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A 10-Year Incidence of Acute Whiplash Injuries After Road Traffic Crashes in a Defined Population in Northern Sweden

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Abstract

Objective

An examination of the annual incidence rates of acute whiplash injuries following road traffic crashes in our geographical catchment area during 2000-2009.

Design

Descriptive epidemiology based on prospectively collected data from a defined population.

Setting

The study was carried out at a public hospital in Sweden.

Participants

The population of the hospitals catchment area (136,600 inhabitants in 1999 and 144,500 in 2009).

Methods

At the emergency department (ED), all injured persons ($\approx 11,000$ per year) were asked to answer a questionnaire about the injury incident. Data from the medical records were also analyzed. During 2000-2009, 15,506 persons were injured in vehicle-crashes. Those who were subject to an acute neck injury within Whiplash Associated Disorders grade 1-3 were included. The overall and annual incidences were calculated as incidence rates. Age, gender, type of injury event and direction of impact were described. The incidences were compared with national statistics on insurance claims from 2003, 2007 and 2008 to detect changes in the proportions of claims.

Main outcome measures

The annual incidence rates of acute whiplash injuries. Secondary outcome measures were types of injury events, age and gender distribution, changes in the proportion of rear-end crashes during 2000-2009 and changes in the proportion of insurance claims during 2003-2008.

Results

During 2000-2009, 3,297 cases of acute whiplash injury were encountered. The overall incidence rate was 235/100,000/year. The average yearly increase in incidence was 1.0%. Women made up 51.9% and men 48.1% of the injured. Car (86.4%) and bicycle occupants (6.1%) were most frequently injured. The proportion of rear end crashes decreased from 55% to 45% during 2000-2009. The proportion of insurance claims significantly decreased between 2003 and 2008 ($p<.0001$, Chi-square).

Conclusion

The incidence of ED-visits due to acute whiplash injuries following road traffic crashes have been relatively stable during the past decade in our area except in 2007 and 2008 when a peak occurred.

Introduction

Traumatic neck injuries causing persisting pain, headache and impairment have been described in the literature since the second half of the 19th century, initially under names such as “railway spine” (Erichsen’s disease), “concussion of the spine” and “traumatic neurasthenia”. Crowe launched the term whiplash in 1928 (1,2) but the term was not widely used until the 1950s when 57 papers were published with the word whiplash found in the title. During the 1990s and the first decade of the 21st century this number increased rapidly, with 360 and 769 papers respectively found in PubMed. In the classical rear end car crash, the injury occurs after an acceleration-deceleration-motion of the body, thus making the head pivot above the shoulder region, thereby causing a flexion and elongation of the neck (3). More recent kinematic studies provide a complex picture of flexion, extraction, compression, tension and shear at different levels of the cervical spine during the different stages of the neck movement (4,5). Whiplash injuries also occur after car crashes with other directions of impact. Falls and various injury events in sports can cause whiplash injuries as well (6). However, little is known about the actual tissue damage and why persisting pain occurs in some individuals (7). In a review by Sterner and Gerdle possible mechanisms of injury such as damage to the intervertebral discs and zygapophysial joints as well as inflammatory responses are discussed. Yet, the authors conclude that neither in acute whiplash nor in chronic whiplash have the mechanisms of injury/pain been studied enough and that there are probably subgroups of injuries (8). Among possible contributing factors, Linnman et al. recently found increased uptake of a marker for chronic inflammation ([11C]2D-Deprenyl) in a large subset of chronic whiplash patients (9). Studies have investigated the relationship between psychological factors and chronic pain after whiplash injuries, Williamson et al. found limited evidence that post-traumatic stress and low self-efficacy is related to a higher risk of developing late whiplash syndrome (10). Whiplash associated disorders (WAD) (11) with a number of long-lasting clinical symptoms constitutes a major economic burden on society. As an example, the total lifetime cost for all whiplash injuries that occurred in Sweden during 2001 (8.9 million inhabitants) is estimated to 550 million USD (12).

About 30-40% of subjects involved in rear-end car crashes experience a neck injury (13). In a review based on data from Sweden, the USA, the UK and the Netherlands during 1970-2000, Holm et al. drew

the conclusion that the annual cumulative incidence of hospital visits due to traffic-related acute whiplash injuries had increased during the time period and was estimated to be >300 per 100,000 inhabitants (6). The major Swedish insurance companies reported a rise in the number of claims during the 1990s and the latest known figure is 30,000 claims per year in 2003 (i.e. 334/100,000/year) (12). Figures from the Association of British Insurers state that the number of claims due to whiplash injuries has increased by 25% between 2002 and 2008. If recalculated, the Association of British Insurers assertion that 1 in every 140 British citizens makes a whiplash claim every year would provide an incidence of 714/100,000/year (14).

There is a lack of epidemiological data of acute whiplash injuries during the last 10 years. In fact, no population-based study on emergency department (ED) visits following acute whiplash injuries has been published during recent years. Although many cars of today have modern whiplash protection systems, studies have not investigated if this has changed the epidemiology of whiplash injuries. The aim of this study was to perform a thorough examination of the annual incidence rate of ED-visits due to acute road traffic whiplash injuries in our geographical catchment area during the last decade. Secondary aims were to compare the number of acute whiplash injuries with recent statistics on whiplash claims from the Swedish Insurance Federation (SIF) to determine if the proportion of claims have increased or decreased since 2003 and to investigate if the proportion of rear end crashes causing whiplash injuries have decreased during the study period (along with improved whiplash protection systems in cars).

