VILLE MATTILA

Injuries and Their Risk Factors in Finnish Adolescents

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ACADEMIC DISSERTATION

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ABBREVIATIONS

AHLS	Adolescent Health and Lifestyle Survey
BMI	Body mass index
CI	Confidence interval
EHLASS	European Home and Leisure Accident Surveillance System
ER	Emergency room
HR	Hazard ratio
ICD	International Classification of Diseases
NHDR	National Hospital Discharge Register
OCDS	Official Cause-of-Death Statistics
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
RR	Risk ratio
STAKES	National Research and Development Centre for Welfare and Health
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

ABSTRACT

The purpose of this study was to investigate the occurrence and risk factors of unintentional and violence-related injuries in Finnish adolescents.

The study used three different data sets. The first data was based on the Official Cause-of-Death Statistics of Finland. The study population consisted of all Finns 0–14 years of age and the outcome variable was unintentional or violence-related death in 1971–2001. The second data set was obtained from a cross-sectional survey of the Adolescent Health and Lifestyle Survey (AHLS) in 1999. A structured questionnaire including questions about unintentional and violence-related injuries, sociodemographic background, health and health behaviour variables was mailed to a sample of 12, 14, 16, and 18-year-olds in 1999. The mean ages of the respondents were 12.6, 14.6, 16.6, and 18.6 years. The questionnaire was sent to 10 883 adolescents of which 8216 returned the questionnaire (response rate 76%). The third data used in the paper V was based on longitudinal data of the Adolescent Health and Lifestyle Surveys linked to the National Hospital Discharge Register and Cause-of-Death Statistics between 1979 and 2001. The main outcomes were injury-related death and hospitalisation due to injury. Baseline data for the analyses were collected from 1979 to 1997. The baseline population consisted of 72 194 persons of which 57 297 responded in the AHLS, the response rate being 79%.

The results indicated that the incidence of fatal injuries among 0–14-year-old Finns declined by 83% during the 30-year study period. The decline was almost solely attributable to the decline in unintentional injury deaths. The incidence of violence-related death did not change markedly during the study period.

While fatal injuries have decreased, less severe injuries have become common among Finnish adolescents. Occurrence of unintentional and violence-related injuries was 5.5% and 1.7% per one month, respectively. Unintentional injuries were more common among boys while girls reported more violence-related injuries. Most injuries were less severe, such as sprains, strains and contusions. The main anatomical locations were the extremities in unintentional and the head in violence-related injuries. Concerning violence-related injuries, some 40% of injured adolescents reported that either they or the other party were under the influence of alcohol at the time of injury.

The strongest risk factors for unintentional injury were not living with own parents, stress symptoms daily, violence occurrence and frequent participation in organised sports. The corresponding risk factors for violence-related injuries were not living with own parents, stress symptoms daily, unintentional injury occurrence and smoking. Our longitudinal data revealed that the strongest predictor of injury death was poor school success in boys and smoking in girls, while the strongest predictor of injury hospitalisation was frequent participation in organised sport in both sexes.

In conclusion, unintentional injury deaths have declined markedly over the 30-year study period. The reasons for this positive development are multi-factorial, but an increased general awareness of high-risk situations (for example, increased supervision when child commutes to school or when child is near water), safer playgrounds, improved traffic safety measures such as intensive promotion of child safety seat restraints, and bicycle helmets are probably among the most important single factors.

Our findings indicate that, apart from some sociodemographic factors, health and health behavioural factors in particular are associated with injuries. Overall, it seems evident that several indicators of poor health status accumulate. Although, in Finland, a self-reported sociodemographic background appears to be a less important predictor of injury, efforts supporting the well-being of families may reduce the occurrence of injuries. In planning the targeting of injury-preventive measures, health and health behavioural factors should be considered as well. Since frequent participation in organised sports is strongly related to hospital-treated injuries, clearly more attention should also be paid to sports injury prevention.

TIIVISTELMÄ

Tutkimuksen tarkoituksena oli selvittää suomalaisnuorille tapahtuneiden tapaturmien ja väkivallan aiheuttamien vammojen yleisyyttä, vakavuutta sekä riskitekijöitä.

Tutkimus perustui kolmeen aineistoon. Kuolinsyyrekisteristä poimittiin 0–14 -vuotiaiden suomalaisten tapaturmaiset ja väkivaltaiset kuolemat vuosina 1971–2002. Toinen aineisto perustui Nuorten Terveystapatutkimukseen (NTTT). Postikyselynä toteutettu tutkimus sisälsi vuonna 1999 kysymyksiä tapaturmien ja väkivallan yleisyydestä, nuoren sosioekonomisesta taustasta, terveydentilasta ja terveyskäyttäytymisestä. Lomake lähetettiin 10 883 nuorelle, joista kyselyyn vastasi 8 216 (vastausprosentti 76%). Osallistujien keski-iät olivat 12.6, 14.6, 16.6 ja 18.6 vuotta. Kolmas, pitkittäinen tutkimusaineisto sisälsi vuosien 1979–1997 NTTT-otoksen, joka yhdistettiin henkilötunnuksen avulla kuolinsyy- ja hoitoilmoitusrekisteriin. Otos oli kooltaan 72 194 henkilöä, joista 57 297 oli vastannut NTTT-kyselyyn. Otoksen ihmisiä seurattiin kuolinsyyrekisterissä tai hoitoilmoitusrekisterissä keskimäärin 10 vuotta. Päävastemuuttujina olivat tapaturmaiset ja väkivaltaiset kuolemat ja sairaalahoitoon johtaneet vammat, jotka analysoitiin erikseen.

Tapaturmaisen ja väkivaltaisen kuoleman ilmaantuvuus vuonna 1971 oli 0–14-vuotiailla suomalaispojilla oli 36.7 jokaista 100 000 henkilöä kohden, vuonna 2001 vastaava luku oli 7.1. Tytöillä vastaavat luvut olivat 20.1 ja 2.8. Muutos tutkimusajanjaksona oli huomattava, poikien tapaturmakuolemat vähenivät 30-vuoden aikana 81%, tyttöjen 86%. Väkivaltaisien kuolemien ilmaantuvuus ei muuttunut tutkimusaikana.

Lievemmät tapaturmat ovat yleisiä suomalaisnuorten keskuudessa. Kyselyä edeltäneen kuukauden aikana lääkärin tai sairaanhoitajan hoitoa vaatineita tapaturmia ilmoitti 5.5% 12–18-vuotiaista suomalaisnuorista, väkivallan aiheuttamia vammoja ilmoitti vastaavasti 1.7% nuorista. Pojat raportoivat merkitsevästi enemmän tapaturmia kuin tytöt, kun taas tytöt ilmoittivat poikia useammin väkivallan aiheuttamia vammoja.

Pääosa tapaturmien ja väkivallan aiheuttamista vammoista oli lieviä venähdyksiä, ruhjeita ja revähdyksiä. Tapaturmien aiheuttamat vammat sijaitsivat anatomisesti pääasiallisesti alaraajoissa, väkivallan aiheuttamat vammat olivat tyypillisimmin pään ja yläraajan vammoja.

Alkoholi liittyi erityisesti väkivallan aiheuttamiin vammoihin, sillä 40% väkivallan aiheuttamia vammoja raportoineista kertoi, että he itse tai väkivallan toinen osapuoli oli alkoholin vaikutuksen alaisena väkivallan sattumishetkellä.

Tapaturmien vahvimmat riskitekijät merkittävyysjärjestyksessä olivat äskettäin koettu väkivalta, aktiivinen liikunta urheiluseurassa, päivittäiset stressioireet ja eläminen ei-ydinperheessä. Vahvimpia väkivallan aiheuttamien vammojen

riskitekijöitä olivat vastaavasti äskettäinen tapaturma, päivittäiset stressioireet, tupakointi sekä eläminen ei-ydinperheessä.

Seuranta-aineistomme perusteella vahvin tapaturmaisen ja väkivaltaisen kuoleman ennustaja pojilla oli huono koulumenestys ja tytöillä tupakointi. Sairaalahoitoon johtaneen vamman vahvin ennustaja sekä tytöillä että pojilla oli aktiivinen liikunta urheiluseurassa.

Tapaturmaiset kuolemat ovat vähentyneet selkeästi 30 vuoden aikana. Tämän positiivisen kehityksen syyt ovat moninaiset, mutta lisääntynyt tieto tapaturmista, lasten valvonta vesien äärellä ja koulumatkoilla, turvallisemmat leikkikentät ja yleinen liikenneturvallisuuden paraneminen ovat todennäköisesti suurimmat yksittäiset tekijät.

Tutkimuksemme perusteella tapaturmien ja väkivallan aiheuttamien vammojen riskitekijät ovat samankaltaisia. Sosioekonomisista taustatekijöistä suomalaisnuorilla vain perherakenne ja maantieteellinen alue selittävät tapaturmia ja väkivallan aiheuttamia vammoja. Keskimääräistä huonompi terveydentila ja negatiiviset terveystottumukset ovat sosioekonomista taustaa merkittävämpiä tapaturmien ja väkivallan aiheuttamien vammojen riskitekijöitä suomalaisnuorilla. Yksittäisistä terveystottumuksista aktiivinen liikunta urheiluseurassa on tapaturmien vahvin riskitekijä. Erityisesti liikuntatapaturmien ehkäisyyn tulee jatkossa kiinnittää lisää huomiota.

INTRODUCTION

Adolescent injuries and violence have been recognised as a major problem of health and welfare worldwide during the past few decades (Peden et al. 2000). At the same time unintentional injury-deaths have declined in developed countries, but they still are the leading cause of death and one of the leading causes of morbidity in young people in developing countries (The injury chart book ... 2002). Annually, one million adolescents receive a fatal injury (A league table of child deaths ... 2001). Besides unintentional injuries, violence-related deaths pervade the lives of increasing numbers of people around the world (Krug et al. 2002). Not all injuries or violence result in death, in fact injury deaths represent only the tip of an iceberg as for every injury death many more will sustain disability and far more will suffer.

Adolescent injuries have been recognised as a public health problem in Finland, too. The Government Resolution on the Health 2015 (Valtioneuvoston periaatepäätös ... 2001), released by the Finnish government in 2001, is a public health programme which has outlined the targets for Finland's national health policy for the decade, the main focus being health promotion. The most important target concerning adolescents and young adults was to reduce the occurrence of fatal injuries in young men by 30% (Valtioneuvoston periaatepäätös ... 2001).

The World Health Organisation has made major contributions to injury and violence research worldwide by providing data on the most serious injuries. Most of the other research evidence of injuries and violence derives from the United States. It is already known that unintentional injury rates in Finland have been among the highest in Europe since the 1960s (1997), and violent death rates among adolescents are considerably higher than elsewhere in Northern Europe (Lehti 2004). While the occurrence of injury-related deaths has been accurately described in Northern Europe, studies concerning less severe injuries and their risk factors have been absent.

Several institutions have been conducting injury research in Finland. Statistics Finland has collected data, produced statistics and provided information services on cause-of-deaths (Official Cause of Death Statistics 2003). The National Research and Development Centre for Welfare and Health (STAKES) has offered information on injuries by maintaining statistics on hospitalisations (Ruusinen 1992). An important role in injury research in Finland has been played by The National Institute of Legal Policy (Aromaa 1971) and the Central Union for Child Welfare in Finland (Kemppainen et al. 1981). Few theses concerning injuries have been published in the University of Kuopio (Tolonen 1984) and University of Helsinki (Antti-Poika 1988).

In addition to research institutes, there have been some projects by different authorities concerning injuries during the past decades. One of the first national

research and prevention programmes started in 1972 and focused on traffic injuries (Laine 1984). The Finnish National Board of Health launched the Finnish Accident Registration Project in 1980 (Honkanen 1983) with the main purpose to develop injury surveillance, which at the time was estimated to be inadequate (Honkanen 1983). The Consultative Committee for the Prevention of Home and Leisure Accidents, set by the Finnish Government, has been a major actor in injury prevention in the 1990' s and has prepared several reports describing injuries in Finland during that decade (1997).

This study aimed at increasing our knowledge on adolescent injuries and their risk factors in Finland, an area which has not been widely studied. Knowledge on injuries has been used when designing injury prevention policies (Valtioneuvoston periaatepäätös ... 2001). The substantial decline in traffic-related deaths in Finland since the 1960s is a bright example of preventive measures that have been able to affect injury-related deaths. Moreover, the decline seen in the 1940s in children's drowning and poisoning deaths has probably been a result of the intensive prevention programmes. However, many aspects of injury epidemiology are unclear, and the lack of studies on adolescent injuries in Europe is noteworthy. In order that the decline in injury mortality will continue, new issues concerning adolescent injuries should be approached. The first task of injury research is to produce information about injuries and their risk factors. This knowledge in turn can be harnessed for the work targeted at injury prevention.

STUDY BACKGROUND

Concept of injury

History of injury definition

Previously, the word “accident” has been used to describe injuries. An accident can be defined as a random event, or a sequence of random events, that results or could result in an injury (Bijur 1995). This traditional view with its implications may be blamed for the historical neglect of this area of public health (Waller 1985). Later, it has been recognised that injuries are preventable and, subsequently, the term “accident” has been increasingly replaced with the term “injury”, which is neutral with respect to intentionality and predictability (Bijur 1995). The Finnish counterpart to injury is “tapaturma”, which may, however, be partly misunderstood as a physical injury of inevitable and unpredictable quality, such as an accident.

Injury definition

The present literature favours the term “injury”. An injury has been defined as physical damage that results when human body is suddenly subjected to levels of energy exceeding the threshold of physiological tolerance (ICECI Coordination and Maintenance Group ... 2004). The nature of energy causing an injury may be mechanical, radiant, thermal, electrical or chemical, and the time between the exposure to energy and appearance of an injury is short (Holder et al. 2001). Injuries may also result from a sudden lack of essential agents such as oxygen or warmth (ICECI Coordination and Maintenance Group ... 2004). The definition above includes poisonings and toxic effects as well. Overall, the word “injury” represents only the outcome of a process, and it does not take a stand as to whether the injury was unavoidable or deliberate.

Injuries are commonly categorised by intent as unintentional injuries, which are thought to occur randomly, and violence-related (intentional) injuries, which are deliberately caused by violent actions. The same division is used in this thesis, too. Violence-related injuries include self-inflicted and interpersonal injuries (Holder et al. 2001). Suicides are understood as self-inflicted, violence-related injuries. Violence-related injuries are often referred to as intentional injuries, since it is evident that the injury has been caused with intent. It is agreed

that the term “injury” covers a wide spectrum of insults ranging from minor lacerations to injury-related deaths whether violence-related or unintentional.

Data sources and measurement for injury occurrence

Injury classification and categorisation

World Health Organisation (WHO) has compiled international standards for the classification and coding of data on injuries. The Tenth Revision of the International Statistical Classification of Diseases (ICD-10) (1994) defines injuries as acute physical conditions, which are listed in chapters XIX (Injury, poisoning and certain other consequences of external causes) and XX (External causes of morbidity and mortality). External cause of injury (E-code) is used to describe the circumstances of injury and to describe whether injury was violence-related or unintentional. Another related classification scheme on injuries from WHO is the International Classification of the External Causes of Injuries (ICECI), which provides classification and codes for a range of factors associated with injury occurrence (ICECI Coordination and Maintenance Group ... 2004). These classifications are recommended for use in injury surveillance to ensure comparability of injury information between countries and they are widely used in scientific literature (Holder et al. 2001). Another classification used is the European Home and Leisure Accident Surveillance System (EHLASS) (1986).

Cause-of-death statistics

Information on adolescents’ injury-related deaths can be obtained from the Cause-of-Death Statistics (Official Cause of Death Statistics 2003). Most countries collect data on the populations’ health status and health service utilisation, mortality data included. Mortality statistics are based on death certificates, which normally contain data on the cause and date of death, age, sex, date of birth, and place of residence of the deceased (Official Cause of Death Statistics 2003). The coding of the cause-of-death today is mainly based on the Tenth Revision of the International Statistical Classification of Diseases (ICD-10) (International Statistical Classification ... 1994). Death certificates are usually written by the physician if the cause-of-death and the subject were known to the physician, in other cases, they are written by the police or other authorities (Childhood Injuries 1998).

The Official Cause-of-Death Statistics of Finland is an extensive, medical-legal investigation system of the causes of death (Official Cause of Death Statistics 2003). It has been entirely computer-based since 1971 and is annually

updated and quality-controlled by the Cause-of-Death Bureau at the Statistics Finland, the Central Statistical Office of Finland. The Finnish Official Cause-of-Death Statistics are in practice 100% complete, since each death, its certificate, and the corresponding personal information in our computerized population register is crosschecked. The accuracy of the data is, in turn, maximized by a 3-phase process in which each death certificate and its codes are cross-examined (Official Cause of Death Statistics 2003). In injury-based deaths, the accuracy of the Finnish death certificates and their cause-of-death codes are further verified by autopsies performed in 94% to 97% of these deaths (Official Cause of Death Statistics 2003).

Hospital discharge registers

It is possible to obtain information on severe injuries from hospital registers, such as the National Hospital Discharge Register (Salmela et al. 1987) or hospital-based trauma registers (Damore 2003). They include information of patients admitted to hospitals for the treatment of trauma. Diagnoses and external causes of injuries in hospital discharge registers are usually coded by using the Tenth Revision of the International Statistical Classification of Diseases (ICD-10) (International Statistical Classification ... 1994). Most developed countries have hospital register based injury surveillance systems, while most developing countries have none (Annual Report 2002 2003).

Many developed countries have established specific trauma registers that utilise hospital discharge registers (McClure et al. 2004). These are usually based on individual hospitals, regions or states, rather than being nationally representative. Specific trauma registers are not primarily designed for injury surveillance purposes. Such registers are absent in Finland.

The Finnish National Hospital Discharge Register (NHDR) is a statutory, computer-based register that is continually quality controlled and updated by the National Research and Development Centre for Welfare and Health, Helsinki Finland. It covers the whole country and its accuracy has been proved good (Salmela et al. 1987).

Emergency department registers

Emergency department injury surveillance presents data on less severe injuries (Walsh et al. 1996). Only few countries have national surveillance systems to monitor injuries treated in emergency departments. The National Electronic Injury Surveillance System has been collecting data on non-fatal injuries treated in hospital emergency departments in the United States since 2000 (Quinlan et al. 1999).

The only specific emergency department register is located at The Department of Orthopaedics and Traumatology at the University Central

Hospital of Helsinki (Honkanen et al. 1980). However, emergency department based injury studies made in Finland are scarce (Korhonen 1986).

Primary care registers

It is well documented that the majority of minor injuries are treated in primary care practices (Schappert 1999). Only little is known about injured adolescents who receive evaluation and treatment in primary care practices (Hambidge et al. 2002), since to our knowledge, national primary care surveillance systems do not exist. Some local registers exist, like for example the primary care register of the National Defence Forces in Finland. This primary care register was established in 2004, and contains information of the less severe injuries in conscripts including the external causes of injuries.

Surveys

In countries where no national hospital discharge registers or emergency department registers exist, a community-based survey may elicit information on injuries. Several wide cross-sectional surveys including questions about injuries and violence exist, such as the World Health Organization's Health Behaviour in School-aged Children (Pickett et al. 2002), National Health Interview Survey Child Health Supplement (Fraser 1996), Youth Risk Behaviour Surveillance in the United States (Kann et al. 2000), and the Dunedin Study in New Zealand (Langley et al. 1989).

The Victim Survey of Finland has been conducted in 1980, 1988, 1993, 1997 and 2003. It has explored the occurrence of injuries and violence in over 15-year-old Finns (Heiskanen et al. 2004).

Other data sources

There is a wide range of other data sources that may be of use in injury prevention and research. Workers' compensation databases, insurance company information, police traffic crash report database, occupational health and safety registers and school based injury surveillance systems may all include useful information for the purpose of injury research. These potential sources have limitations in their coverage and accuracy, but for the purpose of special research they can give valuable information. All of the data sources mentioned above exist in Finland, but they have been poorly utilised.

Strengths and limitations of data sources for injuries

The strengths and limitations of the cause-of-death statistics are presented in Table 1. The degree of accuracy and completion of cause-of-death statistics

differs greatly between countries, from an estimated 19% in some African countries to nearly 100% in Finland (London et al. 2002). The variety in the form and accuracy of such data will depend on the level of development in the country, the resources available, as well as on the extent of their utilisation in health status assessment and resource allocation (Childhood Injuries 1998).

Several practical problems limit the usefulness of a hospital discharge register (Table 1). Possible sources of bias may be constituted in the different definitions of an injury, readmissions for the same injury and underreporting of the external cause of injury (Langley et al. 2002). Limitations of hospital-based register studies also include the fact that results can be generalised to the population that is treated, not to the population at risk for injury. However, in developed countries, hospital discharge registers may give an accurate data on injuries (Keskimaki et al. 1991).

Table 1. *Strengths and limitations of injury measurement systems*

Injury measurement system	Strengths	Limitations
Cause-of-death statistics	– Complete and accurate in 7 developed countries – Usually autopsies – Comparability between countries – ICD-10 classification	– Includes fatal injuries only – Contain no information on injury circumstances
Hospital discharge register	– Includes all hospitalised patients – Includes some background information as well as external causes – ICD-10 classification	– Underreporting of external causes – Utilisation of medical services may vary depending on availability – External cause is usually self-reported
Emergency department register	– Presents data on less severe injuries – ICD-10 classification	– Difficult to evaluate the population at risk – Only few countries have national registers
Primary care register	– Includes most injuries, also less severe	– Lack of universal injury coding system – Difficult to evaluate the population at risk – Only local primary care registers exist
Surveys	– Includes all kinds of non-fatal injuries – Population based – Obtains valuable information in developing countries without other measuring systems	– Effect of non-response – Recall bias – Telescope effect – Problematic injury definition

A limitation of community-based emergency department studies is the very fact that they are usually emergency-department-based instead of population based (Table 1). Accordingly, they cannot be used to determine the incidence, because the catchment area of a hospital is sometimes difficult to define. On the other hand, a community-based emergency department register can give comprehensive and descriptive information on injuries within a specific area (Engstrom et al. 2002), provided that the medical emergency services protocol directs all injured patients to specific regional trauma centres (Matteucci et al. 1995) and that assessment of the risk factors for injuries are performed as well (Macdonald et al. 1999).

