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Health of Young People

A prospective population based study of childhood injuries: the Velestino town study

Eleni Petridou, Anastasia Anastasiou, Konstantinos Katsiardanis, Nick Dessypris, Themis Spyridopoulos, Dimitrios Trichopoulos*

Background: Unintentional injuries in childhood constitute a significant public health problem. Our purpose is to estimate the incidence of identifiable unintentional childhood injuries of any type and severity, and to document risk factors of non-transient nature. **Methods:** We have undertaken a prospective population-based investigation in a Greek town with a population of 748 children (0–14 years old). All identifiable injuries have been monitored during a twelve-month period through information provided by the health care outlets or educational institutions as well as the police station and the regional hospital. **Results:** The overall incidence was 28.2 per 100 person-years (95% confidence interval from 24.4 to 32.0), whereas the incidence of injuries with Hopkins Injury Severity Score equal to or higher than four was 6.3 with 95% confidence interval 4.5 to 8.1. The incidence of total injuries was higher among boys than among girls ($p < 0.01$) and the gender difference was particularly evident among older children. Almost half of the injuries were due to falls and more than 20% were due to cutting. Children of younger and less educated parents have higher risk for injury and children from families with more injuries were more likely to be injured themselves. There was no evidence that somatometric characteristics were associated with injury risk. **Conclusion:** The incidence of unintentional childhood injuries is high and represents a considerable health burden. Family related variables are important risk factors for childhood injuries, whereas somatometric characteristics play a minimal role.

Key points

- Incidence and risk factors of all injuries in a population- based study among children
- About 28 per 100 children got injured over a period of one year
- There is evidence that younger paternal age and lower education may be associated with increased injury risk
- Family related variables seem to be important risk factors for childhood injuries, whereas somatometric characteristics play minimal role

Keywords: childhood injury, prospective population-based study, risk factors

The public health importance of childhood injuries and the need for the development of effective preventive strategies is widely recognized. Several injury risk factors for childhood injuries, of permanent or transient nature, have been identified through case control or case cross-over investigations.[1–4] The burden of injuries, however, has mainly been approximated through mortality and hospital contact statistics.[5] In contrast, there are very few population-based studies on the incidence of all injuries in geographically defined communities.[6,7] Yet, all injuries, regardless of their severity, have important implications in terms of cost, transient disability, loss of school time, associated anxiety and overall quality of family life.[7–9]

We have undertaken a study in a small town of Greece with a stable population aiming at monitoring all children with injuries who sought the care of any health, school or administrational professional during a one-year period. All children who sustained an injury were also involved in a population-based nested case control study aiming at identifying sociodemographic, somatometric or health related injury risk factors.

* Eleni Petridou[1,2], Anastasia Anastasiou[1,3], Konstantinos Katsiardanis[1], Nick Dessypris[1], Themistoklis Spyridopoulos[1], Dimitrios Trichopoulos[1,2]

1 Department of Hygiene and Epidemiology, Athens University Medical School, Greece

2 Department of Epidemiology, Harvard School of Public Health, Boston, USA

3 Health Center of Velestino, Magnesia, Greece

Correspondence: Eleni Petridou MD, MPH, Department of Hygiene and Epidemiology, Athens University Medical School, 75 M. Asias Str. Goudi, Athens 115 27, tel: +30 210-7462187, fax: +30 210-7462105, e-mail: epetrid@med.uoa.gr

