[10 12 25] But it is quite likely that those with lower socioeconomic status reside in living areas where living and housing conditions are less favourable, a phenomenon that has been observed in a number of ecological studies (differential exposures).

Further studies could help reveal the extent to which the results obtained in the current study are modified when consideration is taken of the physical and social environment where children live.

Key points

- There are negligible socioeconomic differences in injury risk among 0–4 year olds in Sweden.
- From the age of 5, socioeconomic differences appear in traffic injury risk among Swedish children.
- The greatest absolute differences are found in the oldest age group (15–19), in traffic injuries for boys, and in self inflicted injuries for girls.
- The greatest relative differences are found for intentional injuries, in the age group 10–14, for both boys and girls.
- Adjusting for other social characteristics lowers the relative risks of socioeconomic status considerably for intentional injuries, but not remarkably for traffic injuries.

IMPLICATIONS FOR PREVENTION

Our results suggest that socioeconomic differences in injury risks are not deterministic and can be combated. Falls and

traffic related injuries among preschoolers are examples of this and may have to do with Sweden's housing and car safety regulations.[10]

The absence of socioeconomic differences in fall injuries throughout the ages covered, and the emergence of differences in three other diagnostic groups from the age of 5–9, suggest that some specificity may be required for health equity to be best achieved in the future.[10 40] Traffic injuries are of particular concern because the potential for improvement, in absolute terms, is great, especially in late adolescence. Likewise, self inflicted injuries deserve attention, especially in older teenaged girls.[41]

Without denying the part played by individual behaviours in injury occurrence in childhood and youth, safety policy for those ages must address the environment and social context.[42]

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