The strength of primary care based injury surveillance would be that the study setting included the minor injuries, too (Table 1). In Finland, although information on injuries is being collected to patient files, which in most cases are electronic databases, this information does not offer value for injury research owing to its disorganised content and nature.

The strengths and limitations of survey studies are shown in Table 1. Non-response has shown to be a significant limitation and it may bias the results. Another possible source of bias is the complexity of defining an injury in a survey study, since individual perceptions of injuries may vary. There is, however, some evidence that respondents' definition conforms to that of doctors and nurses (Pickett et al. 2000).

Concerning survey studies, it is important to elaborate on the issue of recall bias. Two main categories of recall bias have been described (Harel et al. 1994), the memory decay which means a loss of information due to failure to recall the event, and the telescope effect which is the tendency to remember events in the past as if they occurred closer to the present than they actually did. It is estimated that when using a 12-month recall period only 28%–60% of injuries are reported compared to a one-month recall period (Mock et al. 1999), and, consequently, a 1–2-month recall period is recommended. It has likewise been shown that, compared to injury incidences seen in emergency department based studies, survey studies may underestimate the injury incidence by over 50% (Petridou et al. 2004). However, survey studies do not always underestimate injury incidence since some common injuries, such as burns and bicycle injuries, may be overreported (Peterson et al. 1993).

REVIEW OF THE LITERATURE

Occurrence of adolescent injuries

Occurrence of injuries in Finland

In Finland, information on deaths has been available since 1749 (Official Statistics of Finland 2003). The earliest information concerning specific causes of death of adolescents dates back to the 1940s, when a system of cause-of-death statements certified by physicians was established (Honkanen 1983). At that time, the major cause of injurious death among adolescents was drowning (Laine 1984), the incidence of which, however, declined to a half in the 1950s. This positive development concerning deaths due to drowning can probably be attributed to education. In 1952, the overall incidence rates of fatal injury in adolescent boys were 61.4 per 100 000 persons and 17.2 among adolescents girls (Kemppainen et al. 1981). In the 1950s, the density of vehicles began to rise, resulting in an increase in the occurrence of traffic-related deaths. In fact, between 1955 and 1965, traffic-related deaths among adolescents increased more than 450% (Laine 1984), and in 1965 they overtook drowning deaths as the leading cause of injurious death.

Overall, adolescent mortality for injuries in Finland has been among the highest in Europe in the 1950s and in the 1960s (Accidents in Finland 1996 1997). The incidence rate of injury-related deaths among adolescents decreased slightly among boys but increased among girls from the 1950s to 1970s, being 49.0 in boys in 1972 and 22.8 in girls, respectively (Kemppainen et al. 1981).

The incidence of injury-related deaths began its substantial decline in the mid 1970s. Indeed, the incidence of fatal injury in adolescent boys was 30 per 100 000 persons and in girls 10 per 100 000 in 1980 (Honkanen 1983). During the time of relatively accurate statistics, the percentage of injury-related deaths of all deaths has remained at a steady level, from 30–40% (Kemppainen et al. 1981).

The first studies based on the Finnish National Hospital Discharge Register concerning injury hospitalisation (both unintentional and violence-related) in children (0–14-year-olds) reported that the incidence of injury hospitalisation increased from 1640 to 2260 per 100 000 persons between 1960 and 1979 (Kemppainen et al. 1981). In a large study published in 1990, it was seen that the incidence of injuries resulting in hospitalisation in 10–14-year-old boys was 1186 per 100 000 persons per year, while the corresponding figure in girls was 674 (Honkanen 1990). The limitation of hospital discharge studies made in the

1970s and 1980s was the reporting of external causes of injuries, which varied between 43% and 98% (Mönkkönen et al. 1989). Underreporting of E-codes may have caused serious inaccuracy to the results (Honkanen 1990).

A nationally representative and accurate study with focus on childhood deaths and severe injuries was published in 2000, when Parkkari and co-workers described the incidence and trends of fatal and hospitalised injuries among children in 1971–1995 (Parkkari et al. 2000) (Table 2). They showed that injuries were the leading cause of death among adolescents aged 10–14-years. The overall incidence of fatal injury declined markedly from 31.3 per 100 000 person-years in boys and 13.4 per 100 000 person-years in girls in 1971 to 9.5 and 5.0 seen in 1995, respectively (Parkkari et al. 2000).

The most common causes of death during the past few decades have been traffic-related and drowning. Since the incidence of traffic-related deaths declined by 80%, the overall decline seen was mainly attributable to the decrease in these two categories. While fatal injuries showed a decreasing trend, non-fatal injuries increased slightly during the study period, being 677 per 100 000 person-years in girls and 1083 per 100 000 person-years in boys in 1995. Due to underreporting of E-codes, the intent of the injury leading to hospitalisation was not assessable.

Concerning less severe injuries among adolescents, lack of research in Finland has been pointed out already in the 1980s (Honkanen et al. 1982). In a study conducted in Mikkeli region, the first visits due to injury during one year were registered between 1980 and 1981. The results showed that the occurrence of injuries were 145 per 1000 persons per year in boys aged 0–14 years, and 85 in girls of the same age-group (Honkanen et al. 1983).

In addition, only few reports based on small or selected samples have been written, considering for example children's intoxications (Eskola 1983), school accidents (1982) and sport-related injuries (Korhonen 1986).

The only nationally representative study investigating less severe unintentional injuries among older adolescents and adults in Finland is the victim survey, started in 1980 by the National Institute of Legal Policy and Statistics Finland. In 1980, a survey study based on a nationwide sample (N=10 000 persons aged 15–74 years) was conducted by phone interviews and personal visits. Half (50%) of the adolescents at 15–19 years of age reported an unintentional or violence-related injury during the past year, and it can be estimated that 40% of all sustained an unintentional injury (Lättilä et al. 1982). Injuries requiring treatment in hospitals were reported by 29% of adolescents (Lättilä et al. 1982). A closer examination reveals that most injuries were related to sports or traffic (Lättilä et al. 1982). The small number of older adolescents (15–19-year-olds), however, presents a severe limitation in the reporting of adolescent injuries in this study.

Table 2. *Register study based on occurrence of injuries among adolescents in Finland*.

Authors	Country	Number of injuries	Age-group	Injury outcome	Incidence/10^5/ year
Parkkari et al. 2000	Finland	180 000	10–14	Death	10 in boys 5 in girls
				Hospitalisation	1 083 in boys 677 in girls
Honkanen 1990	Finland	3 280	10–14	Hospitalisation	1 450 in boys 674 in girls
Honkanen et al. 1990	Finland	8 396	10–19	Emergency room visit	26 000 in boys 10 000 in girls
Honkanen et al. 1983	Finland	1 400	0–14	Primary care visit	14 500 in boys 8 500 in girls

Based on later victim surveys, it seems evident that the injury occurrence has been increasing (Heiskanen et al. 2000). Results from a survey in 1997 indicate that some 35% of 15–24-year-old persons sustained a physical unintentional injury. However, this rising trend presented by the authors needs critical investigation. An injury in the first survey in 1980 was defined in a way that might have induced some people to report even situations without physical injuries which, naturally, may have caused overestimation of the true injury occurrence (Lättilä et al. 1982).

In next survey by the same study group in 1988, the definition was altered to include physical injuries only, but it still included traffic injuries with material damages (Lättilä et al. 1983). From 1993 onwards the definition of an injury has referred to physical injuries only. This inconsistency hampers the comparability between years. Based on this bias, it can be assumed that the increase has been even greater than the authors describe. Another limitation in these studies is that the age groups were not kept the same. Another injury survey made among adolescents in Finland, the WHO school health survey in 1994 showed that 25% of adolescents aged 11 to 15-years reported an injury that had required medical treatment by a doctor (Kannas 1995).

The first emergency department based study in Finland was made in the hospital of Aurora, in Helsinki. The authors concluded that unintentional injuries were a significant cause of morbidity among children 0–15 years old (Honkanen 1984). Most injuries were wounds and bruises and they occurred mainly at home (Honkanen 1984).

Occurrence of injuries outside Finland

Injuries are the leading cause of death among adolescents worldwide (Krug et al. 2000). It is estimated by the UNICEF that annually over 20 000 adolescents in

developed countries and almost one million adolescents in developing countries receive a fatal injury (A league table of child deaths ... 2001). The magnitude of the problem varies by sex, region and income group, thus the rates of fatal injuries tend to be higher in boys, rural areas and less developed countries (The injury chart book ... 2002). Table 3 presents an encapsulation of studies concerning occurrence of unintentional injuries among adolescents.

Sweden has reported the lowest fatal adolescent injury rates in the world, incidence being 5.5 per 100 000 in 10–14-year-old adolescents. The average level in the EU region is 10 per 100 000 person-years and in the United States 14 per 100 000 person-years (Childhood Injuries 1998). The corresponding figures are 13 per 100 000 person-years in girls in Eastern Europe and as high as 30 per 100 000 in the area of former Soviet Union (Childhood Injuries 1998). Concerning adolescents 15 to 19 years, the death rates in the EU are 50 per 100 000 in boys and 18 per 100 000 in girls, in the Eastern Europe 60 and 20, and in the former Soviet Union 130 and 40 (Childhood Injuries 1998).

Since the form and accuracy of cause-of-death registers vary depending on the level of development in the country, we have to rely on estimates when describing the incidence in less developed countries (London et al. 2002). It is estimated that the injury mortality rates may be more than four times higher in developing countries than in the European Union (1999).

Considering the recent trends of unintentional injury deaths, it is evident that injury mortality in developed countries among children under the age of 15 has fallen to a half between 1970 and 1995 (A league table of child deaths ... 2001). The main reason for this positive development has been the decline in traffic-related deaths. However, nations have lowered their mortality rates at very different speeds. The greatest decline of all has occurred in Germany where the incidence of fatal childhood injuries has declined by more than 70% between 1971 and 1995, while in the Czech Republic the decline over the same period has been 37% (A league table of child deaths ... 2001). There is some evidence that a significant decline in mortality is associated with a higher social class since the rates among adolescents of a lower social class remain unaltered (Roberts et al. 1996). Although injury rates have declined markedly, the proportion of injury deaths of the total deaths has increased, while deaths from other causes have declined even more rapidly (A league table of child deaths ... 2001).

The knowledge about the occurrence of non-fatal severe injuries is more insufficient than that of fatal injuries. Large population based studies made in developed countries indicate that the incidence of adolescent injury hospitalisation varies substantially, between 310 and 1700 per 100 000 persons (Table 3). The reason for this variation in incidence is probably due to the variation in true incidence figures but also differences in hospitalisation policies.

Table 3. *Register study based occurrence of unintentional injuries among adolescents outside Finland.*

Authors	Country	Number of injuries	Age-group	Injury outcome	Incidence/10^5 /year
Schlueter et al. 2004	Switzerland	3 700	15–19	Death	47 to 83 in boys 18 to 26 in girls
Morrison et al. 1999	Scotland	1 728	0–14	Death	6 to 11
Roberts et al. 1996	The United Kingdom	5 700	0–15	Death	16 to 82
Gofin et al. 2002	Israel	11 058	10–17	Hospitalisation, death	7560
Anderson et al. 1998	The United States	1 361	0–15	Hospitalisation, death	403 Hispanic 231 Other
Walsh et al. 1996	The United Kingdom	12 500	10–15	Emergency room visit, hospitalisation, death	25 000
Gallagher et al. 1984	The United States	5 953	13–19	Emergency room visit, hospitalisation, death	35 000 in boys 19 000 in girls
Hippisley-Cox et al. 2002	The United Kingdom	35 042	5–14	Hospitalisation	7 700
Durbin et al. 2000	The United States	46 348	0–15	Hospitalisation	323
Marganitt et al. 1992	The United States	35 746	0–13	Hospitalisation	320
Smith 1991	Scotland	1 388	0–14	Hospitalisation	1 978
Langley et al. 1989	New Zealand	58 457	10–20	Hospitalisation	1 700 in boys 1 000 in girls
Zuckerbraun et al. 2004	The United States	1 950	10–14	Emergency room visit	4 350
Faelker et al. 2000	Canada	5 894	10–19	Emergency room visit	37 000
Quinlan et al. 1999	The United States	32 432	10–19	Emergency room visit	15 600
Laing et al. 1999	The United Kingdom	1 147	10–14	Emergency room visit	18 000 in boys 10 400 in girls
Gorman et al. 1999	Scotland	17 330	10–19	Emergency room visit	39 000 in boys 19 800 in girls
Waller et al. 1995	The United States	3 059	10–19	Emergency room visit	13 000 in boys 9 000 in girls
Zwi et al. 1995	South Africa	695	0–19	Emergency room visit	4 100

Table 3 shows a summary of emergency room based studies conducted with comparable methods in developed countries, according to which the incidence of adolescent unintentional injuries requiring treatment in emergency departments has varied between 9880 and 26 000 per 100 000 persons. There is evidence that emergency department based studies may underestimate the occurrence of injury by 20–40% if access to medical care is limited or expensive (Overpeck et al. 1995). Another point worth noting is the effect of social status to the use of medical care, even in situations where it is available for all. It was shown in Israel that, even though the Arabs' injury-related death rates were significantly higher, the incidence of injury-related visits seen in emergency departments was slightly lower (Gofin et al. 2002). The threshold to seek medical treatment varies by culture and sociodemographic status.

Table 4. *Survey based occurrence studies of unintentional injuries among adolescents*

Authors	Country	Sample size	Age-group	Injury outcome	Incidence/10^5/year
Pickett et al. 2002	Canada	11 329	11–15	Medically attended injury	36 700
Hambidge et al. 2002	The United States	6 358	13–18	Medically attended injury	14 400
Pickett et al. 2002	Twelve countries	49 461	11–15	Medically attended injury	24 000 to 48 000
Michaud et al. 2001	Switzerland	3 609	10–19	Medically attended injury	36 000 in boys 32 000 in girls
Mazur et al. 2001	Twelve countries	53 533	11–15	Medically attended injury	41 300
Danseco et al. 2000	The United States	unknown	0–21	Medically attended injury	25 000
Bussing et al. 1996	The United States	11 630	5–17	Medically attended injury	15 000
Williams et al. 1997	The United Kingdom	4 710	11–15	Medically attended injury	42 100
Currie et al. 1996	The United Kingdom	4 710	11-15	Medically attended injury	41 900
Fraser 1996	The United States	7 470	10–17	Medically attended injury	20 300 in boys 12 600 in girls
Alexander et al. 1995	The United States	758	13	Medically attended injury	53 000 in boys 37 700 in girls
Overpeck et al. 1995	The United States	11 710	12–17	Medically attended injury	22 500
Scheidt et al. 1995	The United States	17 110	0–17	Medically attended injury	27 000
Riley et al. 1996	The United States	2 712	11–17	Self reported injury	64 700
Lodge et al. 1990	New Zealand	849	14–15	Self reported injury	46 000 in boys 31 000 in girls
Chalmers et al. 1989	New Zealand	850	12–13	Self reported injury	43 000 in boys 32 000 in girls
Langley et al. 1987	New Zealand	803	10–11	Self reported injury	38 000

Table 4 shows population based surveys describing the incidence of adolescent injuries. It can be assumed that the occurrence of unintentional injuries among adolescents varies between 30% and 50% per year. This variation may be partly due to the different definition of injury in these studies. Another important aspect is the recall period: the longer the period is the smaller will be the occurrence of injuries. Most of these studies used a recall period of one year, despite the clear evidence that a year is too long and a 1–3 month recall-period is recommended (Harel et al. 1994).

Occurrence of violence

Occurrence of violence in Finland

Violence can be regarded as the universal risk factor for violence-related injuries. It is defined by WHO as "The intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation" (Krug et al. 2002). This definition of violence covers a broad range of outcomes, from threat of psychological harm to use of physical power resulting in injury. In this thesis, violence is apprehended as a risk factor for violence-related injuries, and thus the point of view is that of epidemiology.

There is a wide range of actual or potential data sources that may be of use for violence surveillance. It is evident that population based surveys describe aspects of violence different from those in criminal statistics. Information on the most serious violence in Finland can be obtained from the report "Crime and Criminal Justice in Finland" of The National Institute of Legal Policy of Finland (Crime and Criminal ... 2004), which has monitored the numbers and trends of murders and assaults reported to police since 1975. According to the report, the number of severe assaults and murders among 15–20-year-olds ranged between 300 and 25 in 1983 (Crime and Criminal ... 2004). While murders committed by adolescents have remained at the same level, the number of assaults reported to police has doubled (Kaipainen 1996). From the European perspective, the general annual homicide rate per population in Finland at present is in all ages considerably higher than in most western European countries or Scandinavia (Lehti 2004).

Information about violence among Finnish adolescents was first studied in a time series with a relatively small sample (sample size varied between 1000 and 2000) between 1970 and 1976 (Aromaa 1977). It showed that 45% of men aged 15–21 years had encountered violence, and the corresponding figure among women of the same age was 20% (Block 1984). Persons living in cities reported slightly more violence than persons living in rural communities. For the most part, violence took the form of threatening, grabbing and pushing (Block 1984),

and persons using alcohol frequently had higher violence occurrence rates than abstinent persons (Aromaa 1977).

A few years later, in 1980, Lättilä and colleagues estimated that one third of adolescent boys and one fifth of girls reported violence during the past year (Lättilä et al. 1983). The following victim surveys suggested that the overall occurrence of violence declined significantly among adolescents aged 15–19 years, from 27% in 1980 to 19% in 1997 (Kivivuori et al. 2003). However, the most recent report published in 2004 indicates that the occurrence of adolescent violence has returned to the same level as in 1980 (Heiskanen et al. 2004). Meanwhile, violence in workplaces and family surroundings in Finland has been examined in a few studies only (Kouvonen 2001).

One of the most comprehensive peer-review studies concerning violence in Finland was published in 2002, when Heiskanen described in his thesis (Heiskanen 2002) the trends and the nature of violence among the Finnish population between 1980 and 1997. Heiskanen used the data of victim surveys, thus the study population consisted of 15 to 74-year-old persons, and the data was collected with phone interviews and visiting the study subjects. Violence among adolescents was not analysed separately in this study.

Occurrence of violence outside Finland

The occurrence rates of adolescent violence differ to a remarkable degree. In the World Health Organisation's recent report "World Report on Violence and Health" focusing on adolescent males in secondary schools, the percentage of reported involvement in physical fighting in the past year ranged from 22% in Sweden to 44% in the Unites States and 76% in Israel (Krug et al. 2002). The majority of the population based violence research has been carried out in the United States where violence rates exceed the rates in other developed countries. A positive sign is that the recent trends of violence occurrence in the United States have been decreasing (Brener et al. 1999). Nevertheless, violence victimisation rates continue to be high (Sells et al. 1996). In 1997, 37% of adolescents in schools reported physical violence (Brener et al. 1999). Other violent behaviours, such as carrying a weapon, are substantially more common in the United States than in other western countries (Brener et al. 1999). Youth Risk Behaviour Surveillance, a nationwide survey monitoring health-risk behaviours among adolescents in the Unites States (Kann et al. 2000), exposed that 60% of adolescents had been in a physical fight during the preceding 12 months (Grunbaum et al. 1999). A comparable study from Switzerland performed as part of the international Health Behaviour in School-aged Children Study revealed that 15% of boys and 3.5% of girls reported physical fighting (Kuntsche 2004).

Occurrence of violence-related injuries

Occurrence of violence-related injuries in Finland

Information on deaths resulting from unintentional and violence-related injuries was not reported separately until 1981 (Kemppainen 1985). Violence-related injuries have accounted for 3.2% of all childhood deaths in 1955–59 and 5.4% in 1975–77, however, the incidence was not reported (Kemppainen 1985). In the first studies describing the incidence of fatal violence-related injuries, the incidence was between 1.0 and 1.5 per 100 000 persons per year between 1972-1981 (Kemppainen 1985). According to most recent evidence from Parkkari and colleagues, the incidence of fatal violence-related injuries has been under three per 100 000 persons among boys and under two per 100 000 persons among girls, without undergoing any marked change between 1971 and 1995 (Parkkari et al. 2000).

The only study investigating the occurrence of violence-related injuries treated in hospitals suggests that the occurrence of violence-related injuries increased significantly between 1980 and 1990 in Finland (Ruusinen 1992) However, the classification of injuries was based on external causes, and hence the trend seen may partly reflect changes in reporting the E-codes. The incidence of violence-related injuries (both self-inflicted and assaults) increased from 6 per 100 000 persons among boys aged 0–14 years and 7 per 100 000 persons among girls seen in 1980 to 9 per 100 000 and 11 per 100 000 in 1990, respectively (Ruusinen 1992). The higher incidence rate among girls was an interesting finding, which was explained by a higher rate of self-inflicted injuries (Ruusinen 1992).

The less severe violence-related injuries treated in emergency departments of Finnish adolescents have been little explored. A report by Honkanen states that violence-related injuries accounted for only 0 to 2% of all injuries treated in emergency departments (Honkanen 1984).

The first population based studies on less severe violence-related injuries were conducted between 1970 and 1976, when Aromaa and colleagues wrote that 17% of men and 10% of women aged 15–21 years had encountered violence-related injury (Block 1984). A few years later, in 1980, Lättilä and colleagues reported that 6% of men and 3% of women aged 15–24 years had experienced at least one violence-related injury, of which most typical injury types were bruises and wounds (Lättilä et al. 1983). Occurrence of violence-related injuries has remained unaltered since (Heiskanen et al. 2000). More detailed, population based information on the anatomical location or the risk factors for violence-related injuries has not been available in Finland.