Methods

Velestino is a town located in central Greece with a mostly agricultural economy. The estimated total population of this town in September 1994 was about 3800 people, out of whom there were 748 children 0–14 years old. During a 12-month study period from 11 September 1994 to 10 September 1995 all identifiable injuries of these children irrespective of severity, have been monitored through information provided by a number of health care outlets or educational institutions (health care centres, privately practising physicians, pharmacies and schools) as well as the police station in the town of Velestino and the regional hospital in the proximal city of Volos. For all injuries a record was completed describing the circumstances of the accident and the characteristics of the injury. The information concerning injuries was subsequently coded according to the ICD-9 revision, N and E codes, for nature of injury and external conditions of the accident) and the European Home Leisure Accident Surveillance System (1986)

coding system that allows more detailed description of the injuries.[10,11] Injury severity scores as developed by Baker[12] were assigned to each injury and those with a score equal to or higher than four were considered as more serious. Burns, poisonings and insect bites were considered as more serious when they required hospitalization. Cross-checking between various sources of injury ascertainment provided assurance for comprehensive registration of injuries in the study population during the study period, whereas special care was taken that there were no duplicate cases among the few who sought care in multiple settings. An injury was recorded as soon as it was ascertained and in no instance was the interval between injury occurrence and ascertainment longer than two weeks. Intentional injuries and late injury effects were not investigated.

In order to examine individual and family characteristics that may predispose to injuries, we have undertaken a gender and age (± 6 months) matched case control study. This investigation included all children who suffered one or more injuries during the study period and two controls per case, with matching gender and the age characteristics randomly selected from the population at risk. If a control suffered an injury during the study period he/she was evaluated as both a case and a control as recommended by Miettinen.[13] This has happened in 69 instances. A child who suffered more than one injury was counted only once. Matched cases and controls as well as their guardians were interviewed in person within a period of three weeks by one of the authors, the chief pediatrician at the regional health centre (AA). Interviews took place in the health centre (about two-thirds of them) or at the home of the interviewee. At the time of the interview somatometric characteristics of the child were measured and data concerning sociodemographic, family and health characteristics were recorded. Paternal rather than maternal education was used as predictor of family socioeconomic status, in line with previous experience from population studies in Greece.[14] Children were considered as having vision problems when they wore correcting glasses, they had strabismus or had been diagnosed as having reduced visual acuity. In addition, the guardian, mainly a family member, and usually the mother, was asked about the total number of cohabitating family members, including the child, as well as about the total number of injuries that took place during the previous year, as of the date of interview (excluding the index injury).

For the statistical analysis, incidence rates were estimated and their confidence interval calculated under the Poisson assumption.[15] Circumstances of the accident and characteristics of the injury (the first injury when the child sustained more than one during the study period) were tabulated. The case control data were initially cross-tabulated and univariate testing was undertaken. Subsequently, the data were modelled through multiple logistic regression using the SAS statistical package.[16] Both conditional and unconditional (controlling for gender and age) models were run and the results were essentially the same. We present the results from unconditional modelling in order to obtain data that will be comparable with those from possible future subset analyses.

Results

All 748 children have been monitored throughout the 12-month study period, so that the incidence rate per 100 person-years can also be thought of as the probability of injury occurrence per 100 persons over a period of one year. Thus, in the childhood population of Velestino the overall incidence rate of injuries, as distinct from injured persons, was 28.2 per 100 person-years or 28.2 injuries per 100 children over a period of one year (table 1). The standard error of the rate of injuries is 1.9 so that the 95% confidence interval of the incidence of injuries is 24.4 to 32.0 per 100 person-years. For relatively more serious injuries, the rate per 100 person-years is 6.3 with 95% confidence interval 4.5 to 8.1. The incidence of total injuries was significantly higher among boys than among girls ($p < 0.01$) and the gender difference was particularly evident among older children aged 10–14 years (table 1). With respect to serious injuries, proportionally similar excess was evident among boys, but the difference did not reach statistical significance, because absolute numbers were generally smaller.