Occurrence of violence-related injuries outside Finland

The World Health Organisation published a report "World Report on Violence and Health" in 2002, in which violence-related injuries were named a major and growing public health problem across the world (Krug et al. 2002). It is estimated by the WHO that the incidence of fatal violence-related injuries in the world among 5–14-year-olds is 2 per 100 000 persons, and the corresponding figure among 15–24-year-olds is 13 per 100 000 persons (Krug et al. 2002). It should be recognised that adolescents' violent death rates vary considerably by region, ranging from 0.9 per 100 000 persons in the high-income countries in Europe to 84.4 per 100 000 persons in Colombia (Krug et al. 2002). In the 1980s and 1990s, violence-related deaths have been increasing in most parts of the world, but most dramatically in the area of the former Soviet Union and Eastern Europe (Krug et al. 2002). Some countries, such as Australia, on the other hand, have succeeded in decreasing their homicide rates (Krug et al. 2002).

Tables 5 and 6 show recent studies examining the occurrence of violence-related injuries. As seen, the majority of violence-related injury research has been conducted in the United States where violence has been a major concern for over two decades (Wright et al. 1996). The incidence of violence-related emergency department visits in the United States has far exceeded that in the other industrialized countries (Cheng et al. 2001).

Table 5. *Register based studies of violence-related injuries among adolescents*

Authors	Country	Number of injuries	Age-group	Injury outcome	Occurrence/10^5/year
Sells et al. 1996	The United States	Unknown	14–25	Homicide	22
Gofin et al. 2000	Israel	432	0–17	Hospitalisation	310
Wladis et al. 1999	Sweden	17 453	10–19	Hospitalisation	100 in boys 15 in girls
Cheng et al. 2001	The United States	15 190	10–19	Emergency room visit or hospitalisation	14 800
Schwarz et al. 1994	The United States	46 260	10–19	Emergency room visit	4 800
Sege et al. 2002	The United States	2 035	3–18	Emergency room visit	530
Sege et al. 1996	The United States	211	3–18	Emergency room visit	410

Table 6. *Survey based studies of violence-related injuries among adolescents*

Authors	Country	Sample size	Age-group	Injury outcome	Occurrence/year
Grunbaum et al. 2002	The United States	13 627	15–18	Medically attended injury	5.2% in boys 2.9% in girls
Brener et al. 1999	The United States	55 000	13–16	Medically attended injury	4.4%
Grunbaum et al. 1999	The United States	8 918	15–18	Medically attended injury	14% in boys 7% in girls

Among the few studies made outside the United States is a large, hospital discharge register based study from Sweden (Wladis et al. 1999) which indicates that the incidence of unarmed violence-related injury leading to hospitalisation was 40 per 100 000 persons among 10–14-year-old boys and 10 per 100 000 persons among 10–14-year-old girls, while in 15–19-year-old adolescents the corresponding figures were 110 and 18, respectively (Wladis et al. 1999). It is noteworthy, however, that firearm-related injuries were excluded from the study and, consequently, it does not report the total incidence.

Risk factors for adolescent injuries

Strengths and limitations of study designs

The risk factors for injury are measurable characteristics associated with a higher probability of a specific injury. The term risk factor incorporates environmental exposure, sociodemographic background, personal attributes, health, and health related behaviours. It involves characteristics that are risk indicators as well as those that are causes of injury. Some risk factors are modifiable (such as risk taking behaviour) and some (such as sex) are not. All of these risk factors, despite the causality, are important from an epidemiological point of view in that they help to identify the group with an increased injury risk.

Epidemiology works at the level of populations in order to compare the frequency of injury in groups with different exposure and different background variables. These comparisons may contribute to the decision about the importance of the risk factors in whether the association between the risk factor and the outcome (injury) is causal. The causality cannot be tested in practice as it would require a randomised study setting comparing one group with and without the risk factor at the same time. The causality remains, therefore, to be concluded by the researcher rather than to be considered a true reality.

In the following, a brief overview of the major study designs is given to indicate some of their strengths and weaknesses for investigating the risk factors for injuries. Tables 7–9 are classified on the basis of the study designs.

A cohort or follow-up study covers a defined population, and measures risk factors at the baseline. The population is then followed up over a period of time, and the occurrence of the outcome is measured. By comparing the frequency of outcome in the different exposure groups, the effect of a risk factor is calculated. A cohort study is a prospective study setting, meaning that the study is initiated before anything has happened. The strength of cohort studies includes the fact that none of the participants has suffered the outcome before the risk factors are measured. Therefore no reverse temporal association between the risk factor and the outcome exists. The limitation of cohort studies is that they are time consuming and rather expensive. If the injury outcome is rare, large numbers of participants are required. All cohort studies, except data linkage studies, suffer from loss of study participants over time, which can create notable biases in the study.

A cross-sectional survey has been the most common method when studying risk factors for injuries (Table 9), because it is relatively easy to conduct and large samples can be used. Surveys can be performed by mailed questionnaires, telephone interviews, school-based questionnaires, or interviewing persons at home. Limitations of surveys include non-response. Since it has been shown that non-respondents differ from respondents in many aspects (Pietila et al. 1995), non-response is a possible source of bias. When the outcome variable is based on self-reporting, recall bias has to be taken into account. Recall bias is more thoroughly discussed on page 11. It has to be kept in mind that, concerning injuries, a cross-sectional study setting is in fact retrospective since injuries must have occurred before the study.

Case-control studies offer a number of features that make them suitable for identification of risk factors. In a case-control study, every participant of a case-series has suffered an injury. This group's exposure is compared with the exposure of the control group without the outcome. Many risk factors can be studied at the same time. The major threat to the validity of a case-control study is the way the controls are selected. It is vitally important that the controls represent the same population as the cases. Differences between the cases and controls will bias the results if they are associated with the exposure of injuries.

Descriptive studies, such as case series, case reports and trauma registers can give valuable information on the circumstances and the nature of the injury, but they cannot be regarded as epidemiological studies as they provide no information on the population at risk.

Considering the risk factors for injuries, confounding has to be discussed. Confounding means the mixing of effects of risk factors by an unbalanced occurrence of another factor. In practice, it is likely that exposure groups (for example frequent drinkers and non-drinkers) will also differ in other ways affecting their injury risk. The confounding effect of risk factors can be studied by investigating the interactive effects of risk factors and other factors.

Confounding can be minimised by taking these interactions into consideration, but most studies use residual confounding that affects the results to some degree.

Risk factors for unintentional injuries in adolescents

Sociodemographic risk factors for unintentional injuries

Being a male is probably the most familiar risk factor for injury, men having a risk 1.4 to 3 times that of women based on large cross-sectional as well as longitudinal studies (Scheidt et al. 1995). A point worth noting is that when the exposure time to injury and intensity of action is consistent, like in the military training, women may have an even greater risk of unintentional injury than men (Almeida et al. 1999). Such results have been explained by physical and anatomical factors. Based on these studies, it can be stated that men's risk of injury is partly due to a higher exposure.

The risk of injury increases with age, and younger adolescents (10–14-years) have proved to have a smaller risk of unintentional injuries than older adolescents (15–19-years) (Fraser 1996).

In many societies, ethnic background is a well-known risk factor for unintentional injuries. Population based cross-sectional reports from the Unites States suggest that persons other than Caucasian have 1.5 to 2 times the risk of unintentional injury (Overpeck et al. 1997). It appears that the increasing effect of ethnic background is associated with being part of a minority, rather than the ethnic background itself.

The association between a low sociodemographic background and unintentional injuries has been widely studied, and it has mainly showed to increase the risk of unintentional injury (Mazur et al. 2001). This has also been verified in Sweden, a country, like Finland, with relatively small sociodemographic differences (Laflamme et al. 2002). It appears that the smaller the sociodemographic differences are inside the country, the smaller is their increasing effect on the risk of unintentional injury.

According to studies in the United States, living in rural areas has been demonstrated to increase the risk of unintentional injuries (Runyan et al. 1989), although opposite results have been described from Sweden (Engstrom et al. 2002). The conflicting results can be explained by smaller sociodemographic differences between rural and urban areas in Sweden than in the United States.

Not living with both biological parents is a well-described risk factor for unintentional injuries (O'Connor et al. 2000). Hussey wrote further that the household's low education increases a child's risk of unintentional injury (Hussey 1997). Father's occupation affects a child's risk of injury, since it has been shown that farmers' children have an increased risk of unintentional injury (Hasselberg et al. 2001).

Health-related risk factors

Concerning the association between health variables and the unintentional injury risk in adolescents, overweight is an argued risk factor (Reynolds et al. 2002). It seems evident that overweight increases the risk of certain specific unintentional injuries, such as overuse injuries and heat illness (Gardner et al. 1996) (Tables 7–9).

Depressed mood has been shown to increase the risk of unintentional injuries in a matched case-control study (Spirito et al. 2001), while the use of corrective eyeglasses has not (Petridou et al. 1995). An increased unintentional injury risk has been found in children with decreased auditory acuity (Petridou et al. 1995), as well as in adolescents with attention deficit hyperactivity disorder (Hoare et al. 2003).

In a cohort study with a follow-up of 14 years, Räsänen and colleagues wrote that psychoses and personality disorders increase the risk of death due to various injuries among the Finnish adult population (Rasanen et al. 1998). To our knowledge, other studies concerning the association between unintentional injury risk and health status do not exist.

Health behavioural risk factors

Studies describing health behavioural risk factors for unintentional injuries among adolescents are shown in Tables 7–9. Apparently, either low (Shaffer et al. 1999) or high physical fitness and activity are risk factors for unintentional injuries (Bijur et al. 1995) (Table 8). This result may be explained by negative health behaviours associated with low physical fitness and activity on the one hand and a relatively high exposure time to sports-related injuries among persons with high physical fitness and activity on the other hand.

The relation between alcohol, drugs and injuries has been ascertained in retrospective as well as in prospective studies. Smoking, similarly, has been proved to be associated with an increased risk of unintentional injury (Avi et al. 2001) (Table 8).

Several behavioural factors, such as emotional instability, truancy, and problems at school have been found to be associated with unintentional injuries in cross-sectional and in longitudinal studies (Table 7). In addition, risk-taking behaviours, like driving without seatbelts, climbing trees etc. increase the unintentional injury occurrence (Ma et al. 2004). Risk factors for violence-related injuries in adolescents

Table 7. *Longitudinal studies of the risk factors for unintentional injuries among adolescents*

Author	Country	Number of participants	Age group	Follow-up time	Injury outcome	Risk-factor	Result (b=boys, g=girls)
Dischinger et al. 2001	The United States	27 339	>15	1.5 to 14.5 years	Death	Previous alcohol-related injury	RR 1.9, p<0.05
Neeleman et al. 1998	The United Kingdom	3 591	0–16 years	34 years	Death	Adolescent emotional instability	OR 1.1 (0.8-1.5) b OR 1.3 (1.0-1.7) g
Hussey 1997	The United States	157 318	0–17	9 years	Death	Low education of household's Other than biological parents Low family income	RR 1.9 (1.3-2.7) RR 1.4 (0.9-2.4) RR 1.0 (0.9-1.2)
Hasselberg et al. 2004	Sweden	1.4 million	1–14	10 years	Hospitalisation	Farmers' children vs. intermediate and high level salaried employees' children	RR 2.4 (1.8-3.2)
Hasselberg et al. 2001	Sweden	1.5 million	0–15	7 years	Hospitalisation	Farmers' children vs. intermediate and high level salaried employees' children	OR 2.8 (2.3-3.4)
Kendrick et al. 2001	The United Kingdom	771	3–12	2 years	Emergency room visit	Residence in a deprived area	RR 1.6 (1.3-2.0)
Reynolds et al. 1994	The United States	181	21 years	1 year	Medically treated injury	High BMI Poor physical performance	RR 2.2 (1.3-4.0) RR 2.8 (1.4-5.6)
Begg et al. 1999	New Zealand	1 037	15–18	<6 years	Self-reported injury	Low involvement with family	OR 3.0 (1.4-6.4)
Cobb et al. 1995	The United States	271	10- and 13-years-old	4 to 5 years	Self-reported injury	Childhood aggression	P<0.03 for injuries and close calls
Anderson et al. 1994	The United States	1 245	12–16	3 years	Self-reported injury	Poor sociodemographic status	NS

RR= risk ratio, OR= odds ratio, NS= non-significant

Table 8. *Cross-sectional studies of the risk factors for unintentional injuries among adolescents*

Author	Country	Number of participants	Age group	Injury outcome	Risk factor	Result (b=boys, g=girls)
Morrison et al. 1999	Scotland	All children	0–14	Death	Poor sociodemographic status	RR 2.3 (1.8-2.9)
Roberts et al. 1996	The United Kingdom and Wales	All children	1–15	Death	Poor sociodemographic status	RR 5.0, p<0.001
Marcin et al. 2003	The United States	5 507	0–18	Hospitalisation, death	Poor sociodemographic status	Incidence 15.5 vs. 8 per 10 000
Laflamme et al. 2002	Sweden	2.2 million	0–19	Hospitalisation, death	Poor sociodemographic status	significant in 5-19 year olds
Anderson et al. 1998	The United States	213 906	0–15	Hospitalisation, death	Poor sociodemographic status	RR 1.1 (1.0-1.2)
Gofin et al. 2002	Israel	11 058	0–17	Emergency room visit, hospitalisation, death	Ethnic background Poor sociodemographic status	RR 1.5 OR 1.3 (1.1-1.5)
Engstrom et al. 2003	Sweden	1.5 million	5–19	Hospitalisation	Poor sociodemographic status	RR 1.3-3.3 (significant)
Engstrom et al. 2002	Sweden	2.2 million	0–19	Hospitalisation	Poor sociodemographic status	RR 1.7 (1.6-1.9)
Conseur et al. 1997	The United States	6 993	13–17	Hospitalisation	Previous juvenile delinquency	OR 2.7 b OR 1.6 g, p<0.05
Miller et al. 2001	The United States	1.5 million	>10	Emergency room visit, hospitalisation	Alcohol Drugs	OR 1.3 (1.3-1.4) OR 1.5 (1.4-1.5)
Johnston et al. 2003	The United States	16 335	0–15	Emergency room visit	Previous sibling injury	RR 1.4 (1.4-1.5)
Valent et al. 2001	Italy	292	1–14	Emergency room visit	Previous inadequate sleep duration	RR 4.0 (1.1-14.2)
Faelker et al. 2000	Canada	35 380	0–19	Emergency room visit	Poor sociodemographic status	RR 1.7 (1.5-1.9)

Table 8 *continued*

Laing et al. 1999	The United Kingdom	1 147	0–14	Emergency room visit	Poor sociodemographic status vs. high	Incidence 192 vs. 96 per 1000, p<0.001
Stark et al. 2002	Scotland	4 512	0–14	Fracture in emergency room	Poor sociodemographic status	P<0.01
Porter 2000	The United States	4 309	12–25	Severity of injury in emergency room	Alcohol	NS
Hambidge et al. 2002	The United States	48 000	0–19	Primary care office visit	Living in rural area	OR 1.4 (1.1-1.9)
Pickett et al. 2002	12 countries	49 461	11–15	Self-reported medically attended injury	Smoking	OR 1.7 (1.5-2.1)
					Drinking	OR 1.7 (1.5-2.0)
					Truancy	OR 1.6 (1.1-2.4)
Pickett et al. 2002	Canada	11 329	11–15	Self-reported medically attended injury	Family composition	OR 0.8 (0.6-1.2)
					Low parental support	OR 1.1 (1.0-1.3)
Williams et al. 1997	Scotland	4 710	11–15	Self-reported medically attended injury	Poor sociodemographic status	NS
Bussing et al. 1996	The United States	11 630	5–17	Self-reported medically attended injury	Family composition	16% for both own parents vs. 20% otherwise, p=0.01
Overpeck et al. 1995	The United States	17 110	0–17	Self-reported medically attended injury	Lack of health insurance	RR 0.6-0.8, p=0.001
Towner et al. 1994	The United Kingdom	4 637	11–14	Self-reported injury	Poor sociodemographic status, lower age, being male	P<0.05
Riley et al. 1996	The United States	2 712	11–17	Self-reported injury	Risk-taking	p<0.01
					Play on sports team	p<0.01
Alexander et al. 1995	The United States	178	13	Self-reported injury	Physical activity	RR 1.6
					Risk taking	RR 2.4
					School problems	RR 2.1, p<0.05
Mazur et al. 2001	12 countries	53 533	11–15	Self-reported injury	Poor sociodemographic status	p<0.05 in 9 countries

RR= risk ratio, OR= odds ratio, HR= hazard ratio, NS= non-significant

Table 9. *Case-control studies of the risk factors for unintentional injuries among adolescents*

Author	Country	Number of participants	Age group	Injury outcome	Risk factor	Result
Li et al. 1994	The United States	466	>15	Hospitalisation or death	Alcohol vs. no alcohol	12.9% vs. 2.9% p<0.01
Hoare et al. 2003	Scotland	196	2–14	Emergency room visit or hospitalisation	ADHD vs. controls	52% vs. 37%, p<0.01
Humphrey et al. 2003	New Zealand	273	>16	Emergency room visit	Alcohol	RR 2.8
Petridou et al. 1995	Greece	432	5–14	Emergency room visit	Auditory acuity Previous injury	OR 2.4, p<0.05 OR 1.3, p=0.002
Loiselle et al. 1993	The United States	134	13–19	Emergency room visit	Positive toxicology screen	34% vs. 2% in controls, p<0.001
Ma et al. 2004	Tasmania	642	9-16	Upper limb fracture	Risk-taking Coordination	OR 2.6 (1.3-5.7) OR 1.1 (1.0-1.2)

RR= risk ratio, OR= odds ratio

Risk factors for violence-related injuries in adolescents

Sociodemographic risk factors

Men encounter more violence-related injuries than women, the risk varying from 1.5 to 4 (Burt et al. 1998). An increased risk of violence-related injury among men may partly be explained by the male behavioural features. However, we can only assume that exposure to violent situations may be higher among men. Being a woman, on the other hand, is a significant risk factor for specific types of violence, such as home violence (Heiskanen 2002).

Age is markedly related to the risk of injury in that older adolescents have shown a persistently increased risk of violence-related injuries compared to younger adolescents (Rachuba 1995).

Ethnic background has emerged as a significant risk factor for violence-related injury; the rates of violence-related injuries and violent deaths among black persons are three times that of white persons' (Burt et al. 1998) (Tables 10–11). According to the interesting findings from a Swedish study, persons born in Finland had the highest risk of all of becoming homicide victims in Sweden, RR being 6.4 (95% CI: 5.1–8.0), compared to persons born in Sweden (Allgulander et al. 2000).

Tables 10–11 show the studies examining the association between a low sociodemographic status and violence-related injuries. A strong association has been described in cross-sectional as well as in longitudinal studies (Falbo et al. 2001). Not living with both parents seems to increase the risk of violence in a school survey of 9487 adolescents (Singer et al. 2000), but to our knowledge studies on violence-related injuries and family structure are absent. An interesting Finnish study suggested that being an only child increases the risk of criminal offending (Kemppainen et al. 2001). Being married appears to be a protective factor against violence-related injuries, never married or divorced adults encounter significantly more violence-related injuries in the United States (Perkins et al. 1996) and more violence-related injury deaths in Sweden (Allgulander et al. 2000).

The risk of violence-related injury seems to be higher in urban than rural areas. A report from the United States described that violence-related injury rates were 60% higher in metropolitan areas (Burt et al. 1998). In addition to urbanisation, firearm prevalence is associated with severe self-inflicted violence-related injuries even when other confounding factors were taken into account (Miller et al. 2004).

Health-related risk factors

Only few health factors have been shown to increase or decrease the risk of violence-related injury in adolescents. Adolescent emotional instability is a predictor of suicide in a cohort of British adolescents followed up over 34 years (Neeleman et al. 1998). In a case-control study of 532 women in the United States, a history of depression increased the risk of violence-related death 260-fold (Bailey et al. 1997).

Health behavioural risk factors

Of health behavioural factors associated with violence-related injuries, a previous injury of any kind is the strongest risk factor for violence-related injury. In a population based follow-up study from New Zealand, the risk of violence-related injury was 176 times higher among persons with a previous self-inflicted injury and 6 times higher among persons with a previous unintentional injury (Conner et al. 2003). Several reports support this increased risk (Conner et al. 2003).

The association of perceived alcohol and drug use with violence-related injuries has been well documented in longitudinal and cross-sectional studies (Tables 10 and 11) in the Unites States (Perkins et al. 1996), Brazil (Falbo et al. 2001), Sweden (Allgulander et al. 2000), Russia (Pridemore 2002), and Finland (Paunio et al. 1994). Besides substance use, smoking has been shown to be associated with violence-related injuries (Ellickson et al. 1997). The increased violence-related injury risk of smokers was also seen in a study by Puska and colleagues among Finnish adults in that smokers had a 2.3 (95% CI: 1.7–3.4) risk of injury-related death (Vartiainen et al. 1994).

Other behavioural factors associated with violence-related injuries include problems at school (Anderson et al. 2001), delinquent behaviour, (Ellickson et al. 1997), and bullying (Nansel et al. 2003). However, these results have not been confirmed in longitudinal studies (Table 10.).

Table 10. *Longitudinal studies of risk factors for violence-related injuries among adolescents*

Author	Country	Number of participants	Age group	Follow-up time	Injury outcome	Risk factor	Result
Hussey 1997	The United States	157 318	0–17	9 years	Homicide Suicide	Low education of household's Low education of household's	RR 5.3 (2.1-13.6) RR 1.2 (0.6-2.3)
Neeleman et al. 1998	The United Kingdom	3 591	0–16	34 years	Suicide	Adolescent emotional instability	OR 2.0 (1.2-3.6) in boys OR 1.8 (1.3-2.5) in girls
Conner et al. 2003	New Zealand	3 710 000	all	1 year	Hospitalisation	Previous self-inflicted injury Previous unintentional injury Assault	RR 176 (155-200) RR 5.6 (4.8-6.6) RR 9.2 (4.8-6.6)
Dowd et al. 1996	New Zealand	3.3 million	all	1 year	Hospitalisation	Previous unintentional injury hospitalisation	RR 3.2 (2.7-3.9)

RR= risk ratio, OR= odds ratio

Table 11. *Cross-sectional studies of risk factors for violence-related injuries among adolescents*

Author	Country	Number of participants	Age group	Injury outcome	Risk factor	Result
Lunetta et al. 2001	Finland	45 544 violent deaths	>15	Death	Use of alcohol	55% of homicides and 29% of unintentional injuries are alcohol related, p<0.05
Miller et al. 2002	The United States	7 797 deaths	>4	Suicidal death	Firearm availability	Rate of suicide attempts using firearms was associated with prevalence of firearms, p>0.001
Engstrom et al. 2002	Sweden	All adolescents	10–19	Hospitalisation, death	Poor sociodemographic status	RR 1.6 (1.3-2.0) boys of unskilled workers compared to high level employees
Moskowitz et al. 2001	The United States	24 000	12–18	Hospitalisation	Pre-existing cognitive impairment	OR 1.7 (1.1-2.5)
Gofin et al. 2000	Israel	1.9 million	0–17	Hospitalisation	Being a Jew Urban residence	Lower incidence in Arabs, p=0.0001 p=0.0001
Wright et al. 1996	The United States	998	5–25	Re-hospitalisation	Previous violence-related injury hospitalisation	RR 4.3 (2.4-7.5)
Mollen 2003	The United States	600	8–24	Emergency room visit	Age	OR 1.6 (1.0-2.5) in 15-24-year-old compared to 8-14-year-olds
Swahn et al. 2004	The United States	8 885	12–21	Self-reported medically attended injury	Drinking frequency	OR 2.0 (1.3-3.0)
Nansel et al. 2003	The United States	15 686	11–15	Self-reported injury	Weekly bullying	OR 32 (25-39)
Brener et al. 1999	The United States	54 000	14–17	Self-reported injury	Being black Being male	OR 2.0 (1.6-2.4) OR 2.2 (1.9-2.3)

RR= risk ratio, OR= odds ratio

Summary of adolescent injury research

According to the existing information, adolescent injury death rates in Finland have been among the highest in Europe until their decline which started in the 1970s. At present, the fatal injury rates represent an average European level. The decline is mainly a result of a decrease in fatal traffic-related deaths. The occurrence of violence-related deaths has remained on the same level for 30 years (Parkkari et al. 2000).

While fatal injuries have been showing a decreasing trend during the past 30 years, non-fatal injuries seem to be increasing. Three population based studies supporting this increasing trend has been published (Kemppainen et al. 1981). It can be assumed that 30–40% of adolescents sustain an unintentional injury every year, and some 25–30% of adolescents require medical treatment due to an unintentional injury.

Violence among Finnish adolescents seems to be on the rise since the number of severe assaults has doubled in 20 years (Kaipainen 1996). Survey based information on the occurrence of violence has been reported on older adolescents only (Heiskanen et al. 2000), indicating that approximately one fourth of 15–24-year-old adolescents encounter violence every year (Heiskanen et al. 2004), while information on the occurrence of violence among younger adolescents is absent.

Only few Finnish studies concerning adolescent violence-related injuries exist. The latest hospital discharge register based study showed that the occurrence of violence-related injuries requiring hospitalisation increased by 50% in the 1980s (Ruusinen 1992). Occurrence of less severe violence-related injuries has remained unaltered, and it is estimated that 5 percent of adolescents sustain a violence-related injury every year (Heiskanen et al. 2000).

Several factors have been related to the increased occurrence of unintentional and violence-related injuries in international studies. The sociodemographic background has been evidently shown to increase the risk of injuries. Whether this is true in Finland is not known. Health and health behavioural risk factors have been much less studied internationally, and no Finnish studies exist. Awareness of the factors associated with injuries would help us to target preventive measures at groups with a higher injury occurrence.

AIMS OF THE STUDY

The general aim of this study was to find out the occurrence, nature and risk factors of adolescent injuries in Finland. The detailed objectives of the study were to investigate:

1) Occurrence and time-trend of injury-related death
2) Occurrence, nature and severity of unintentional and violence-related injuries
3) Risk factors for less severe unintentional and violence-related injuries
4) Predictors of injury-related death and injury hospitalisation

MATERIALS AND METHODS

The present study was based on three data sets. The first data was based on the Official Cause-of-Death Statistics Finland in 1971–2001 (paper I). The second was based on the cross-sectional data of the Adolescent Health and Lifestyle Survey in 1999 (papers II, III and IV). The third was based on the longitudinal data of the Adolescent Health and Lifestyle Surveys from 1979 to 1997, linked to the data of the National Hospital Discharge Register and to the Official Cause-of-Death Statistics Finland between 1979 and 2001 (paper V).

Study populations

The Official Cause-of-Death Statistics

The data used in the paper I was a time series data obtained from the Official Cause-of-Death Statistics (OCDS) of Finland, concerning all injury-related deaths of 0–14-year-old Finns in Finland between 1971 and 2001. This statutory register has been computer-based since 1971 and updated and reviewed for data quality by the Cause-of-Death Bureau at the Central Statistical Office of Finland (2003c). The Finnish OCDS contains information on age, sex, marital status, place of residence, and place, cause and time of death of the deceased. The study population consisted of all Finnish children at 0–14 years of age. The annual child mid-population was obtained from the Official Statistics of Finland (2003c), a computer-based official population register of Finland. The child population (0–14-year-olds) was 1 107 280 in 1971 and 933 962 in 2001 (2003c).

The Adolescent Health and Lifestyle Survey, cross-sectional

The second data set was obtained from a cross-sectional survey, the Adolescent Health and Lifestyle Survey (AHLS) of 1999. The AHLS is a national monitoring system of adolescent health and health behaviours, initiated in 1977 to study the impact of the Tobacco Act on adolescent smoking. A structured questionnaire including questions about sociodemographic background, health and health behaviours has been mailed to a large sample of adolescents in every other February since 1977. Some questions have been the same during the study period, but some topics have varied.

The sample of 12, 14, 16, and 18-year-olds has been drawn from the National Population Register Centre by selecting all Finns born on certain days in June, July or August. The mean ages of the respondents have been 12.6, 14.6, 16.6, and 18.6 years. The comparability of the survey data has been quality controlled by maintaining the timing of the study and the sample obtained from the National Popular Register Centre similar. Two re-enquiries have been sent to non-respondents after three and seven weeks.

Data in the present study was based on the sample composed of 12, 14, 16 and 18-year-old Finnish adolescents as part of the Adolescent Health and Lifestyle Survey in 1999. The questionnaire was sent to 10 883 adolescents, of which 8216 returned the questionnaire (response rate 76%) (Table 12). The number of study subjects who gave valid answers for the outcome variable in the papers II and III was 8135 adolescents. The paper IV concentrated on the 14, 16 and 18-year-old adolescents of this survey. The sample size in paper IV was 9759 adolescents and the response rate was 68% in boys and 83% in girls (N=7370).

Table 12. *Number of respondents and response rates by age and sex. Adolescent Health and Lifestyle Survey 1999.*

	Boys age (years)				Girls age (years)				Total
	12	14	16	18	12	14	16	18	
Number of respondents	442	1187	1110	1112	407	1313	1333	1315	8216
Response rate (%)	79	74	68	63	85	85	85	80	76

The Adolescent Health and Lifestyle Survey, longitudinal

Using the opportunity to combine survey data with data from national registers, a longitudinal study design was constructed to provide information on the predictive factors for severe injuries.

The sample of 14, 16, and 18-year-olds was drawn from the National Population Register Centre by selecting all Finns born on certain days in June, July or August. The mean ages of the respondents were 14.6, 16.6, and 18.6 years. Baseline data for the analyses were collected from 1979 to 1997. As some of the persons had appeared more than once in the AHLS over the years, only their first appearance in the survey was included (Table 13). The baseline population consisted of 72 194 persons, of which 57 297 responded in the AHLS, the response rate being 79% (Table 13).

Table 13. *Design of the follow-up study*

Baseline year	Age at baseline	Number of respondents		Response rate (%)		Age at follow-up in 2001
		Boys	Girls	Boys	Girls	
1979	14	562	534	86	91	37
	16	527	576	83	91	39
	18	514	511	78	86	41
1981	14	484	546	87	92	35
	16	531	529	85	92	37
	18	516	519	81	88	39
1983	14	429	481	79	86	33
	16	411	508	75	91	35
	18	-	-	-	-	
1985	14	393	430	75	88	31
	16	453	499	77	87	33
	18	404	469	67	83	35
1987	14	1673	1787	81	89	29
	16	1379	1477	80	89	31
	18	1011	1270	74	89	33
1989	14	360	430	75	90	27
	16	362	379	70	82	29
	18	326	406	63	80	31
1991	14	1626	1833	74	87	25
	16	1560	1910	71	87	27
	18	1285	1622	61	82	29
1993	14	1859	2007	75	88	23
	16	1650	1942	71	87	25
	18	1458	1788	67	84	27
1995	14	1177	1300	75	85	21
	16	1232	1469	72	88	23
	18	1070	1311	67	86	25
1997	14	1167	1344	69	84	19
	16	1124	1414	68	87	21
	18	1087	4135	60	83	23
Total		26630	30667	72	87	

We linked our baseline cohort (both respondents and non-respondents of 14 to 18-year-olds during 1979–1997) with these two nationwide registers with the help of the unique national personal identification number. The sample of a specific year were followed up in the NHDR and the Cause-of-Death Statistics starting from April 30th of each data collection year, and ending at the first hospitalisation due to injury or death, or at the end of the follow-up, December 31st in 2001. In the event a person came up first with hospitalisation due to injury and immediately thereafter with injury-related death, it was regarded as death in the analyses. The cohorts were followed up on average for 10.3 years, the total follow-up time being 749 434 person-years. The follow-up time varied between 0 and 23 years, thus the persons were 14 to 41 years old at the end of the follow-up. (Table 13).

Outcomes of injury

The Official Cause-of-Death Statistics

In investigating the occurrence of injury-related death, the outcome was either an unintentional or a violence-related death in 1971–2001. The main categories for an unintentional injury in the Official Cause-of-Death Statistics of Finland are: road traffic crash, water traffic crash, fall, drowning, and poisoning; and the main categories of death for a violence-related injury are a suicide and a homicide (2003b).

The Adolescent Health and Lifestyle Survey, cross-sectional

The main outcome variables in the analysis of the second data set were the occurrence of unintentional injuries, violence and violence-related injuries during the past month. Occurrence of unintentional injuries was elicited with the question: ”Have you, during the past month, suffered from an unintentional injury that needed attention by physician or nurse?” Our unintentional injury variable (unintentional injury, yes/no) was based on this question and used in the logistic regression as a dependent variable. Those who answered “no” were instructed to skip the rest of the injury questions. Some (N=117) adolescents did not answer the main question, but they answered some of the later questions (nature, severity of injury). These were classified as not having had an unintentional injury.

Place of occurrence was investigated with a question: “Where did this injury occur?”, to which the alternatives provided were: ”at home”, ”at school”, ”on the way to school”, ”elsewhere in traffic”, ”in connection with sports activities (not at school), ”elsewhere during leisure-time”, ”other place, where?”. When possible, answers to the open question were included in the preceding alternatives. Type and location of injury were investigated with an open question: ”What kind of injuries you received?” The answers were classified by the EHLASS codes (1986) into 52 categories according to the anatomical site of the injury, and into 19 categories according to the type of injury. In the analysis, the anatomical sites were re-classified into the following five categories: upper limb, lower limb, head, neck and torso.

Severity of the injury was inquired via a question: ”Did you have to stay away from school, work or hobbies because of this injury”, with alternatives “no”, “part of a day”, “one day”, “2–3 days” and ”over 3 days” (time-loss question). We also asked: ”Had you used alcohol at the time of injury?”, to which the response alternatives were ”no” and ”yes”.

Occurrence of violence was asked with the question: ”Have you, during the past month, been in a fight or subjected to violent actions?” The provided alternatives were: ”no” and ”yes, how many times?” with alternatives “once”, “2

times", "3 times or more". Those who answered "no" were instructed to skip the rest of the violence questions. Those who answered "yes" to the main question were instructed in the following questions to consider the latest fight or violent situation in which they had participated, and, on that basis, to answer the questions about the person they had had the fight with or who had violated them, and the place of occurrence. The type and location of the violence-related injury caused by violence during the past month were elicited with an open question.

The Adolescent Health and Lifestyle Survey, longitudinal

The outcome variables in our longitudinal data set were injury hospitalisation and injury-related death. The injury hospitalisation data were obtained from the National Hospital Discharge Register (NHDR). The injury-related death data were obtained from the Finnish Official Cause-of-Death Statistics. The diagnosis in the NHDR and in the Cause-of-Death Statistics had been coded using the Eighth (1979–1986), Ninth (1987–1995), and Tenth (1996–2001) revisions of the International Classification of Diseases (ICD). Injury hospitalisation was defined as an injury necessitating hospital admission, with the main diagnosis of a traumatic injury. The ICD-8 and the ICD-9 used injury codes 800–959 and 990–994, excluding late effects 905–909, foreign bodies 930–939, and early complications 958. The corresponding ICD-10 codes used were S00–S99 and T00–T71, excluding foreign bodies T15–T19 and intoxications T36–T65.

The Finnish NHDR contains data on the diagnosis, length of stay, site and cause of injury, age, and place of residence of the patient. Cause-of-Death Statistics recodes ICD-based causes of deaths into 54 classes, where unintentional and intentional injury-related deaths are defined by codes 42–53 (2003b).

Risk factors

All explanatory variables, except for the age and the sex, of the respondent and the level of urbanisation of the place of residence used in this study were obtained from the adolescents' self-reports in the AHLS questionnaire. The risk factors were divided into five groups: sociodemographic background, health, health behaviours, school success, and biological maturation. This division was made in order to minimise interaction between variables.

Sociodemographic background

Father's or other guardian's education was classified into low (nine years or less of education) (63% of all), middle (9–12 years) (14%), and high (over 12 years) (23%). Father's or other guardian's occupation was classified according to the status classification of Statistics Finland: upper white-collar employee (24%),

lower white-collar employee (31%), farmer (6%), blue-collar employee or unskilled (36%). Father's and mother's employment status was divided into: working outside home (74% and 70%), working at home (7% and 12%), unemployed (7% and 12%), and pensioner or on long-term sick leave (6% and 3%). The structure of the respondent's family indicated whether the respondent was living with own parents (75%) or not (25%). Urbanisation level of residence was defined by the population density: capital area (Helsinki and the adjoining towns) (14%), large town (population over 100 000) (16%), small town (32%), village (densely populated areas in rural municipalities) (23%), sparsely populated rural municipality (isolated homesteads in rural municipalities) (13%). Geographic area was divided into the areas of North (14%), South (23%), South-West (34%), East (15%) and Central-West (15%).

Health

Adolescents' health was monitored according to their perceived health (excellent 30%, good 51% and average or poor 18%), chronic disease or disability restricting daily activities (no 92%, yes 8%), and counting a summary index of eight stress symptoms (stomach aches, feeling nervous or tension, irritability or temper tantrums, difficulties in falling asleep or waking up during the night, headache, trembling of hands, feeling tired or weak, and feeling dizzy) perceived weekly (none 34%, one 20%, two 14% and three or more 32%). Adolescents were also asked whether they had felt themselves blue or hopeless during the last month, and whether they at the same time had felt that nothing interests them or brings them pleasure. Those who answered positively to both of these questions were categorised as having a depressive mood (no 82%, yes 18%). Body mass index (BMI) was calculated by dividing weight (kg) with the square of height (m). Cut-off point of overweight was set according to Cole and colleagues (Cole et al. 2000) (overweight 12%).

Health behaviours

Adolescents' health behaviour was described by the daily use of tobacco (never tried 30%, not daily or tried only 47%, less than 10 cigarettes daily 10%, more than 10 cigarettes daily 12%) and snuff (never tried 80%, tried 16%, more than 50 times 3%). Alcohol consumption was estimated by questions about the use of alcohol and the frequency of drunkenness, and a drinking style was derived (abstinence 17%, occasional drinking 26%, recurring drinking 30%, recurring drunkenness 24%). Regularity of tooth brushing was asked (daily 82%, not daily 18%), as well as frequency of participation in organised sports (never 51%, once a week or less 17%, 2–5 times a week 23%, approximately every day 5%). The frequency of other leisure time physical exercise (never 4%, once a week or less 40%, 2–5 times a week 39%, approximately every day 15%) was measured by combining three physical exercise variables; exercise a) organised by school or

workplace, b) organised by other associations or clubs, and c) done alone or with friends or family members. Sleeping hours were determined by asking at what time the person usually went to bed and got up (more than 9 hours 26%, 8 to 9 hours 40%, less than 8 hours 34%). Adolescents were also asked whether they had drug-using acquaintances (no 56%, yes 44%) (this variable was used only in connection with violence and related injuries).

School success

Respondents‘ school success, at ages 12 and 14, was measured by the pupil's own assessment of his/her position in the class according to the average grade in the preceding end-of-term school report (excellent 16%, good 55%, satisfactory 20%, poor 9%). At ages 16 and 18, school success was indicated as the combination of school type attended (upper secondary, vocational school, trade course, course for unemployed) and school success (excellent, good, satisfactory, poor).

Timing of biological maturation

The timing of biological maturation was assessed by questions about the respondent's age at the time of first ejaculation (boys) and first menstruation (girls). We classified maturation into three categories: early (boys at the age of 12 or earlier and girls at the age of 11 or earlier) (31%), average (boys at the age of 13 or 14 and girls at the age of 12 or 13) (52%) and late (boys at the age of 15 or later and girls at the age of 14 or later) (17%).

Methods of analysis

The Official Cause-of-Death Statistics

In the statistical analysis, incidence was calculated by dividing the number of injury-related deaths by the midyear number of persons in a specific age group. The numbers and incidence rates of injury deaths were the true results of the child population in Finland rather than cohort-based estimates.

The Adolescent Health and Lifestyle Survey, cross-sectional

The unintentional injury occurrence rate, the violence occurrence rate and the violence-related injury occurrence rate per one month, expressed as percentage, were calculated by dividing the number of adolescents reporting injuries, respectively, by the number of respondents. The Pearson χ^2–test was used to

study the type and distribution of injuries in both sexes and the different age groups, with statistical significance at the level of $p < 0.05$.

Logistic regression was applied to study the association between the outcome variables (unintentional injuries, violence, and violence-related injuries) and the categorical explanatory variables. Due to the small number of 12-year-old adolescents reporting violence-related injuries (11 cases) they we excluded from the analysis. Odds ratios were calculated with a 95% confidence interval.

First, association between the dependent variables and age and sex was examined. In the initial models, age and sex were forced to the model, and each independent variable was analysed one at a time. Tables 20 and 23 show the univariate models. The variables used in the models of unintentional injuries and violence and violence-related injuries are not fully identical, the composition of the univariate models is shown in Tables 20 and 23.

In the multivariate models, forward stepwise logistic regression was used. For the first stage of a multivariate model, only the significant explanatory variables of the initial models were included, and variables were divided into three categories: sociodemographic background (father's or other guardian's education and occupation, father's and mother's employment status, family composition, urbanisation level of the place of residence, geographic area, and school success), health (perceived health, possible chronic disease or disability, stress symptoms, depressive mood, and BMI), and health behaviour (smoking, use of snuff and alcohol, frequency of drunkenness, regularity of tooth brushing, frequency of participation in organised sports, frequency of other leisure time exercise, sleeping hours, and violence occurrence). Analyses were done for each category separately.

In the final multivariate model, only the significant variables from the first stage of the multivariate model were included. All significant variables were put into the same forward stepwise logistic regression model. The model of unintentional injuries included the following variables: family composition, geographic area, stress symptoms weekly, chronic disease or disability restricting daily activities, smoking, use of snuff, frequency of drunkenness, frequency of participation in organised sports, and violence occurrence. The final models of violence and violence-related injuries included family composition, father's education (not in violence-related injuries), stress symptoms weekly, perceived health (not in violence-related injuries), depressive mood, unintentional injury occurrence, smoking, snuff use, drinking style (derived from the variables frequency of drunkenness and use of alcohol), drug-using acquaintances, and frequency of participation in organised sports (not in violence-related injuries).

Logistic functions were computed using respondents who had provided answers to all variables under study. The frequency of missing values in explanatory variables varied between 1–6% in the initial models and 3–14% in the first stage of the multivariate models. The frequency of missing values in the final multivariate models of unintentional injuries, violence, and violence-related injuries were 9%, 33%, and 27%, respectively.

The Adolescent Health and Lifestyle Survey, longitudinal

The aim of our analyses was to determine the best set of factors that predicted injury hospitalisation and injury-related death. Analyses were carried out in three stages, separately for men and women, since sex was associated with several of our background variables. The risk factor analyses were carried out only for the respondents. The *initial model* was a bivariate analysis by cross-tabulation to select variables that showed an association with the outcome variables. We followed the method of Hosmer and Lemeshow (Hosmer et al. 1989) and used a relatively high cut-off value ($P<0.2$) for the selection of explanatory variables to be carried forward to stage two.

At stage two, *univariate Cox regression* was run for each independent variable one at a time, with age forced into the model. Only variables significantly associated with the outcomes were selected for the final analysis.