In subsequent tabulations we have limited the analysis to the 170 children who suffered injuries rather than to the 211 injury events that these children have suffered during the study period. Whenever there were more than one injury per child only the first injury was taken into account in the analysis to avoid multiple counting of individual characteristics. Table 2 shows the distribution of 170 unintentionally injured children by event- and injury-descriptive variables. The peak incidence of injuries is during the summer months and the excess incidence is statistically significant ($p < 0.05$) as judged by Edward's test for seasonality. On the contrary, there is no significant variation by day of the week. Diurnal variation follows the pattern of daily activity with peaks in late morning and evening hours. It is of interest that 16 individuals (9.4% of the total) were injured after 10 o'clock at night, that is, at a time when few children should be exposed to injury risk (data not shown). About 50% of the injuries occurred in and around the home environment, whereas the proportional incidence of road traffic and school injuries were, each about one in seven. Concerning

Table 1 Number (*N*) and Rate (per 100 person-years) of injuries[a] suffered by all children in a town of Greece by severity of injury[b], age and gender (town of Velestino, Greece: September (1994–August 1995)

Age	Male						Female						Total					
(years)	Serious		Minor		All		Serious		Minor		All		Serious		Minor		All	
	N	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*	Rate
0–4	5	5.2	24	25.0	29	30.2	7	8.8	15	18.8	22	27.5	12	6.8	39	22.2	51	29.0
5–9	10	7.2	36	26.1	46	33.3	6	5.0	28	23.5	34	28.6	16	6.2	64	24.9	80	31.1
10–14	15	9.4	46	28.8	61	38.1	4	2.6	15	9.7	19	12.3	19	6.0	61	19.4	80	25.4
Total	30	7.6	106	26.9	136	34.5	17	4.8	58	16.4	75	21.2	47	6.3	164	21.9	211	28.2

a: A total of 211 injuries suffered by 170 children out of a total of 748 children during a 12-month period.
b: Serious, those with injury severity score ≥ 4.

Table 2 Distribution of the 170 unintentionally injured children aged 0–14 years of the Velestino municipality by accident- and injury-descriptive variables

Variable	*N*	%
Season of accident		
Winter	33	19.4
Spring	32	18.8
Summer	59	34.7
Autumn	46	27.1
Place of accident		
in home	39	23.0
around home	41	24.2
road	27	15.9
sports area	13	7.6
school	23	13.5
amusement area, playground	14	8.2
other	13	7.6
Mechanism of the accident		
fall on the same level	31	18.2
fall from height	38	22.4
other fall	5	2.9
cutting	38	22.4
hit-collision	24	14.1
other mechanical contact	14	8.2
hot liquids, objects	9	5.3
poisoning	2	1.2
Other	9	5.3
Type of injury		
contusion-bruise abrasion	51	30.0
open wound	74	43.5
Fracture	3	1.8
distortion dislocation	11	6.5
poisoning	2	1.2
Burn	9	5.2
Swelling (stings or bites)	15	8.8
Other	5	3.0
Injured body part		
Skull	17	10.0
head & face	43	25.3
Fingers	26	15.3
other parts of upper limbs	27	15.9
lower limbs	41	24.1
Trunk	16	9.4

the mechanism of the injury-generating event, almost half were falls and more than 20% were due to cutting. Two in three children had wounds (contusion, bruise, abrasion or more serious as open wounds). The most frequent type of injury was the open wound. There were also 15 children who suffered from injuries caused by animals, mostly insect stings. Nine children had suffered burn injuries, of which eight were minor ones. The most frequently injured body parts were the skull and head–face area, representing about 35% of all recorded injuries.

Table 3 shows the distribution of the 170 unintentionally injured children and their matched controls by sociodemographic and somatometric variables. This table serves only descriptive purposes but also allows an insight into the univariate injury risk implications of some variables. Thus, there is evidence that younger paternal age and lower education may be associated with increased injury risk. Table 4 presents multiple logistic regression derived, mutually adjusted odds ratios for an injury at the study population by the variables indicated in table 3. The data in this table confirm that children of younger and less educated fathers have a considerably higher risk for injury. Children reporting having been employed, generally on a part time basis, are at higher risk of injury, as are children with vision problems –mostly strabismus– although neither of these associations was statistically significant. The excess injury risk among working children was also evident (p-0.06) when the analysis was restricted to those 10–14 years old. Most families have reported one or more injuries during the last year before the recorded injury event. Children from families with more than one reported injury were more likely to be involved in an injury. There was no evidence that height or body mass index were associated with injury risk among children.