Since many of the background variables were strongly correlated in the *multivariate model*, variables were divided into five categories, and the final analyses were accomplished in these categories: sociodemographic background, health, health behaviour, biological maturation, and school success. As the variables indicating use of snuff contained many missing values (25%), we excluded this variable from the final analyses, despite its significancy at stage 2. For the multivariate model, a forward stepwise Cox-regression was applied. Hazard ratios (HR) were calculated with a 95% confidence interval.

Reliability and validity of data

Reliability of questions in the Adolescent Health and Lifestyle Survey has been tested with a re-test in 1995 by repeating the survey in March-April 1995 among 16 and 18-year-olds. An identical questionnaire was sent at an interval of one month to a systematic sample of adolescents who had responded to the first enquiry. The questionnaire was sent only once, thus the response rate was lower that in the original survey. The number of adolescents responding to both surveys was 733. Table 14 shows the kappa-coefficients. Values suggested by Fleiss (Fleiss 1981) may be regarded as references to evaluate the reliability. Values over 0.75 are thought to indicate excellent reliability, values between 0.40 and 0.75 fair to good reliability, and values below 0.40 signify a low degree of reliability. Owing to the interval of six weeks until repetition, it is possible that the occurrence of some factors, such as stress symptoms, may have changed to a notable degree. Thus the relatively poor kappa-coefficients reflect the variation in the occurrence of the factors rather than a poor reliability.

The information on the injury hospitalisations and deaths was obtained from two national, computer-based registers. The National Hospital Discharge Register is quality controlled continuously and updated by the National Research and Development Centre for Welfare and Health, Helsinki Finland (2003c). The injury-related death data were obtained from the Finnish Official Cause-of-Death Statistics, which is also a statutory, computer-based register covering the entire country. Both the NHDR and Cause-of-Death Statistics have been shown to have excellent coverage and high accuracy are thus well suited for epidemiological studies (Parkkari et al. 2003).

Table 14. *Kappa-coefficients for background variables in the one-month test re-test reliability study of 16–18-year-old Finns in the Adolescent Health and Lifestyle Survey of 1995.*

Variable	kappa
Sociodemographic background	
Urbanisation level of the place of residence	0.899
Father's education	0.721
Father's occupation	0.798
Family composition	0.924
Father's employment status	0.870
Mother's employment status	0.866
Health	
Perceived health	0.471
Stress symptoms	
abdominal pains	0.490
anxiety	0.361
irritability	0.380
difficulties in sleeping	0.370
headache	0.448
trembling of hands	0.416
fatigue or weakness	0.369
dizziness	0.424
Body mass index	0.728
Chronic disease or disability restricting daily activities	0.613
Health behaviours	
Daily smoking	0.755
Use of snuff	0.882
Frequency of drunkenness	0.619
Use of alcohol	0.394
Regularity of tooth brushing	0.708
Frequency of participation in organised sports	0.525
Other leisure-time physical activity	0.323
Drug using acquaintances	0.665
Biological maturation	
Girls	0.863
Boys	0.640
School success	
School achievement	0.593
School type	0.806

RESULTS

Injury-related death (I)

Occurrence

During the 30-year study period, 1971–2000, injuries were the leading cause of death in Finnish children aged 1–14 years, but not in infants. The proportion of injury deaths from all deaths decreased from 54% in 1971 to 40% in 2001. The incidence of fatal injuries in Finnish children (per 100 000 persons) decreased considerably in all age groups and both sexes; in girls, from 20.1 in 1971 to 2.8 in 2001, and in boys from 36.7 in 1971 to 7.1 in 2001 (Figure 1). Boys' fatal injuries decreased by 81%, while the corresponding figure in girls was 86%. The injurious death risk of boys was 2.5 times that of girls' in 2001. The significant reduction seen was almost solely due to the decreasing number of unintentional injuries. In 2001, 38% of all the injury deaths among 0–14 year-old Finnish children were motor vehicle accidents, followed by drowning (17%). Some 21% of the injury deaths were violence-related injuries.

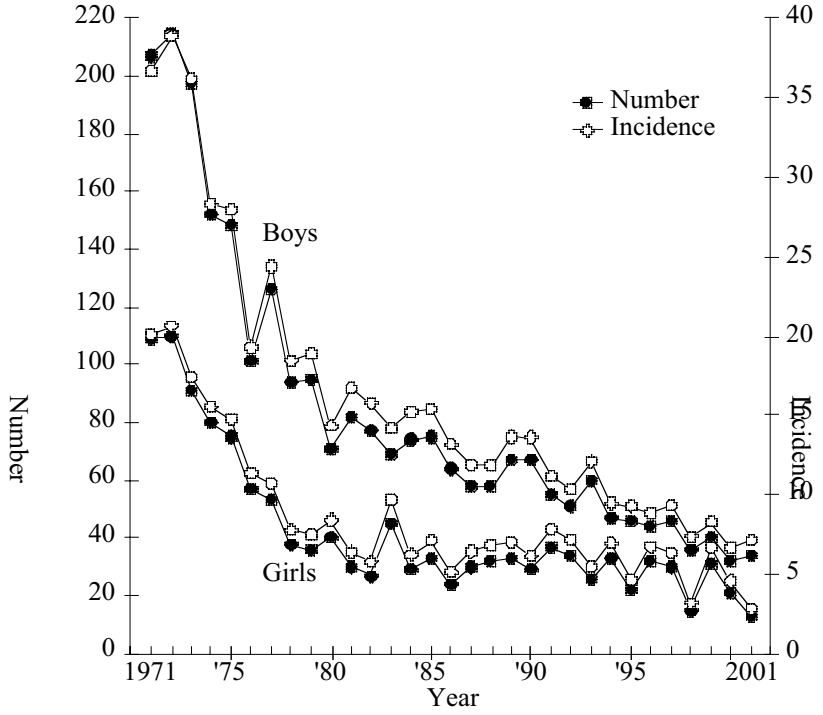

Figure 1. *The annual number and incidence (per 100 000 persons) of fatal injuries among 0–14 year-old Finnish girls and boys between 1971 and 2001*

Unintentional injuries (II)

Occurrence

Of the 8216 respondents, 454 reported an unintentional injury during the past month that had required medical attention, hence the unintentional injury occurrence rate was 5.5%. Most adolescents reported only one unintentional injury during the past month, 0.4% reported two, and 0.1% three or more injuries. The total number of unintentional injuries was 506 and the incidence rate 62 per 1000 person-months. Boys reported higher occurrence rates than girls, but the difference was not statistically significant. Concerning age, the highest rates were reported by the 14-year-olds (Table 15).

Table 15. *Injury occurrence rate per one month, number of cases, and male-to-female ratio among 12–18-year-old Finnish boys and girls by age*

Age	Total Rate % (Number)	Boys Rate % (Number)	Girls Rate % (Number)	Male-to-female ratio (95% CI)
12	4.9 (41)	5.0 (22)	4.7 (19)	1.1 (0.6-2.0)
14	6.4 (158)	6.7 (78)	6.1 (80)	1.1 (0.8-1.5)
16	5.8 (140)	6.5 (71)	5.2 (69)	1.3 (0.9-1.8)
18	4.8 (115)	5.2 (58)	4.4 (57)	1.2 (0.8-1.2)
Total	5.5 (454)	6.0 (229)	5.2 (225)	1.2 (1.0-1.4)

Anatomical location and severity

The most common anatomical locations of injuries were the upper limb (30% of all injuries), the lower limb (24%), and the head (14%), while the most common injury types were joint sprains (27%), fractures (26%), and wounds (16%). Age or sex had no significant effect on the anatomical location or type of injury. Half (53%) of adolescents reported time-loss from school or hobbies due to injury, and the most common length of time-loss was over three days. Injury severity measured by time-loss from school or hobbies was not related to age or sex.

The circumstances of occurrence

In both boys and girls, time of injury occurred most often during leisure time sports activities (39% and 29%), school activities (19% and 23%), and leisure time activities other than sports (18% and 20%). Boys reported significantly more sport-related injuries than girls ($p = 0.008$).

Association between injuries and alcohol

Alcohol was moderately related to unintentional injuries in our study in that 12% of the 16-year-olds and 18% of the 18-year-olds reported to have been under the influence of alcohol when the injury occurred. Use of alcohol was not related to sex.

Violence (III)

Occurrence of violence

Occurrence of violence was studied as a predisposing factor to violence-related injuries. A total of 646 adolescents reported violence during the past month. The percentage of persons reporting violence was 7.9% or (79 / 1000). Most of the adolescents (67%) had experienced one violent event; 18% had encountered two events, and 15% three or more events. The total number of violent acts during the last month was 953.

The violence occurrence rate varied by age and sex (Table 16). Boys reported significantly higher occurrence rates in all age groups. The overall male-female ratio was 1.9 (95% CI: 1.6–2.2). The highest violence rate (132 / 1000) was observed among 12-year-old boys.

Table 16. *Violence occurrence rate per one month, number of cases, and male-to-female ratio among 12–18-year-old Finnish boys and girls by age*

Age	Total Rate % (Number)	Boys Rate % (Number)	Girls Rate % (Number)	Male-to-female ratio (95% CI)
12	9.0 (75)	13.2 (57)	4.5 (18)	3.2 (1.9-5.6)
14	8.8 (215)	11.0 (127)	6.8 (88)	1.7 (1.3-2.3)
16	8.8 (211)	10.7 (115)	7.3 (96)	1.5 (1.1-2.0)
18	6.1 (145)	8.7 (95)	3.9 (50)	2.4 (1.7-3.4)
Total	7.9 (646)	10.5 (394)	5.9 (252)	1.9 (1.6-2.2)

Other party of violence

The other party of violence was mostly a person whom the respondent already knew, followed by a complete stranger, or a friend (Table 17). When violence was examined by sex, it was evident that in girls the other party was more often a family member (8% in boys and 43% in girls) ($p<0.001$). Violence resulted in time-loss from school or hobbies in 13% of girls' cases and 6% of boys'. In respect of time-loss, the violence appeared to have been less severe, since the most typical length of time-loss was a part of the day

Table 17. *Percentage distribution (%) of other party of the last violent act (N=646) by age and sex of respondent*

Other party	Boys age (years)				Girls age (years)				Total
	14	16	18	all	14	16	18	all	
	Percentage distribution (%)								
Complete stranger	15	44	49	35	10	11	21	13	26
Father/mother	3	4	2	3	17	17	6	15	8
Brother/sister	3	4	2	3	21	22	8	19	10
Boy/girl with whom I go steady	-	3	4	2	2	10	21	9	5
Friend	14	10	10	11	12	15	10	13	12
Other person I know	55	33	27	40	29	17	23	23	33
2 persons	6	4	5	5	8	6	8	7	6
3 persons	3	-	-	1	1	2	2	2	1
Total	100	100	100	100	100	100	100	100	100
Number	123	112	92	327	87	94	48	229	556
Missing, N	25	17	18	60	7	12	11	30	90

The circumstances of occurrence

Adolescent boys experienced violence most often at leisure-time (58% of all violence), school (27%), and home (9%) (Table 18). In girls, the most common places were home (47% of all violence) and leisure-time (46%). The difference in the place of occurrence was significant between sexes ($p<0.001$). The proportion of leisure-time violence increased with age in boys (28% in the 14-year-olds compared to 79% in the 18-year-olds) ($p<0.001$).

Table 18. *Percentage distribution (%) of place of occurrence of last violent act (N=646) by age and sex of respondent*

Place of occurrence	Boys age (years)				Girls age (years)				Total
	14	16	18	all	14	16	18	All	
	Percentage distribution (%)								
Home	11	7	9	9	44	50	45	47	25
School	52	13	9	27	11	4	-	6	18
Trip to school	1	-	-	0	2	-	-	1	1
Sports	8	5	3	6	1	1	-	1	4
Leisure-time	28	74	79	58	42	45	55	46	53
Total	100	100	100	100	100	100	100	100	100
Number	121	113	90	324	86	95	49	230	554
Missing, N	25	20	27	72	7	8	5	20	92

Association between violence and alcohol

The overall percentage of adolescents reporting violence under the influence of alcohol was 2.4% of all respondents per one month. The percentage of adolescents reporting alcohol-related violence increased dramatically with age, thirteen percent of the 14-year-olds reporting violence also reported being under the influence of alcohol at the time of violence, and the corresponding figures for the 16 and 18-year-olds were 41% and 62%, respectively. Moreover, some 18% of the 14-year-old adolescents reported that the other party had been under the influence of alcohol, while the frequency was 48% in the 16 and 65% in the 18-year-olds ($p<0.001$). Sex was not significantly associated with the use of alcohol at the time of violence. Nearly a half (45%) of all violent incidents were alcohol-related, meaning that the respondent and/or the other party of violence were under the influence of alcohol.

Alcohol-related violence most often occurred in leisure-time (86% in boys and 75% in girls) and home (6% and 22%, respectively). In alcohol-related violence, the other party was a stranger (55% in boys and 34% in girls) or a person the victim already knew (23% in boys and 34% in girls).

Violence-related injuries (III)

Occurrence

A total of 135 adolescents reported a violence-related injury during the past month that had required medical attention of a doctor or nurse, thus the percentage of persons reporting an injury was 1.7% or (17 / 1000). Violence-related injuries as a result of violence were more frequently reported by girls than by boys (31% vs. 15%) ($p< 0.001$), with a total of 78 injuries in girls compared to 57 in boys. The male-female ratio was 0.8 (95% CI: 0.6–1.2) and the highest violence-related injury occurrence rate (23 / 1000) was observed among the 16-year-old girls (Table 19.).

Table 19. *Violence-related injury occurrence rate per one month, number of cases, and male-to-female ratio among 12–18-year-old Finnish boys and girls by age.*

Age	Total Rate % (Number)	Boys Rate % (Number)	Girls Rate % (Number)	Male-to-female ratio (95% CI)
12	1.3 (11)	1.2 (5)	1.5 (6)	0.8 (0.2-2.5)
14	1.6 (39)	1.5 (17)	1.7 (22)	0.9 (0.5-1.6)
16	1.8 (43)	1.2 (13)	2.3 (30)	0.5 (0.3-1.0)
18	1.8 (42)	2.0 (22)	1.6 (20)	1.3 (0.7-2.4)
Total	1.7 (135)	1.5 (57)	1.8 (78)	0.8 (0.6-1.2)

Anatomical location and severity

In both boys and girls, the most common violence-related injury locations were the head (69% of all injuries), the upper limb (21%), the abdomen and the back (7%). The most common types of violence-related injuries among boys were contusions (62%), followed by fractures (12%), and wounds (6%). Among girls, the distribution of injury types was nearly alike: contusions (67%), wounds (10%), and sprains (8%). One fifth (22%) of adolescents with violence-related injury had had time-loss from school or hobbies due to injury. When measured by time-loss, girls' violence-related injuries seemed to be more severe in that 27% of the girls with violence-related injury reported time-loss compared to 14% of the boys.

The place of occurrence

Violence-related injuries most often occurred in leisure-time (57%) in boys and (49%) in girls, followed by school (23%) in boys, and home (46%) in girls. The difference in the place of occurrence was statistically significant between sexes ($p<0.001$). Violence in connection with a sports activity was rare; some 6% of boys and 1% of girls reported violence occurrence during sports.

Association between injuries and alcohol

Alcohol was associated with half of the boys' violence-related injuries, while some 31% of the girls reported that either they themselves or the other party of violence had been under the influence of alcohol at the time of violence. Alcohol, however, was not related to the type or the anatomical distribution of injury.

Risk factors for unintentional injury (II)

Risk factors, univariate models

Of the *sociodemographic background* variables, family composition was associated with unintentional injuries (Table 20). The risk of unintentional injury was highest in the southern and western parts of Finland. When the association of urbanisation of the place of residence was studied, it was seen that adolescents living in the capital had 1.5 (95% CI: 1.02–2.2) times the risk of injury compared to their peers living in rural municipalities. Father's or other guardian's occupation and education, or mother's and father's employment status were not significant predictors of injury occurrence, and they did not continue to the multivariate models.

Table 20. *Age- and sex-adjusted odds ratios (OR) of unintentional injury occurrence by sociodemographic background, health, health behaviour, and school success (N=8135). Estimates from the univariate logistic regression model.*

Risk factor	Category	Unintentional injury OR
Sociodemographic background		
Family composition		
	Own parents	1
	Other	1.6 (1.3-1.9)
Father's or other guardian's occupation		
	Upper white-collar employee	1
	Lower white-collar employee	1.1 (0.9-1.5)
	Farmer	1.2 (0.8-1.8)
	Blue-collar employee or unskilled	1.1 (0.9-1.5)
Father's education		
	High	1
	Middle	1.3 (1.0-1.6)
	Low	1.1 (0.8-1.6)
Father's employment status		
	Working outside home	1
	Working at home	0.7 (0.5-1.1)
	Unemployed	1.0 (0.7-1.5)
	Pensioner or on long-term sick leave	1.3 (0.9-1.9)
Mother's employment status		
	Working outside home	1
	Working at home	1.1 (0.8-1.5)
	Unemployed	1.1 (0.8-1.5)
	Pensioner or on long-term sick leave	1.5 (0.9-2.4)
Geographic area		
	North	1
	South	1.7 (1.2-2.4)
	South-West	1.5 (1.1-2.1)
	East	1.1 (0.7-1.7)
	Central-West	1.5 (1.0-2.1)
Urbanisation level of the place of residence		
	Rural municipality	1
	Other rural settlement	1.1 (0.8-1.6)
	Town	1.3 (0.9-1.8)
	Capital city area	1.5 (1.0-2.2)
Health		
Number of stress symptoms weekly		
	0	1
	1	1.4 (1.0-1.9)
	2	2.1 (1.5-2.8)
	3+	2.3 (1.8-3.0)
Chronic disease or disability		
	No	1
	Yes	2.2 (1.7-3.0)
Perceived health		
	Excellent	1
	Quite good	0.9 (0.8-1.1)
	Average	1.1 (0.9-1.1)
	Rather poor	1.0 (0.6-1.7)
	Very poor	2.4 (0.5-12.0)

Table 20 *continued*

Depressive mood		
	No	1
	Yes	1.5(1.2-1.9)
Overweight		
	No	1
	Yes	1.2 (0.9-1.6)
Health behaviours		
Use of snuff		
	Never tried	1
	Tried	2.0 (1.5-2.5)
	More than 50 times	3.8 (2.5-5.8)
Frequency of participation in organised sports		
	Never	1
	Once a week or less	1.2 (0.9-1.6)
	2-5 times a week	1.8 (1.5-2.3)
	Approximately every day	3.6 (2.6-5.0)
Other leisure-time physical activity		
	Never	1
	Once a week or less	1.0 (0.6-1.6)
	2-5 times a week	1.0 (0.6-1.7)
	Approximately every day	1.1 (0.7-1.9)
Violence occurrence		
	No	1
	Yes	3.6 (2.8-4.6)
Frequency of drunkenness		
	Not using any alcohol	1
	Never	1.6 (1.
	Less often than once a month	1.6 (1.1-2.2)
	Once a month	2.3 (1.6-3.2)
	1-2 times a week	3.0 (1.9-4.8)
Use of alcohol		
	Not using any alcohol	1
	Less often than once a month	1.4 (1.0-2.0)
	Once a month	1.7 (1.2-2.5)
	Twice a month	2.0 (1.4-2.8)
	More often than once a week	2.1 (1.5-3.0)
Smoking		
	Never tried	1
	Not daily or tried only	1.6 (1.2-2.0)
	Less than 10 cigarettes daily	1.6 (1.1-2.3)
	More than 10 cigarettes daily	2.5 (1.8-3.4)
School success		
	Excellent	1
	Good	1.6 (0.9-2.7)
	Satisfactory	1.5 (0.9-2.4)
	Poor	1.9 (1.1-3.4)
Biological maturation		
	Early	1
	Normal	1.2 (0.8-1.4)
	Late	1.4 (0.5-2.8)

Stress symptoms were strongly associated with unintentional injuries (Table 20). Adolescents reporting more than three stress symptoms weekly had a 2.1 (95% CI 1.7–2.7) times higher risk of unintentional injury than adolescents having no symptoms. Injuries were more prevalent in adolescents with a chronic disease or disability as well as in those reporting worse than average or poor perceived health. A depressive mood during the past month was associated with unintentional injuries, while the BMI was not.

With regard to *health behaviours,* smoking and snuff use were found to be associated with unintentional injuries in univariate models (Table 20). Those who smoked at least 10 cigarettes daily had a 2.4 times higher risk of injury than those who had never smoked. Use of alcohol and frequency of drunkenness were likewise associated with injuries. Adolescents reporting approximately daily participation in organised sports had 3.6 (95% CI: 2.6–5.0) times the risk of unintentional injury compared to those who did not participate in sports clubs, and the risk seemed to rise linearly with the intensity of exercise. The frequency of other leisure time activity did not associate significantly with unintentional injuries. Association between occurred violence and unintentional injuries was strong, the OR being 4.1 (95% CI 3.2–5.1).

Risk factors, first stage of multivariate models

When the significant *sociodemographic background* variables from the univariate models where employed in the same forward stepwise logistic regression model, not living with own parents remained as one of the strongest risk factors for unintentional injuries, OR being 1.5 (95% CI: 1.2–1.9). Adolescents living in southern Finland displayed an increased risk of unintentional injury compared to those living in northern Finland (Table 21). In the multivariate models, however, urbanisation level of the place of residence lost its significance.

Four *health* variables appeared in the multivariate model. Of these, the number of stress symptoms weekly and the chronic disease or disability were statistically significantly associated with unintentional injuries. Adolescents reporting more than three stress symptoms weekly showed a 2.2 times higher risk (95% CI: 1.7–1.9) of injury compared to adolescents with no stress symptoms (Table 21).

Occurred violence during the past month remained as the most significant risk factor, OR 3.6 (95% CI: 2.8–4.6) of unintentional injuries in the multivariate model of *health behaviours*. Adolescents participating in organised sports daily had a 3.3 (95% CI: 2.3–4.6) times higher injury risk compared to those who never attended sports clubs (Table 21). The frequency of drunkenness and the use of alcohol lost their statistical significance in the multivariate model.

Table 21. *Age- and sex-adjusted odds ratios (OR) of unintentional injury occurrence by sociodemographic background, health, and health variables separately (N=8135). Estimates from the first stage multivariate forward stepwise logistic regression model.*

Risk factor	Category	Unintentional injury OR
Sociodemographic background		
Family composition		
	Own parents	1
	Other	1.5 (1.2-1.9)
Geographic area		
	North	1
	South	1.6 (1.1-2.4)
	South-West	1.6 (1.1-2.4)
	East	1.1 (0.7-1.7)
	Central-West	1.6 (1.1-2.3)
Urbanisation level of place of residence		
	Rural municipality	1
	Other rural settlement	1.1 (0.8-1.6)
	Town	1.1 (0.8-1.6)
	Capital city area	1.1 (0.7-1.8)
Health		
Number of stress symptoms weekly		
	0	1
	1	1.4 (1.0-1.9)
	2	2.0 (1.5-2.7)
	3+	2.2 (1.7-1.9)
Chronic disease or disability		
	No	1
	Yes	2.0 (1.5-2.6)
Perceived health		
	Excellent	1
	Quite good	0.8 (0.6-1.1)
	Average	1.0 (0.6-1.1)
	Rather poor	1.0 (0.6-1.7)
	Very poor	2.4 (0.5-12.0)
Depressive mood		
	No	1
	Yes	1.1 (0.9-1.4)
Health behaviours		
Use of snuff		
	Never tried	1
	Tried	1.4 (1.1-1.8)
	More than 50 times	1.8 (1.2-2.9)
Frequency of participation in organised sports		
	Never	1
	Once a week or less	1.1 (0.9-1.5)
	2-5 times a week	1.8 (1.4-2.3)
	Approximately every day	3.3 (2.3-4.6)
Violence occurrence		
	No	1
	Yes	3.6 (2.8-4.6)
Frequency of drunkenness		
	Not using any alcohol	1
	Never	1.4 (1.0-1.9)
	Less often than once a month	1.1 (0.7-1.6)
	Once a month	1.3 (0.8-1.9)
	1-2 times a week	1.2 (0.6-2.1)

Table 21 *continued*

Use of alcohol		
	Not using any alcohol	1
	Less often than once a month	1.3 (0.8-1.8)
	Once a month	1.3 (0.9-1.9)
	Twice a month	1.3 (0.8-1.9)
	More often than once a week	1.1 (0.7-1.8)
Smoking		
	Never tried	1
	Not daily or tried only	1.2 (0.9-1.6)
	Less than 10 cigarettes daily	1.2 (0.8-1.8)
	More than 10 cigarettes daily	1.6 (1.0-2.3)

Risk factors, final multivariate model

The final forward stepwise logistic regression model, which included all statistically significant variables from the first stage multivariate models, is shown in Table 22. Frequent participation in organised sport remained as the strongest risk factor for unintentional injuries, followed by violence occurrence during the past month. The use of snuff and chronic disease or disability also maintained their significance.

Risk factors for violence (IV)

Risk factors, univariate models

When the *sociodemographic background* variables were studied, it became evident that adolescents not living with both parents had 1.7 (95% CI: 1.4–2.1) times the risk of violence than adolescents living with both parents. Father's low educational status increased the risk of violence (Table 23). Father's or other guardian's occupation and employment status were also significantly associated with violence in our adolescent sample.

Examining the *health* variables significantly associated with violence in the univariate model, adolescents with more than three stress symptoms weekly displayed 3.4 (95% CI 2.7–4.3) times the risk of violence compared to adolescents reporting no stress symptoms at all (Table 23.). Violence occurrence was related to the adolescent's chronic disease or disability, poor perceived health, or a depressive mood. An unintentional injury during the past month increased the risk of violence occurrence, OR being 4.5 (95% CI: 3.6-5.9

Concerning the *health behaviours*, the use of snuff and smoking were positively associated with the risk of violence. Those reporting recurring drunkenness were more likely to encounter violence. Having drug-using acquaintances showed a strong relationship with violence, OR being 3.2 (95 % CI: 2.6-3.9) (Table 23).

Table 22. *Age- and sex-adjusted odds ratios (OR) of unintentional injury occurrence by sociodemographic background, health, and health variables together (N=8135). Estimates from the final multivariate forward stepwise logistic regression model. Only significant variables are shown.*

Risk factor	Category	Unintentional injury OR
Family composition		
	Both own parents	1
	Other	1.4 (1.2-1.9)
Geographic area		
	North	1
	South	1.6 (1.1-2.4)
	South-West	1.6 (1.1-2.3)
	East	1.2 (0.8-1.8)
	Central-West	1.5 (1.0-2.3)
Number of stress symptoms weekly		
	0	1
	1	1.3 (1.0-1.8)
	2	1.8 (1.3-2.5)
	3+	1.9 (1.5-2.5)
Chronic disease or disability		
	No	1
	Yes	2.0 (1.5-2.8)
Use of snuff		
	Never tried	1
	Tried	1.4 (1.1-1.8)
	More than 50 times	1.9 (1.2-2.9)
Sports in a sports club		
	Never	1
	Once a week or less	1.2 (0.9-1.6)
	2-5 times a week	1.9 (1.5-2.5)
	Approximately every day	3.7 (2.6-5.2)
Violence occurrence		
	No	1
	Yes	3.0 (2.4-3.9)

Table 23. *Age- and sex-adjusted odds ratios (OR) of violence occurrence and violence-related injury occurrence by sociodemographic background, health, and health behaviours (N= 7370). Estimates from the univariate logistic regression model.*

Risk factor	Category	Violence occurrence OR	Violence-related injury occurrence OR
Sociodemographic background			
Family composition			
	Own parents	1	1
	Other	1.7 (1.4-2.1)	2.1 (1.5-3.1)
Father's or other guardian's occupation			
	Upper white-collar employee	1	1
	Lower white-collar employee	1.3 (1.0-1.7)	1.4 (0.8-2.5)
	Farmer	1.7 (1.1-2.4)	2.0 (1.0-4.5)
	Blue-collar employee or unskilled	1.5 (1.2-1.9)	1.7 (1.0-2.7)
Father's education			
	High	1	1
	Middle	1.0 (0.7-1.4)	0.5 (0.2-1.4)
	Low	1.5 (1.2-1.9)	1.9 (1.1-3.1)
Father's employment status			
	Working outside home	1	1
	Working at home	1.2 (0.8-1.6)	1.6 (0.9-3.0)
	Unemployed	1.3 (1.0-1.8)	1.8 (1.0-3.2)
	Pensioner or on long-term sick leave	1.5 (1.1-2.0)	2.3 (1.3-4.1)
Mother's employment status			
	Working outside home	1	1
	Working at home	1.0 (0.8-1.3)	1.0 (0.5-1.8)
	Unemployed	1.3 (1.0-1.7)	1.7 (1.0-2.7)
	Pensioner or on long-term sick leave	1.6 (1.1-2.4)	2.1 (1.0-4.5)
Geographic area			
	North	1	1
	South	0.9 (0.7-1.2)	1.1 (0.7-1.8)
	South-West	0.8 (0.6-1.1)	0.9 (0.5-1.8)
	East	0.9 (0.7-1.2)	1.3 (0.7-2.3)
	Central-West	1.1 (0.9-1.5)	1.4 (0.8-2.5)
Urbanisation level of place of residence			
	Rural municipality	1	1
	Other rural settlement	0.9 (0.7-1.2)	1.1 (0.8-1.3)
	Town	0.7 (0.5-1.3)	0.5 (0.3-1.5)
	Capital city area	1.1 (0.9-1.4)	0.8 (0.7-1.2)
Health			
Number of stress symptoms weekly			
	0	1	1
	1	1.6 (1.2-2.2)	1.8 (0.9-3.7)
	2	2.3 (1.7-3.2)	2.0 (0.9-4.3)
	3+	4.5 (3.5-5.7)	6.0 (3.4-10.6)

Table 23 *continued*

Chronic disease or disability			
	No	1	1
	Yes	1.6 (1.2-2.1)	2.1 (1.2-3.5)
Perceived health			
	Excellent	1	1
	Quite good	1.3 (1.1-1.6)	1.2 (0.8-2.0)
	Average or poor	2.6 (2.0-3.3)	2.9 (1.7-4.8)
Depressive mood			
	No	1	1
	Yes	2.7 (2.3-3.3)	3.1 (2.1-4.4)
Overweight			
	No	1	1
	Yes	1.1 (0.9-1.4)	1.6 (1.0-2.6)
Health behaviours			
Use of snuff			
	Never tried	1	1
	Tried	2.8 (2.3-3.5)	3.4 (2.3-5.2)
	More than 50 times	4.9 (3.4-7.0)	8.0 (4.0-16.4)
Frequency of participation in organised sports			
	Never	1	1
	Once a week or less	1.4 (1.1-1.8)	1.0 (0.6-1.7)
	2-5 times a week	1.1 (0.9-1.4)	1.1 (0.7-1.8)
	Approximately every day	1.1 (0.7-1.6)	1.7 (0.8-3.5)
Unintentional injury occurrence			
	No	1	1
	Yes	4.5 (3.6-5.9)	9.4 (6.4-14.0)
Drinking style			
	Abstinence	1	1
	Occasional drinking	1.5 (1.1-2.2)	1.9 (0.8-4.6)
	Recurring drinking	2.5 (1.8-3.6)	2.5 (1.1-5.9)
	Recurring drunkenness	7.2 (5.1-10.2)	7.5 (3.3-16.8)
Other leisure-time physical activity			
	Never	1	1
	Once a week or less	0.9 (0.6-1.3)	0.8 (0.3-1.8)
	2-5 times a week	0.7 (0.5-1.1)	0.9 (0.4-2.1)
	Approximately every day	1.0 (1.0-1.5)	0.8 (0.3-2.1)
Smoking			
	Never tried	1	1
	Not daily or tried only	1.8 (1.3-2.4)	2.2 (1.2-4.1)
	Less than 10 cigarettes daily	4.3 (3.1-6.0)	3.8 (1.8-7.9)
	More than 10 cigarettes daily	7.5 (5.6-10.2)	7.0 (3.6-13.6)
Sleeping hours			
	More than 9 hours	1	1
	8 to 9 hours	0.9 (0.8-1.2)	0.8 (0.5-1.3)
	Less than 8 hours	1.6 (1.2-2.0)	1.0 (0.6-1.6)
Drug using acquaintances			
	No	1	1
	Yes	3.1 (2.6-3.9)	4.1 (2.6-6.3)
Biological maturation			
	Early	1	1
	Normal	1.3 (0.7-1.3)	1.4 (0.5-3.2)
	Late	1.1 (0.8-1.2)	1.2 (0.3-2.8)

Risk factors, first stage of multivariate model

In the *sociodemographic background* multivariate models of violence occurrence, the strongest background factor was family composition in that adolescents not living with own parents had 1.7 (95% CI: 1.4–2.1) times the risk of violence (Table 24). Also father's education was significantly associated with adolescents' violence occurrence (Table 24).

The *health* variable strongest related to violence in the multivariate model was the occurrence of unintentional injury during the past month: adolescents with unintentional injury reported violence 4.0 times more often (95% CI: 3.1–5.2) than their peers without unintentional injury (Table 24). Weekly stress symptoms were significantly related to violence as well (Table 24).

When the *health behaviours* were employed in the same model, smoking, use of snuff, and drinking style held their significance. Smoking more than 10 cigarettes daily was the strongest risk factor for violence, OR being 3.2 (95% CI: 2.1–4.9), followed by frequent drunkenness (OR 2.9; 95% CI: 1.9–4.5), and recurrent use of snuff (OR 1.9; 95% CI: 1.3–2.9) (Table 24).

Risk factors, final multivariate model

Table 25 shows the final multivariate model of violence. The occurrence of unintentional injury was the strongest risk factor in a model with other risk factors included. Father's education maintained its statistical significance. The number of stress symptoms appeared as a weaker risk factor in the final model than in the previous models.

Risk factors for violence-related injury (IV)

Risk factors, univariate models

Concerning the *sociodemographic background*, family composition was strongly associated with violence-related injuries (Table 23). Father's or other guardian's low education was related to respondents' violence-related injuries.

Regarding *health*, stress symptoms were strongly associated with violence-related injuries. A history of unintentional injury occurring during the past month increased the risk of violence-related injuries, OR being 9.4 (95% CI 6.4–14.0) in the univariate model (Table 23).

Frequent use of snuff and smoking were the *health behaviours* that were associated with the increased risk of violence-related injuries. Adolescents who reported violence-related injuries were more likely to report recurring drunkenness. Having drug-using acquaintances showed a strong relationship with violence-related injuries, OR being 4.1 (95% CI 2.6–6.3) (Table 23).

Risk factors, first stage of multivariate models

Of the *sociodemographic background*, family composition was the only variable that was significantly associated with violence-related injuries. Father's or other guardian's education lost its significance in the multivariate model (Table 24).

When the *health* variables were controlled for in the multivariate analysis, several that were strongly associated with the risk of violence-related injuries in the initial model reduced their significance (Table 24.). Poor perceived health and a depressive mood maintained their significancy as risk factors. Adolescents reporting a recent unintentional injury had a remarkably greater risk of violence-related injuries as well, OR being 8.0 (95% CI 5.3–12.0) (Table 24).

Table 24 shows the odds ratios of violence-related injuries for the *health behaviours.* In the multivariate model, smoking, use of snuff, and drinking style were, as in the initial model, significant risk factors, but their significance weakened. Occasional participation in organised sports was associated with violence-related injuries. Adolescent who had drug-using acquaintances displayed a greater risk of violence-related injuries.

Risk factors, final multivariate models

When all statistically significant risk factors from the first stage multivariate model were analysed together using forward stepwise logistic regression, unintentional injury during the past month remained as the strongest risk factor for violence-related injury (Table 25). In addition, a depressive mood was a notable risk factor, OR being 2.4 (95% CI: 1.4–4.2), and its effect even increased when the sociodemographic background and the health variables were included.

Table 24. *Age- and sex-adjusted odds ratios of violence and violence-related injuries by sociodemographic background, health, and health behaviours separately (N=7370). Estimates from the first stage of the multivariate forward stepwise logistic regression model.*

Risk factor	Category	Violence OR	Violence-related injury OR
Sociodemographic background			
Family composition			
	Own parents	1	1
	Other	1.7 (1.4-2.1)	2.1 (1.4-3.1)
Father's education			
	High	1	1
	Middle	0.9 (0.6-1.3)	0.6 (0.2-1.4)
	Low	1.4 (1.1-1.8)	1.8 (0.9-3.1)
Health			
Number of stress symptoms weekly			
	0	1	1
	1	1.4 (1.0-1.9)	1.8 (0.9-3.9)
	2	2.0 (1.4-2.7)	1.6 (0.7-3.7)
	3+	3.2 (2.5-4.2)	4.3 (2.3-8.0)
Perceived health			
	Excellent	1	1
	Quite good	1.0 (0.9-1.4)	1.1 (0.7-1.4)
	Average or worse	1.5 (1.2-2.0)	1.6 (0.8-3.2)
Depressive mood during the last month			
	No	1	1
	Yes	1.6 (1.3-2.0)	1.8 (1.2-2.7)
Unintentional injury occurrence			
	No	1	1
	Yes	4.0 (3.1-5.2)	8.0 (5.3-12.0)
Health behaviours			
Use of snuff			
	Never tried	1	1
	Tried	1.2 (1.0-1.6)	1.3 (0.7-1.9)
	More than 50 times	1.9 (1.3-2.9)	1.6 (1.2-3.4)
Smoking			
	Never tried	1	1
	Not daily or tried only	1.4 (0.9-1.9)	1.5 (0.7-3.2)
	Less than 10 cigarettes daily	2.4 (1.5-3.6)	1.8 (0.8-4.4)
	More than 10 cigarettes daily	3.2 (2.1-4.9)	2.9 (1.3-6.5)
Drinking style			
	Abstinence	1	1
	Occasional drinking	1.3 (0.8-2.0)	1.1 (0.5-2.8)
	Frequent drinking	1.5 (1.0-2.3)	1.2 (0.5-3.0)
	Frequent drunkenness	2.9 (1.9-4.5)	2.4 (1.0-5.8)
Drug using acquaintances			
	No	1	1
	Yes	2.0 (1.6-2.5)	2.6 (1.6-4.2)
Frequency of participation in organised sports			
	Never	1	1
	Once a week or less	1.6 (1.2-2.0)	1.3 (0.8-1.9)
	2-5 times a week	1.3 (1.0-1.6)	1.2 (0.4-1.9)
	Approximately every day	1.2 (0.8-1.9)	1.2 (0.4-2.6)

Table 25. *Age- and sex-adjusted odds ratios of violence and violence-related injuries by sociodemographic background, health, and health behaviours together (N=7370). Estimates from the final forward stepwise logistic regression model. Only the significant variables are shown.*

Risk factor	Category	Violence OR	Violence-related injury OR
Father's education			
	High	1	
	Middle	0.9 (0.6-1.5)	
	Low	1.5 (1.1-2.0)	
Number of stress symptoms weekly			
	0	1	1
	1	1.1 (0.8-1.7)	1.3 (0.5-3.5)
	2	1.4 (0.9-2.1)	1.6 (0.6-4.4)
	3+	1.9 (1.4-2.8)	2.8 (1.2-6.4)
Depressive mood during the last month			
	No	1	1
	Yes	1.6 (1.2-2.2)	2.4 (1.4-4.2)
Unintentional injury occurrence			
	No	1	1
	Yes	3.6 (2.5-5.0)	6.5 (3.8-10.9)
Smoking			
	Never tried	1	1
	Not daily or tried only	1.3 (0.8-2.1)	1.8 (0.7-4.8)
	Less than 10 cigarettes daily	2.5 (1.5-4.3)	3.2 (1.1-9.2)
	More than 10 cigarettes daily	3.5 (2.1-5.8)	3.7 (1.4-10.3)
Drinking style			
	Abstinence	1	
	Occasional drinking	1.1 (0.6-1.8)	
	Frequent drinking	1.3 (0.8-2.3)	
	Frequent drunkenness	2.5 (1.5-4.3)	
Drug using acquaintances			
	No	1	1
	Yes	1.9 (1.4-2.5)	2.0 (1.1-3.7)
Frequency of participation in organised sports			
	Never	1	
	Once a week or less	1.5 (1.1-2.0)	
	2-5 times a week	1.3 (1.0-1.8)	
	Approximately every day	0.9 (0.5-1.7)	

Predictors of injury-related death and hospitalisation (V)

Occurrence of injury-related death and hospitalisation

During the 749 433 person-years of follow-up (mean follow-up time 10.3 years), altogether 7711 persons (11% of all) experienced an injury hospitalisation, and there were 462 (0.6%) injury-related deaths. Men were significantly more likely to experience injury hospitalisation than women: 4211 (15.8%) occurred in men and 1577 (5.1%) in women), the HR being 3.3 (95% CI: 3.1–3.5) in men as compared to women. The correspondent figures in injury-related deaths were

244 and 68, HR being 4.4 (95% CI: 3.4–5.8). The most common causes of the first injury hospitalisations were sprains and strains of the knee and the leg (11.4%), sprains and strains of the ankle and the foot (8.3%), and dislocations of the patella or tears of the cartilage or the meniscus of the knee (8.1%). Injury hospitalisations resulted in a total of 26 000 hospital bed days, the average length of hospitalisation being 3.4 days in men and 3.1 in women. The most common causes of death were a suicide (221 deaths) and a traffic death (117 deaths). The occurrence figures were calculated for the whole sample, including both the respondents and the non-respondents, while the risk factor analysis was carried out for the respondents only.

Predictors of injury-related death

Unintentional and violence-related deaths were analysed together since their predictive factors showed no differences.

When the association between the background variables and the injury-related deaths was investigated in the *initial model*, it was obvious that in men all the sociodemographic background variables were associated with injury-related death with a cut off value of $p<0.2$. In women, the sociodemographic variables were likewise associated with injurious death, yet with the exception of father's education and occupation which showed no association.

Of the health variables, only the stress symptoms perceived weekly in men, and the perceived health and chronic disease or disability in all subjects were associated with the injury-related deaths in the initial model. The health behaviour variables that did not continue to the next model were: frequency of other leisure time activity in both sexes, and drinking style and regularity of tooth brushing in women. Biological maturation was not related to injurious death, neither in men nor in women, while school success was.

In the *univariate Cox's regression model,* living without own parents in adolescence predicted injury-related death later in life in men and women, HR being 1.6 (95% CI: 1.2–2.1) in men and 1.9 (95% CI: 1.1–3.1) in women. In addition, father's low education and occupational status were significant predictors of injury-related death in men, HR being 1.7 (95% CI: 1.1–2.6) and 2.1 (95% CI: 1.3–3.5), respectively.

The only health variable to be a significant predictor of injury-related death in men was the reporting of more than three stress symptoms weekly (Table 26). In women, no such a predictor existed. Health behaviours that predicted injury-related death in men were recurring drunkenness, HR being 2.8 (95% CI: 1.8–4.2), recurrent smoking HR 2.0 (95% CI: 1.6–2.7), recurrent use of snuff, regularity of tooth brushing, and having drug using acquaintances. In women, only recurring smoking predicted injury-related death, HR being 2.5 (95% CI: 1.5–4.2). School success lost its significance in women in the Cox- regression model, while in men it remained as a significant predictor of injury-related death.