Discussion

In this prospective population-based investigation we found that among 100 children-years, a total of 28.2 injuries were recorded of which 6.3 had an injury severity score four or more. These rates are comparable with or slightly higher than those observed in earlier studies in other parts of the world and highlight the importance of injuries as a health and social problem among children.[7,17–21] In spite of all extensive efforts, some underestimation of injury rate cannot be excluded, particularly with respect to very mild injuries. In this family oriented community, where the investigation was conducted, family sociodemographic characteristics were significant risk factors for childhood injuries, a fact that has been mentioned in several other studies concerning childhood injuries.[3,17,19,20,22–30]

This is one of the few population-based prospective investigations that focused on incidence of injuries among children. Crosschecks among the various sources of injury ascertainment provided reasonable assurance that most injuries, that were brought to the attention of health and educational professionals and administration officials, were recorded, whereas multiple entries were avoided. The study size was large enough to provide reliable estimation of overall injury rates. Unavoidably, estimates were less precise for subcategories of injuries. The study was undertaken in a population that allowed complete coverage but this was done at the cost of representativeness. The town of Velestino is oriented towards a rural economy and such towns represent a minority in the European Union setting. From the methodological point of view, the combination of a prospective cohort design with a nested case control study allows the estimation of injury rates and the documentation of important risk factors of non-transient nature; transient factors, however, which are frequently critical in the occurrence of childhood injuries, cannot be effectively ascertained.

Table 3 Distribution of 170 unintentionally injured children aged 0–14 years of the Velestino municipality and 337 age- and gender-matched controls by sociodemographic variables

Variable	Cases		Controls		*p*-value for trend or contrast
	N	(%)	*N*	(%)	(univariate)
Gender					matched variable
Male	105	61.8	209	62.0	
Female	65	38.2	128	38.0	
Age					matched variable
<5 years	39	22.9	78	23.1	
5–9	67	39.4	135	40.1	
10–14	64	37.7	124	36.8	
Paternal age					0.06
<35 years	35	20.6	49	14.5	
35–39	42	24.7	95	28.2	
40–44	58	34.1	96	28.5	
45–49	23	13.5	61	18.1	
50+	12	7.1	36	10.7	
Paternal education					0.09
<7 years	64	37.6	104	30.9	
7–12	77	45.3	160	47.4	
13+	29	17.1	73	21.7	
Self-reported employment					0.17
yes	24	14.1	34	10.1	
no	146	85.9	303	89.9	
Family members					0.05
<5	130	76.5	229	67.9	
6+	40	23.5	108	32.1	
History of family accidents					0.01
<2 accidents	145	85.3	311	92.3	
2+	25	14.7	26	7.7	
Vision problem					0.09
yes	22	12.9	28	8.3	
no	148	87.1	309	91.7	
Body mass index (kg/m^2)					0.26
<16.5	62	36.5	104	30.9	
16.5–18.5	53	31.2	114	33.8	
18.6+	55	32.3	119	35.3	
Height (cm)					0.87
<122	57	33.5	110	32.7	
122–141	56	33.0	113	33.5	
142+	57	33.5	114	33.8	

Among the few studies that have attempted to estimate injury rates prospectively in circumscribed populations, one by Rivara *et al.* provided an overall 24.7 rate of medically treated injuries in a Health Maintenance Organization population of children and adolescents, whereas another by Arbos *et al.* reported an incidence of injuries of 24.5 in a childhood population attending a local health centre in Majorca.[7,17] Other studies have found somewhat lower injury incidence rates among children attending Emergency Departments.[6,31,32] Different operational definitions of an injury and different methods of