Table 26 shows the final *multivariate Cox's regression model* based on the sociodemographic background, health, and health behavioural predictors of injury-related death. The most significant predictive factor for injury-related death in men was poor school success, HR being 3.9 (95% CI: 2.2–7.1), followed by father's lower educational status HR 2.3 (95% CI: 1.3–3.9), and recurring drunkenness, HR 2.0 (95% CI: 1.2–3.1). Men reporting several stress symptoms weekly at the baseline had an increased risk of injury-related death, HR being 1.7 (95% CI: 1.2–2.5). In addition, tooth brushing not daily was associated with injury-related death only in men, HR being 1.4 (95% CI: 1.1–1.8) (Table 24.). In women, the strongest predictor of injury-related death was daily smoking, HR 2.5 (95% CI: 1.5–4.1). Not living with own parents in adolescence increased the risk of injury-related death in both sexes, HR being 1.6 (95% CI: 1.1–2.1) in men and 1.9 (95% CI: 1.1–3.1) in women.

Table 26. *Age-adjusted hazard ratios of injury-related death by sociodemographic background, health, health behaviour, and school success in men and women. Estimates are from the forward stepwise Cox's regression model. Only the significant variables are shown.*

Characteristic		HR (95% CI) for injury-related death	
Sociodemographic background		Men	Women
Family composition			
	Own parents	1.0 (reference)	1.0 (reference)
	Other	1.6 (1.1-2.1)	1.9 (1.1-3.1)
Father's or other guardian's occupation			
	Upper white-collar employee	1.0 (reference	
	Lower white-collar employee	1.6 (1.0-2.6)	
	Farmer	2.3 (1.3-3.9)	
	Blue-collar employee	2.1 (1.3-3.4)	
	Unskilled	1.9 (0.9-4.0)	
Health			
Number of psychosomatic symptoms perceived at least once a week			
	0	1.0 (reference)	
	1	1.1 (0.8-1.6)	
	2	1.7 (1.1-2.5)	
	3+	1.7 (1.2-2.5)	
Health behaviour			
Smoking			
	Not daily	1.0 (reference)	1.0 (reference)
	Daily	1.6 (1.2-2.2)	2.5 (1.5-4.1)
Drinking style			
	Abstinence	1.0 (reference)	
	Occasional drinking	1.2 (0.8-1.8)	
	Recurring drinking	1.3 (0.9-2.0)	
	Recurring drunkenness	2.0 (1.2-3.1)	
Regularity of tooth brushing			
	Daily	1.0 (reference)	
	Not daily	1.4 (1.1-1.8)	
School success			
	Excellent	1.0 (reference)	
	Good	2.3 (2.3-4.1)	
	Satisfactory	3.2 (1.8-5.6)	
	Poor	3.9 (2.2-7.1)	

Predictors of injury hospitalisation

Apart from urbanisation of the place of residence in men, all the sociodemographic background variables in men and women were associated with injury hospitalisations at a significance level of $p<0.2$ in the *initial model*. Concerning health, chronic disease or disability restricting daily activities was the only health variable predicting injury hospitalisation in men. In women, the associated variables in the stage one were chronic disease or disability, stress symptoms weekly, and overweight. All health behaviours in both sexes were continued to the univariate Cox's regression model. Biological maturation was associated with injury hospitalisation only in women, school success in both sexes.

The *univariate Cox's regression model* of the sociodemographic background showed that the urbanisation level of the place of residence did not predict injury hospitalisation in Finland either in men or in women. Subjects who had not lived with both parents in adolescence exhibited an increased hazard ratio for injury hospitalisation compared to those living otherwise, HR being 1.2 (95% CI: 1.1–1.3) in men and 1.2 (95% CI: 1.0–1.3) in women. Father's low educational and occupational status increased the hazard ratios of injury hospitalisation in men, HR being 1.2 (95% CI: 1.0–1.3) and 1.2 (95% CI: 1.1–1.5), respectively. Father's education was not associated with severe injuries among women.

None of our health variables predicted injury hospitalisation in men. Women reporting more than three stress symptoms weekly showed a 30% greater risk (HR 1.3, 95% CI: 1.1–1.4) of injury hospitalisation compared with women with no symptoms at all. Although a chronic disease or disability and overweight were significant predictors of injury hospitalisation in women, perceived health was not. Among the health behaviours significantly associated with injury hospitalisation in both sexes, and carried out to the multivariate analyses, were: frequency of organised sports club sessions more than 4 times a week, HR 1.8 (95% CI: 1.7–2.0 in men and HR 2.3 (95% CI: 1.9–2.8) in women, recurrent smoking HR 1.4 (95% CI: 1.3–1.5) in men and HR 1.3 (95% CI: 1.2–1.5) in women), drinking style, and regularity of tooth brushing. Frequency of other leisure time physical exercise did not predict injury hospitalisation among the study population. The timing of biological maturation was not significantly associated with injury hospitalisation in women. Poor school success did predict injury hospitalisation in men (HR 1.5, 95% CI: 1.3–1.6) and in women (HR 1.4, 95% CI: 1.2–1.6).

The results from the final *multivariate Cox's regression model* concerning the sociodemographic background, health, health behaviours, school success, and injury hospitalisation are shown in Tables 27 and 28. Frequent participation in organised sports was the most important predictor of injury hospitalisation among our young adult men's cohort. Men participating in sports clubs more than 4 times a week showed a 1.9 (95% CI: 1.8–2.1) and women a 2.4 (95% CI: 2.0–2.9) times higher risk than persons who did not participate at all. The second strongest predictor of injury hospitalisation was poor school success: men and

women not performing well at school during adolescence had a 1.4 (95% CI: 1.3-1.6) and 1.4 (95% CI: 1.1–1.6) times increased risk respectively. Recurring drunkenness as a drinking style increased the risk of future injury, HR being 1.3 (95% CI: 1.2–1.5) in men and 1.2 (95% CI: 1.0–1.5) in women compared to non-drinkers.

Family composition maintained its significance in a model with other sociodemographic variables, HR being 1.2 (95% CI: 1.1–1.3) in men and 1.1 (95% CI: 1.0–1.2) in women. Father's education and occupation were barely significant predictors of injury hospitalisation in men (Table 27.). Women with a chronic disease or a disability or overweight in adolescence showed an increased risk of injury later in life, HR being 1.4 (95% CI: 1.2–1.7) and 1.3 (95% CI: 1.1–1.6) (Table 27).

Table 27. *Age-adjusted hazard ratios of injury hospitalisation by sociodemographic background, health and school success in men and women. Estimates are from the forward stepwise Cox's regression model. Only the significant variables are shown.*

Characteristic		HR (95% CI) for injury hospitalisation	
Sociodemographic background		Men	Women
Family composition			
	Both own parents	1.0 (reference)	1.0 (reference)
	Other	1.2 (1.1-1.3)	1.1 (1.0-1.2)
Father's or other guardian's occupation			
	Upper white-collar employee	1.0 (reference)	
	Lower white-collar employee	0.9 (0.8-1.1)	
	Farmer	0.8 (0.7-0.9)	
	Blue-collar employee	1.0 (0.9-1.1)	
	Unskilled	1.0 (0.9-1.3)	
Father's education			
	High	1.0 (reference)	
	Middle	1.2 (1.0-1.3)	
	Low	1.2 (1.1-1.4)	
Health			
Number of stress symptoms weekly			
	0		1.0 (reference)
	1		1.0 (0.8-1.1)
	2		1.0 (0.8-1.2)
	3+		1.3 (1.1-1.4)
Chronic disease or disability			
	No		1.0 (reference)
	Yes		1.4 (1.2-1.7)
Overweight			
	No		1.0 (reference)
	Yes		1.3 (1.1-1.6)
School success			
	Excellent	1.0 (reference)	1.0 (reference)
	Good	1.1 (1.0-1.2)	1.0 (0.8-1.1)
	Satisfactory	1.2 (1.1-1.4)	1.0 (0.9-1.2)
	Poor	1.4 (1.3-1.6)	1.4 (1.1-1.6)

Table 28. *Age-adjusted hazard ratios of injury hospitalisation by health behaviour in men and women. Estimates are from the forward stepwise Cox's regression model. Only the significant variables are shown.*

Characteristic		HR (95% CI) for injury hospitalisation	
Health behaviour		Men	Women
Smoking			
	Not daily	1.0 (reference)	1.0 (reference)
	Daily	1.3 (1.2-1.4)	1.2 (1.1-1.4)
Drinking style			
	Abstinence	1.0 (reference)	1.0 (reference)
	Occasional drinking	1.1 (1.0-1.2)	1.0 (0.8-1.1)
	Recurring drinking	1.2 (1.1-1.3)	1.0 (0.9-1.2)
	Recurring drunkenness	1.3 (1.2-1.5)	1.2 (1.0-1.5)
Regularity of tooth brushing			
	Daily	1.0 (reference)	1.0 (reference)
	Not daily	1.1 (1.1-1.2)	1.3 (1.1-1.5)
Frequency of participation in organised sports			
	Never	1.0 (reference)	1.0 (reference)
	2-3 times a week or less	1.2 (1.1-1.3)	1.2 (1.1-1.4)
	4-5 times a week or more	1.9 (1.8-2.1)	2.4 (2.0-2.9)

DISCUSSION

This study described the occurrence, nature and risk factors for injuries among adolescents. First, the decreasing trend of injury-related deaths over a 30-year period among Finnish children and young adolescents was reported. Next, the occurrence and nature of self-reported unintentional injuries, violence, and violence-related injuries as well as their risk factors were explored. Finally, a longitudinal follow-up study was conducted in order to determine the predictive factors for injury-related death and injury hospitalisation.

Reliability and validity of data

The Official Cause-of-Death Statistics

On account of the fact that each death certificate and the personal information in the population register are cross-checked, the coverage of the Official Cause-of-Death Statistics of Finland is 100%, (Official Cause of Death Statistics 2003). Moreover, the accuracy of the data of the Official Cause-of-Death Statistics of Finland is ensured by triple-checking: the first check is done by the local population authority (accuracy of the population data of the deceased), the second by the forensic officer at the county administration (accuracy and consistency of the cause-of-death codes with the original death certificate), and the final check by Statistics Finland (computer-aided check of the entire cause-of-death database). At each phase, further information is obtainable from the certifying physician. In injury-related deaths, an autopsy is required and nearly always performed (on 94–97% of these deaths) to verify the cause-of-death (Official Cause of Death Statistics 2003).

The National Hospital Discharge Register

The National Hospital Discharge Register has been operating since 1967 and is continually updated and monitored for quality by the Department of Registers and Statistics of the National Research and Development Centre for Welfare and Health, Helsinki, Finland (Official Statistics of Finland 2003). It is the oldest established nationwide discharge register in the world and its accuracy has shown to be good (Salmela et al. 1987). The strength of the National Hospital Discharge Register is that it covers the entire population of Finland, and, due to ICD-classification, information obtained from this register is valuable for injury

research. However, the National Hospital Discharge Register shows a limitation in underreporting the external causes of injuries, and, in order to minimise this bias, the definition of injury in this study was based on the diagnosis and not on the external causes of injury.

Self-reported injuries and violence

The validity and repeatability of self-reported injuries and violence among adolescents have, to our knowledge, been poorly studied, a fact that entails a limitation to the present study. In a review article assessing the validity of self-reported health-risk behaviour, it has been reported that information on the validity of self-reported injuries has not been published, and that questions assessing unintentional injuries and violence among adolescents exhibited a moderate test-retest reliability (Brener et al. 2003).

Response rate, sample selection, timing of measurements, and survey language are factors affecting the generalisability of results from a survey study to the population level.

High response rates are essential to permit generalisation of survey results to a whole population. Non-response has been associated with negative health behaviour in other studies (Pietila et al. 1995). In order to maintain high response rates, the AHLS questionnaire has been kept as short as possible, and further, two re-enquiries have been mailed to non-respondents. Response rates in the AHLS were excellent in the early 1980s, varying between 78% and 86% in boys and 86% and 91% in girls, but a decline has been evident later, especially in boys. In 1999, the response rate varied between 63% and 79% in boys and between 80% and 85% in girls. The questionnaire has been available in the Finnish language only causing non-response in the Swedish speaking areas of the country: the response rate in the AHLS in 1999 was 77% in the Finnish-speaking adolescents, while the corresponding figure for their Swedish-speaking peers was 52% ($p<0.01$).

The dropping response rate over the years may have affected the results of our longitudinal data set. Non-respondents in the longitudinal AHLS data displayed a slightly higher occurrence of injury hospitalisation (13.2%) than respondents (10.3%), ($p<0.001$). And further, their injuries were more severe in view of the fact that 1.0% of the non-respondents died of injury compared to 0.5% of the respondents during an average follow-up period of ten years ($p<0.001$). When considering sex and response, it can be seen that 1.4% of the non-respondent boys died of injurious causes compared to 0.9% of the respondent boys ($p=0.005$), while in girls, the corresponding figures were 0.2% and 0.2%, respectively.

In order to estimate the effect of non-response in the AHLS in 1999, we divided respondents into three groups based on whether they had answered the first questionnaire or either of the two re-enquiries. Differences in the unintentional injury or violence-related occurrence rates were not found between

adolescents who answered the original questionnaire and those who answered the first or second re-enquiry. The violence occurrence rate was higher (p=0.05) in adolescents responding to the second re-enquiry compared to those responding to the first re-enquiry. In conclusion, the observed rates of unintentional and violence-related injuries are not overestimates, but the observed violence rate may slightly underestimate the true rates.

The sample for the AHLS has been drawn from the National Population Register Centre by selecting all Finns born on certain days, and, accordingly, adolescents have been exactly the same age. Considering that age has been shown to be strongly related to injuries (Parkkari et al. 2000), the similarity of the age over the study years is a strength of this study.

Comparability of the survey data has been quality controlled by means of maintaining the timing of the study unchanged over the years. The AHLS questionnaire concerning injuries was sent to the study sample in February and the response time ended at the end of April. It has been shown that a seasonal injury presentation peak exists in the summer months in Europe, and that February-April period represents an average injury season (Morrison et al. 1999).

The questionnaires were mailed to the adolescents' home address, with instructions to show the questionnaire to their parents before answering if they so desired. Nevertheless, it is possible that the presence of parents may have affected the responses, especially in regard to some background variables, such as drinking (Lintonen 2001) and smoking, and also in regard to the dependent variables, injuries and violence, thus causing our occurrence figures to be slight underestimations.

In general, a population based survey is the dominant data collection method for less severe injuries. However, some limitations of this method must be taken into account. The tendency to remember events closer to the present than they actually occurred is referred to as the "telescope effect". When adolescents in the AHLS were asked about injuries during the past month, they may have reported older injuries, too. Another important limitation connected to survey studies may be the incomplete recall of an injury event. Langley and colleagues reported that when using a two-year recall time, 39% of injuries requiring an emergency room visit were forgotten (Langley et al. 1989). It has also been reported that boys are more prone to forget injuries, and that severe injuries are remembered better than the minor ones (Harel et al. 1994). The study group of from Israel (Harel et al. 1994) concluded that, in survey studies, a 30-day recall period would be reasonable. In the present study, a one-month recall period was used. The widely recommended definition of injury used in the AHLS further contributed to the strength of the study (Pickett et al. 2002).

Background data

All the data in the AHLS, with the exception of sex, age, and urbanisation level of the place of residence, have been self-reported. Although most of the questions deal with facts, their reporting is nonetheless subjective. Since in some questions the comparison of own health behaviour to that of peers has been requested, social desirability or influence by peer group may have influenced the response.

Repeatability of the risk factors was good, the kappa-coefficient of repeatability varied between 0.5 and 0.9, with the exception of stress symptoms, use of alcohol, and other leisure time physical activity, which indicated a somewhat lower test-retest repeatability. Moreover, there is prior evidence that the repeatability of risk factors is good (Koivusilta 2000).

The limitation of our study included the fact that the effect of risk factors may have changed over time. A separate study as to whether, for example, smoking in the 1980s and smoking in the 1990s were similarly associated with injuries was not performed. However, we had no reason to suspect that the effect of significant risk factors might have changed over time.

Occurrence and trends of injury-related deaths

Among the most important findings of the present study is the downward trend of injury-related deaths among Finnish children and young adolescents between 1971 and 2001. Although the incidence of injurious death decreased by over 80% during the study period, injury still remained a significant cause of death among 0–14-year-old Finns. The decrease in injury occurrence was seen in both boys and girls, and it was mainly attributable to the decline in fatal traffic crashes. The incidence of violence-related injuries remained unaltered.

The incidence of children's and young adolescents' injury deaths in Finland in 2001 was comparable to that in other western nations (The injury chart book ... 2002). The decline seen in the overall rate of injury-related deaths in this age group during the study period is similar to that of other developed countries. However, different nations have succeeded in lowering their figures at different speeds. While Finland was in the 20th position of the 1970 child injury death statistics among the OECD countries, the corresponding position was the 9th in 1995. These findings refute the myth that "nothing can be done".

The reasons for this positive development in Finland are multi-factorial, but an increased general awareness of high-risk situations (for example, improved supervision when child commutes to school or when child is near water), safer playgrounds, and intensive promotion of child safety seat restraints and bicycle helmets are probably among the most important single factors. In addition, easily accessible emergency services and improved trauma care may offer more efficient life-saving facilities today than in the past. An important cause for the decline in injury-related deaths in Finland, as well as in other developed countries, has been the drop in traffic-related deaths (A league table of child

deaths ... 2001). Since the 1960s, extensive traffic safety programmes have been implemented in Finland. Lower speed limits along with other improvements in traffic legislation and supervision have had a favourable effect on traffic-related deaths. Improved vehicle safety has probably saved lives as well. Assumptions can further be made towards the reduced road use by child and adolescent pedestrians and cyclists.

Despite the significant decrease seen, the annual incidence of adolescent injury-related death is 50% higher in Finland than in Sweden (A league table of child deaths ... 2001). Traffic volume, sociodemographic status or the quality of trauma care offer no explanation for the difference. The possible reasons may consist of behavioural factors such as excessive risk taking among Finns compared to their Swedish peers. Suicides do not explain the difference in injury mortality in this age group (A league table of child deaths ... 2001).

While the overall incidence of injury-related death has diminished to a half, the incidence of violence-related injury death has remained unaltered. Worldwide, this may be regarded as a success, since the incidence of violence-related deaths has been rising during the same period, especially in the United States. Indeed, homicide as a cause of death was over 50% more common in 1991 than in 1979 (Sells et al. 1996). Based on our study, we may conclude that our society has not become significantly more violent since the 1970s.

Occurrence of unintentional injuries

Occurrence of unintentional injuries among Finnish adolescents in the present study resembles the patterns observed in other developed countries (A league table of child deaths ... 2001). In this regard, our study is unique, since comparable figures from the Northern Europe do not exist, and, as shown, most of the previous studies have been carried out in the United States. We may conclude that the occurrence of unintentional injuries in Finland can be compared to the situation in the United States. The occurrence figures based on surveys with large samples and a similar definition of injury have shown variations of 25%–40% between countries (Mazur et al. 2001). Taking into account the similarities between the countries in Northern Europe, we may assume that our results about the occurrence and nature of unintentional injury are generalisable to Northern Europe.

The short recall period (one month) used in the present study is likely to give us relatively accurate occurrence figures, but on the other hand it hampers the comparison to other works. It can be assumed that the overall occurrence rate of 5.5% during one month corresponds to 40–50% during one year. Given that the survey was conducted in spring and the fact that injuries in Europe have been reported to be most common in the summer (Morrison et al. 1999), we may assume that spring represents an average injury time. In our survey study, also injuries treated by a nurse were included. This hampers the comparability between our figures and other studies, in which the most commonly used injury

definition requires treatment by a doctor. When comparing figures from injury studies, it is important to compare the definitions of injury first.

The widely used explanation for the men's increased risk is their proneness to risk taking. However, when the exposure to risk is similar, like during conscription, women encounter even more injuries (Knapik et al. 2001). Thus, we might claim that women serving voluntary military service are more competitive and risk-taking than their peers not attending military service.

The nature of the less severe unintentional injuries in Finland is similar to that previously reported in New Zealand and Scotland (Lodge et al. 1990). Injuries were mostly sprains and strains in the extremities. One third of all unintentional injuries needing medical treatment were sport-related. This is an important topic and calls for additional research in order to identify targets for preventive measures.

A moderate percentage of adolescents (12% of 16-year-olds and 18% of 18-year-olds) reported alcohol-related injuries. Among adults, injuries are more frequently alcohol-related. Indeed, it has been stated that even a half of trauma patients may be under the influence of alcohol (Rivara 1996). The Finnish alcohol policy has changed markedly since 1999, and, according to estimates, the use of alcohol is on the rise. Future reports are needed to show the association between alcohol and unintentional injuries among adolescents today.

Occurrence of violence

The percentage of persons reporting violence during the past month in our study was 7.9%, which may correspond to 40%–60% annually. The occurrence observed in this study is approximately twice the occurrence previously reported in population-based studies with small samples and relatively long recall periods in Finland (Heiskanen et al. 2000). It is likely that the occurrence of violence among Finnish adolescents has been increasing and that the short recall period (one month) and the larger sample size providing us more accurate (and higher) results than previously published support this statement. It is plausible, however, that a recall period of one month gives a slight overestimation and that of 12 months a clear underestimation of the true occurrence.

The rate of violence occurrence in Finland is comparable with the United States. The results from population-based surveys with one-year recall-periods indicated that the occurrence of fights varied between 43% and 60% per year (Brener et al. 1999). One of the few violence studies among adolescents in Europe showed much higher occurrence rates in Finland than in Switzerland (Kuntsche 2004). A survey study made among 4222 adolescents at the age of 14 in Switzerland, as part of the international Health Behaviour in School-aged Children study, revealed that 15% of boys and 3.5% of girls reported physical fighting during the past year (Kuntsche 2004).

The high occurrence of violence among the Finnish adolescent population is alarming. While it has been previously shown that murders and severe assaults

are at a significantly lower level in Finland than in the United States (Lehti 2004), it appears that less severe violence is equally common. Self-reported violence occurrence figures among adolescents are, to our knowledge, absent from the other Nordic countries.

An important finding in the present study was that two thirds of the violence-reporting adolescents had encountered one event, 18% two events, and 15% three or more events. It seems that violence accumulates much more frequently to the same persons than unintentional injuries do. From the public health viewpoint, this finding helps the appropriate focusing of prevention measures.

In conformity with previous studies describing family violence (opponent being an intimate partner, parent, or relative) as being more common among girls (Diaz et al. 2002), our findings indicated that in girls the opponent in violence was much more frequently a family member than in boys. One possible explanation to this finding is that physical violence against boys may be less likely to be reported due to a greater social acceptance of male involvement in violence. However, it is evident that family violence is a significant problem in Finnish adolescent girls, and more research to investigate family violence is needed.

Occurrence of violence-related injuries

Occurrence of self-reported violence-related injuries during the past month among Finnish adolescents was 1.7%, corresponding to 10–15% annually. To our knowledge, occurrence of violence-related injury in a population based sample has not been described in Northern Europe. Most of the violence and violence-related injury studies have been performed in the United States. When comparing the occurrence figures between Finland and the United States, it has to be kept in mind that the United States is a very heterogeneous society compared to Finland. While the majority of habitants in Finland are alike in regard to ethnic background and language and the sociodemographic differences are among the smallest in the world, the opposite is true in the United States. Moreover, all these factors are known to be related to occurrence of violence and violence-related injuries. In this respect, the occurrence figures observed in Finland are relatively high when compared with the figures between 4% and 10% per year from the United States. One possible explanation is that the AHLS questionnaire might have been slightly unclear in this regard as the requirement of a doctor's or nurse's treatment was not mentioned in the paragraph enquiring about violence-related injuries. Nevertheless, the occurrence of violence-related injuries is alerting.

One of the most conspicuous features in our results was the finding that girls reported more violence-related injuries, the highest occurrence figures were reported by 16-year-old girls. The difference between sexes is interesting as it differs from earlier documentation (Nunez et al. 2000). It may be that girls report less severe violence-related injuries, yet no significant difference in severity

measured with time-loss was observed. Clearly, our finding requires further studies in this respect.

More than a half of the violence-related injuries involved the head, and two thirds were contusions. Head trauma may always be severe, and hence the proportion of head injuries cannot be overlooked despite the fact that only one fifth reported time-loss from school or hobbies due to violence-related injury. The results demonstrated that most of the violence-related injuries associate with leisure-time activities, which confirmed our expectations although, there is a lack of comparable information. One of the main findings was the high proportion of alcohol-related injuries, since approximately 40% of the injured adolescents were under the influence of alcohol at the time of injury. Here, the rates of violence-related injuries were much higher than those of unintentional injuries. It was also evident that the presence of alcohol in a violent event increased the risk of being injured.

In his thesis, Lintonen has given a thorough description of the drinking of Finnish adolescents, and suggests research concentrating on the harm related to drinking (Lintonen 2001). The actual problems associated with drinking have received relatively little attention. Among adolescents, drinking has been connected to losses of belongings and money, as well as to doing something regrettable. From the public health viewpoint, our findings on injuries and alcohol are important in that they give evidence supporting the prevention strategies. While many of the problems related to drinking, such as liver damage or neuropathy, develop over a long time, injuries related to the use of alcohol occur simultaneously. This fact may be used in education, too.

Measures to prevent drinking may decrease the number of violence-related injuries as well. Probably the most effective measure in reducing violence related-injuries would be strict alcohol regulations. In this respect, unfortunately, Finland along with many other EU countries is moving into a more liberal direction. It can further be assumed that the lower alcohol prices in Finland since 2004 may produce a negative impact on the occurrence of intentional injuries.

Risk factors for injuries and violence

Gender

According to prior evidence, boys encounter more unintentional and violence-related injuries as well as violence than girls (Krug et al. 2000). Indeed, men displayed an increased risk of unintentional injuries, injury hospitalisations, and injury-related deaths in the present study, too, but the male-to-female ratio seemed to vary depending on the severity of the injury. The most severe injuries and deaths are even more common among men than less severe injuries, which indicates that the injury profiles may be different between sexes. This was

supported by several factors that did not predict injury death in women, yet were highly significant among men. As a conclusion, it seems that effective preventive measures may be more difficult to target at and accomplish in women.

The results concerning the male-to-female ratio in violence-related injuries differed from previous findings in that Finnish girls reported more violence-related injuries than boys did. The difference was not, however, statistically significant. According to recent evidence, Finnish girls also report other negative health behaviours more than Finnish boys, for example drinking until drunkenness (Lintonen 2001) and smoking (Rimpela et al. 1999). We may assume that the increased occurrence of violence-related injuries in girls reflects an excessive use of alcohol. Another possible explanation for this result is that girls tend to report physical injuries more easily. However, since the time-loss due to injury was similar, this explanation is unlikely. The reason why Finnish girls report high violence-related injury occurrence rates requires more investigation.

Sociodemographic background

Our finding of the increased injury and violence risk in adolescents not living with own parents, even when the age of the respondent was taken into account, is supported by earlier reports (Ellickson et al. 2000). In this finding, no difference was observed between sexes. The protective effect of own parents appears to be rather strong in our adolescent population. Prior studies made in Finland among adolescents have pointed out family composition as an important indicator of health behaviour (Vikat 2002). We may conclude that efforts supporting the well-being of families may reduce the occurrence of injuries and violence.

Table 29 shows a summary of the results concerning the risk factors for injuries in this study. One of the strongest sociodemographic background factors associated with unintentional injuries in our sample was living in the southern or western Finland, which is partly due to the fact that cities are concentrated in Southern Finland. The Nordic countries seem to differ from the United States in this respect (Hambidge et al. 2002), since results from Sweden suggest that adolescents living in rural areas show the same risk of injury as their peers living in urban areas (Engstrom et al. 2002). An association between violence and related injuries and the geographic area was not found in this study.

The relationship of violence and violence-related injuries with the sociodemographic background is complicated (Table 25). There is evidence that violence is more prevalent in deprived areas (Dowd et al. 1996), but on the other hand, there are studies indicating that the demographic factors do not explain the exposure to violence (Singer et al. 1995). In our study, only the education of the father or other guardian was significantly associated with violence, while the other sociodemographic background factors offered no explanation to violence in the adolescent population. The urbanisation level of the place of residence did not affect adolescents' risk of violence-related injuries in Finland. This differs

from the results from the United States where violence-related injuries predominated in the urban areas and unintentional injuries in the non-urban counties (Nance et al. 2002).

A point worth noting is the increased risk of injury death in farmers' sons. This is probably due to machinery and vehicles used on farms. Education and preventive measures should be targeted at farmers to reduce the risk of injury death.

In global perspective, the association between the sociodemographic background and injury seems to be rather weak in Finland. A study conducted in 12 countries (Mazur et al. 2001) shows that the sociodemographic background is quite strongly associated with injuries in these countries. Our hypothesis is that the better the sociodemographic status of the country is and the smaller the economic differences inside the country are, the smaller is the increase in the injury risk.

According to the present study, the effect of the sociodemographic background on injury risk at adolescence seems to decline with age, but it still has some effect even after 10 years. However, confounding factors exists, since the sociodemographic and educational status of the parents may reflect adolescents' own later sociodemographic and educational status (Koivusilta et al. 1999), which again will affect the injury risk. Another possible explanation to the scarce association between the sociodemographic background and injury occurrence is the point in time the parents' sociodemographic status was reported, since it has been shown in Finland that the parents' sociodemographic background, with the exception of family composition, is not a strong predictor of negative health behaviour in adolescence. Similar results, leading to a conclusion that sociodemographic differences are the smallest during adolescence, have been published in Scotland, too (West et al. 2004).

School success

Poor school success was related to injuries in both the cross-sectional and the longitudinal data sets. The reason why poor school success, which was the strongest predictor of injury-related death among men, did not show a similar, significant association in women is somewhat unclear. Our analyses indicated that only 19% of men and 11% of women were in the group of the lowest school success. The small number of deaths among women may be one explanation. It can be assumed that poor success at school in men is more likely to be associated with health damaging behaviour and risk taking than among women, which, in turn, has proved to be closely related to injuries (Conseur et al. 1997). Since the causality of association between school success and injuries is complex, poor school success should be considered as a significant indicator of an increased injury risk among young men. According to earlier AHLS-based studies, poor school success is significantly associated with several health damaging

behaviours, as well as a lower occupational status in the future (Koivusilta 2000).

Table 29. *The association between risk factors and injuries in Finnish adolescents.*

Risk factor	Unintentional injury	Violence-related injury
Sociodemographic background		
Not living with own parents	+++	+++
Father's low educational status	+	
Father's or other guardian's occupation		
Urbanisation level of place of residence		
Geographic area	+	
School success	++	
Timing of biological maturation		
Health		
Stress symptoms	++	+++
Overweight	+	
Poor perceived health	++	
Chronic disease or disability	+	+
Depressive mood	+	++
Health behaviours		
Frequency of participation in organised sports	+++	
Other leisure-time physical activity	+	
Drinking style	+++	++
Smoking	++	+++
Drug using acquaintances	++	++
Use of snuff	++	
Violence-related injury occurrence	+++	
Unintentional injury occurrence		+++
Regularity of tooth brushing	+	+

(+++ = strong association, ++ = moderate association, + = weak association)

Biological maturation

Early biological maturation has been implicated as a factor associated with many kinds of behavioural problems, especially among girls, such as drinking and unintentional injuries (Lintonen et al. 2000). Thus, it is noteworthy that early or late biological maturation was not related to injuries or violence in our data.

Health

The main findings of the present study included the fact that poor health is a strong risk factor for injuries and violence (Table 29). The risk factors found in the present study to be significantly associated with injuries and violence were: number of stress symptoms weekly, poor perceived health (Diaz et al. 2002), chronic disease, and depressive mood (Ellickson et al. 2000). In addition, only few, rather severe health-related factors, such as psychoses (Rasanen et al. 1998),

clinically confirmed depression (Bailey et al. 1997), and auditory acuity (Petridou et al. 1995), have previously emerged to be associated with injuries. The association between the less severe indicators of poor health has not been previously described.

The cross-sectional study setting may have caused bias when investigating the association between injuries and self-perceived health owing to the possibility that injuries may have caused the poorer than average health. However, our longitudinal data set confirmed the association between injuries and previous poor health. In fact, poor health in adolescence was a significant predictor of injury-related death in men and injury hospitalisation in women after ten years. In addition, it seems that poor health predicts injuries better in women.

The finding that adolescents with a chronic disease or disability report more injuries than their healthy peers is alarming in suggesting that several indicators of poor health status accumulate. These adolescents are probably in a regular contact with the health care system due to their disease. Here, in addition to treatment of the chronic disease, physicians should regard injuries as another potential hazard to these patients' health.

A deeper understanding is needed concerning the negative impact of poor health on injury risks. A challenge for future research is also to explore why poor health does not predict injuries in men, a result obtained in our cohort study. Although the magnitude of the increased risk of injury among women in our cohort study was not imposing, this group of women should be kept in mind when planning and directing preventive measures.

Health behaviours

According to the results of this study, negative health behaviours were the strongest risk factors for adolescent injuries in Finland (Table 29). Further, we were able to ascertain that unintentional injury, violence-related injury, and violence were strongly associated. In fact, unintentional injury was the strongest risk factor for violence-related injury, and vice versa. This result leads us to assume that adolescents sustaining unintentional and violence-related injuries share similar characteristics, an assumption receiving support from the literature (O'Connor et al. 2000). It is possible that all respondents have not known the difference between an unintentional and a violence-related injury, which might distort our results to be overestimates of the true risk. Results from other studies without a similar confounding factor attest, however, that the relation is strong. In a cohort of 3.7 million persons in New Zealand, a history of prior unintentional injury increased the risk of violence-related injury to 5.6–fold compared to persons without such history (Conner et al. 2003).

The second most important risk factor for unintentional injuries was related to exposure to organised sports. Despite the evidence that sports have a significant positive impact on health (Zinman et al. 2004), it appears that in adolescence sports may carry negative effects as well. This finding was to be

expected as sport injuries have been shown to account for a significant proportion of adolescent injuries (Bijur et al. 1995). And further, women participating in organised sports have shown a higher risk of injury hospitalisation than men. Other previous reports have indicated that women have a greater risk of severe knee injuries than men (Hewett 2000), which may partly explain the difference seen in the current study.

In contrast, other leisure time physical activities were not related to injuries at all. It is obvious that the intensity of exercise in organised sports is higher than in other leisure time sports, which increases the risk of injury. It is also evident that more competitive persons participate in organised sports. Some studies have found that risk taking and team sports are associated factors and related to injuries (Riley et al. 1996). The implications of these findings are that more effective preventive measures should be adopted among adolescents attending organised sports, and the coaches, physiotherapists and physicians of sports clubs in particular should pay more attention to injury prevention (Parkkari et al. 2001). Involvement in sports offers many advantages, but the accompanying injuries may decrease these benefits resulting in, for example, knee osteoarthrosis in later life (Kujala et al. 2003).

The greatly increased risk of injuries and violence connected with adolescents' tendency to drunkenness shown in the present study is supported by other reports (Antti-Poika et al. 1986, Antti-Poika 1988), thus adding to the extensive documentation verifying that alcohol abuse is involved in varying types of injuries as well as in violence among adolescents (Ellickson et al. 1997). According to our longitudinal study, drunkenness as a drinking style in adolescence predicts injury-related deaths in men and injury hospitalisation in men and women even after 10 years.

Associations between alcohol and violence have been studied rather widely on a geographic level (Antti-Poika 1986). Pridemore and colleagues reported that an increase of one percent in alcohol consumption increases the homicide rates by 0.25% (Pridemore 2002). Unfortunately in this respect, Finland, along with many other EU countries, is moving into a more liberal direction, and the price of alcohol was lowered in 2004. Subsequent views estimate that the consumption of alcohol will rise by more than 10% in a year (Alkoholijuomien kulutus vuonna 2004 2004). The future will show the effects of cheaper alcohol on violence-related injury rates in Finland.

Smoking and use of snuff can be regarded as a health damaging behaviour (Ellickson et al. 1997). In our material, it presented a strong, positive association with injuries and violence, even when controlled for all other significant health variables. Recurrent smoking in adolescence was the strongest predictor of injury-related death in women in our longitudinal study. Besides family composition, it was the only risk factor for injury-related death that was significant in both sexes.

Smoking and drinking seem to create a cumulative effect on injury risk based on the evidence that adolescents reporting a large number of risk behaviours experience significantly higher injury rates than those reporting no risk

behaviours at all (Pickett et al. 2002). According to our studies, it appears that adverse health behaviours and injuries accumulate to the same persons. The challenge for prevention programmes is to modify the injury risk of this particular group.

A point worth noting in designing prevention programmes is that alcohol may be the cause of injuries while smoking is not. In this respect, more strict smoking regulations will probably have no direct impact on injury risk, while alcohol restrictions might well produce the desired effect.

Conclusions

In this study, the risk factors for injuries and violence were studied in cross-sectional and longitudinal study sets. Our prospective cohort study was one of the largest and longest injury cohort studies ever accomplished. The findings of this thesis demonstrated that, in addition to some indicators of a low sociodemographic background, the indicators of poor health and negative health behaviour in particular are significant risk factors for injuries in Finnish adolescents. The risk factors for unintentional injuries and violence-related injuries were largely similar, with the exception of frequent participation in organised sports which was related to unintentional injuries only. Some factors that were significantly related to violence were non-significant risk factors for violence-related injuries and probably resulted in a smaller number of associated injuries.

Among the main findings of the present study was the fact that most of the risk factors for less severe and severe injuries were the same. This may indicate that injury prevention programmes modifying the risk factors for less severe injuries may affect the occurrence of injury-related deaths, too. Another finding of this study, which has not been widely described, was that the sociodemographic background and health variables predicting injury were not the same in men and women.

Given that health and health behaviour are known to associate with sociodemographic background and vice versa, it is noteworthy that the division of variables used (sociodemographic background, health, health behaviour, school success, and biological maturation) weakened this association, but it still exists. However, the multivariate models, which included all statistically significant risk factors in the same model, revealed that the effects between health and health behaviour and the sociodemographic background were smaller than expected. On the other hand, in regard to poor school success, for example, we cannot be sure whether the increased risk of injury originated from the school success itself or from the underlying sociodemographic problems. This complexity has to be kept in mind when interpreting the results of this study.

In summary, the most important risk factor for injury-related death was poor school success in our cohort of young men, and recurrent smoking in women; in both genders, the strongest risk factor for injury hospitalisation was related to

exposure to organised sports. Many other, injury-predicting background factors showed differences between the genders. The risk factors for injury-related death and injury hospitalisation were fairly similar among men, while among women only two factors (family composition and smoking) predicted injury-related death.

According to our findings, injury-preventive measures should be targeted according to health and health behavioural factors. In Finland, a self-reported sociodemographic background seems a less important predictor of injury. Since frequent participation in organised sports is strongly related to hospital-treated injuries, clearly more attention should be paid to sports injury prevention.

Challenges for future studies

Given that our study was the first extensive report describing the occurrence of and risk factors for adolescent unintentional and violence-related injuries in Finland, many aspects of adolescent injury still remain unclear.

As previously described, the Official Cause-of-Death Register and Hospital Discharge Register are accurate, but there is a lack of high-quality injury surveillance systems concerned with less severe injuries in Finland. Less severe injuries present a public health problem, and efforts to identify and reduce their number should be promoted.

The main findings in our study indicate that injuries are more common among Finnish adolescents than could be expected on the basis of prior studies. Similar research is needed in the future to show the time trends. Since alcohol was strongly related to unintentional injuries, violence and related injuries, it will be important to investigate how the decline in alcohol taxation and the increase in alcohol consumption will affect the injury rates of adolescents. Moreover, as the consequences of injuries were not identified in our study, more knowledge is necessary on this issue as well.

One of the most striking findings in the present study was the association between boys' poor school success and injury-related death. No explanation emerged, however, as to why poor school success predicts injuries only among boys. As it appears evident that the risk factors for injuries are different between sexes, the question arises whether we should adopt different injury prevention strategies for boys and girls? On the other hand, it may well be that the varying background problems cause different symptoms and manifestations in boys and girls.

Without a doubt, many of the risk factors for adolescent injuries identified are to be considered as risk indicators. The challenge for future research is to explore the causal relations between the risk factors and the injuries with a special aim to locate those causal risk factors which can be modified in order to reduce the injury risk.

SUMMARY

The occurrence, nature and risk factors for adolescent unintentional and violence-related injuries and violence were described in five original articles. Four of the articles were based on the Adolescent Health and Lifestyle Survey (AHLS). The other data sources used were the Official Cause-of-Death Statistics and the National Hospital Discharge Register of Finland. Two of the papers were purely descriptive and in the three others, also the risk factors for injuries were discussed.

The AHLS based material was collected every other year from 1979 to 1999. Questions on injuries and violence were included in the 1999 questionnaire. The sample was randomly selected on the basis of particular birth dates. Responding to the self-administered questionnaire was voluntary. The response rates were fairly good, however, being slightly lower in the 1990s and among boys. The materials in each year were kept as similar as possible with respect to sampling, research method, questions, and time of enquiry.

The risk factors were self-reported variables describing the sociodemographic background, health, and health behaviours. The dependent variables included self-reported unintentional injury, violence and related injury, as well as nationwide register-based injury hospitalisation and injury-related death. Logistic regression and survival analysis were used to explore the associations between the risk factors and the outcome variables.

Injury-related deaths decreased by 83% during the 30-year study period. Nonetheless, they remained the leading cause of death among Finnish children and young adolescents. The decline was largely attributable to the decrease in traffic-related deaths.

Less severe unintentional and violence-related injuries were remarkably common among Finnish adolescents. Annually, as many as half of the 16–18 –year-olds sustain an unintentional injury and approximately 15% sustain a violence-related injury needing treatment by a doctor or nurse. More than a half of the adolescent population suffers from violence every year. Violence seems to accumulate, since 15% of adolescents reporting violence report more than three violent situations. As much as 40% of adolescents reporting a violence-related injury also reported having been under the influence of alcohol at the time of occurrence.

Most of the unintentional injuries were less severe, such as sprains and strains of the lower extremities. Unintentional injuries usually occurred during leisure time sport activity and at school. Violence-related injuries occurred in leisure time or at home. The other party was typically a person whom the respondent knew in boys and a family member in girls. The most common physical injuries caused by violence were contusions and bruises of the head and the upper limb.

The strongest risk factors for unintentional injuries were previous violence occurrence and frequent participation in sports clubs, while the factors with the strongest association with violence-related injuries were unintentional injury during the past month, three or more stress symptoms weekly, and smoking >10 cigarettes daily. Our finding of the increased injury risk of adolescents not living with own parents is supported by previous reports. The protective effect of an intact family appears quite strongly in our adolescent population. It is evident that adolescents' tendency to drunkenness substantially increases the injury risk. Smoking, similarly, can be regarded as a health damaging behaviour.

One of the main findings of this study was that the risk factors for injury-related death and a less severe injury were similar. Another important finding is that the risk factors for injuries are not identical in boys and girls. Poor school success in boys and daily smoking in girls were the most accurate predictors of injury-related death in our cohort study. Injury hospitalisation, on the other hand, was predicted by frequent sport in a sports club in both sexes. Based on our cohort study, we may assume that the increase in the injury risk of a poor sociodemographic background in adolescence is rather small in Finland.

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