Table 4 Logistic regression-derived, mutually adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for an injury of the childhood population of Velestino by a series of sociodemographic and somatometric variables

Variable	Category or increment	ORs	95%	CIs	*p*-value
Age	5 years more	1.12	0.65	1.93	0.68
Paternal age	5 years less	1.33	1.09	1.64	0.005
Paternal education	6 years less	1.37	1.03	1.81	0.03
Employed	no	baseline			
	yes	1.77	0.93	3.36	0.08
Family members	less than 6	baseline			
	6 or more	0.55	0.35	0.85	0.007
History of family accidents	<2 accidents	baseline			
	2+	2.25	1.21	4.19	0.01
Vision problem	no	baseline			
	yes	1.61	0.85	3.07	0.14
Body mass index (kg/m^2)	<16.5	1.31	0.82	2.09	0.26
	16.5–18.5	baseline			
	18.6+	0.89	0.54	1.48	0.66
Height (cm)	<122	1.17	0.62	2.24	0.62
	122–141	baseline			
	142+	1.11	0.58	2.12	0.74

ascertainment and analyses in the latter studies hinder comparability of results. Nevertheless, it is striking that they all point to an incidence of about 15–25 per 100 person-years, even though the populations where these studies were undertaken had very different sociodemographic, geographical and economic profiles. Hence, one is tempted to speculate that differences in environmental conditions may affect more the nature of the injuries rather than their total incidence. Likewise, injury rates were higher among boys and they almost doubled among school age children.[19,22,33,34] Most of the injuries occurred during summertime, when activities in this community of mainly agricultural economy reach a peak and this is in line with a recent study concerning farm injuries in childhood.[33]

The case control study that was planned to identify stable, rather than transient, risk factors for injuries was nested within an explicitly defined cohort and has all the inherent advantages of this design.[15] In particular, selection bias is minimized and information bias for stable characteristics is generally non-differential. The main findings in the case control component of this investigation are that children of older and more educated parents are at lower injury risk, probably because parents either create a safer environment or provide role models for safer behaviour.[20,26,30] Many studies have pointed out to socio-demographic variables as important risk factors for injuries, although the underlying mechanisms are not fully understood and may vary by type of injury, time period and geographical location.[4,35]

A related, although statistically not significant result of our study, controlling for the age of the child, is that children who have ever been employed are at higher risk for an injury in comparison to those who have never been employed, as also shown by other investigators.[36] This pattern, however, is likely to reflect the consequences of socioeconomic differences between the two groups.

Quality of supervision is an issue that cannot easily be assessed. Yet, another observation of potential interest is that in the extended family households of Velestino, living in a household with a larger number of cohabitants has been associated with a lower injury risk. On the contrary, findings from other parts of the world suggest that living in big family households increases injury risk both among preschool school-age.[37] There is a hint that the risk of injuries may have a familiar component, which may be mediated through the shared environment, physical, social or psychological but the underlying mechanisms are not fully understood.

Several studies, concerning mainly individuals involved in athletic activities have examined the role of somatometric variables in the causation of injuries and high body mass index has been associated with higher injury risk.[38,39] In this investigation, however, as well as in other ones focusing on children or adults, neither height nor body mass index were found to be strongly or significantly related to injury risk.[30,40] A plausible positive association of injury risk with vision problems, mostly strabismus and refractory anomalies, was not statistically significant in this dataset. Earlier studies that examined vision problems in relation to injuries also reported equivocal results.[30,41] It is possible that the balance between compromised vision and compensatory mechanism tilts in different directions in different situations.

In conclusion, we have estimated through a prospective population-based study the incidence of childhood injuries of any type and severity in a town in Greece. We found that this is similar to rates reported from other studies undertaken in populations that were very different in terms of geographical location, economic activities and sociocultural coordinates. Family-related variables are important risk factors for childhood injuries, whereas somatometric characteristics play little, if any, role.

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