Material and methods

Patients and procedure

Umeå University Hospital (UUH) is located in the city of Umeå in northern Sweden. This level 1 trauma center is the only hospital and medical facility that treats emergency trauma victims within a well-defined catchment area with 136,600 inhabitants in December 1999 and 144,500 inhabitants in December 2009.

In the ED, all patients (both in- and outpatients) from the area are treated. Also, the general practitioner on call (outside ordinary working hours) is located at the hospital. Since the beginning of the 1980s, there is a well-established on-going trauma registration procedure at the hospital ($\approx 11,000$ cases/year). Upon arrival at the ED, the medical staff provides the injured person with a questionnaire about the circumstances of the injury incident (**Appendix A**). This self-explanatory questionnaire is filled out by the patient or accompanying persons. Data are also retrieved from ambulance personnel, bystanders and relatives. In some cases, supplementary details are retrieved via patient interview during the recovery phase. Data from all available medical records and police reports are included in the data set. By checking against the hospital's compulsory E-number registration (ICD-10; International Classification of Diseases, 10th revision (15)) for "external cause" of in-patient treatment, the problem of missing in-patients that could be included in the data set is eliminated. Trained administrators then assess all this information to find all injuries and injury mechanisms. In cases with multiple injuries, up to three additional injuries are registered. The proportion of registration misses in the group of outpatients injured in traffic is usually about 5% in the monthly control of the registers quality (i.e. when all registered patients during three randomly selected days are compared with all hospital visits for the same period of time).

The data set for this study originates from the injury register. During the 10-year study period (2000-2009), 15,506 patients arrived at the ED following a vehicle-related injury event (including individuals of all ages). Most patients arrived at the ED within hours after the injury event but patients that arrived within days or weeks after the incident were also included if the visit was the first contact with health professionals due to the injury in question. Among the 15,506 patients, we found 3,815 cases of neck injuries. We then excluded all injuries that occurred outside of our primary catchment area ($n=199$), all

non-whiplash injuries (contusions and skin wounds, n=130), all cervical fractures (n=57), all cervical luxations (n=3), all patients who died prior to arrival at the ED (n=10) and all non-road traffic neck injuries (n=119). This left 3,297 cases of acute neck injury within WAD-grade 1-3 (for definition of the WAD-grades, see below). We have excluded WAD-grade 0 since we don't believe that these cases can be found using our method of choice. We also excluded WAD-grade 4 since most previous studies of the incidence of whiplash injuries are limited to soft tissue injuries.

Data from the Swedish Insurance Federation

SIF was asked for their latest statistics on insurance claims following whiplash injuries. SIF provided data from unpublished investigations in 2007 and 2008 in which the major insurance companies in Sweden were asked about their number of whiplash claims during these years.

Comparison with previous studies from UUH

To make some previous studies from UUH comparable with the new data, the authors have recalculated the incidences based on figures from the original articles, the original data files and population statistics from Statistics Sweden.

Definitions

*Whiplash as defined by the Quebec Task Force on Whiplash-Associated Disorders (11):

“Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck. It may result from rear-end or side-impact motor vehicle collisions, but can also occur during diving or other mishaps. The impact may result in bony or soft-tissue injuries (whiplash injury), which in turn may lead to a variety of clinical manifestations (Whiplash-Associated Disorders).”

*WAD-grades (11):

WAD 0: No complaint about the neck, no physical sign(s)

WAD 1: Neck complaint of pain, stiffness or tenderness only, no physical sign(s).

WAD 2: Neck complaint and musculoskeletal sign(s).

WAD 3: Neck complaint and neurological sign(s).

WAD 4: Neck complaint and fracture or dislocation.

*Chronic whiplash injury (11):

A whiplash associated disorder that has lasted for more than six months

The authors have adapted a definition of acute whiplash injury:

*Acute whiplash injury:

WAD 1-3 arising within one month after a whiplash trauma.

Statistical methods

SPSS 19, Microsoft Excel for Mac 2004 and 2011 were used to analyze the data set. The overall and annual incidences were calculated as incidence rates. Standard descriptive statistics (frequencies, means and medians) were used to summarize the variables. Summing the proportion of increase or decrease in incidence between all of the 10 years calculated the average yearly increase in incidence. Since our data were based on the entire population in our catchment area no statistical tests were performed except when testing for significance between the external data on insurance claims vs. the number whiplash cases in 2003, 2007 and 2008 (years when insurance data were available). A Chi-square test was then used.

Main Outcome measures

The main outcome measures were the annual incidence rates of acute whiplash injuries presented at the ED of UUH between the year 2000 and 2009. Secondary outcome measures were some epidemiological aspects of the whiplash injuries such as age and gender distribution, types of injury events, changes in the proportion of rear-end crashes during 2000-2009 and changes in the proportion of insurance claims during 2003-2008.

Results

During the 10-year study period, 3,297 cases of acute whiplash injuries (WAD 1-3) were identified. All ages were included. This means that an acute whiplash injury occurred in 21.3% of all patients seeking care after a vehicle related incident (n=15,506). The gender distribution was 51.9% women/girls and 48.1% men/boys. The overall incidence rate was 235/100,000 inhabitants and year. The overall annual incidence rates were relatively stable except a peak in 2007-2008 (**Figure 1**). The average yearly increase in incidence was 1.0%.

The incidence rate among children (0-14 years) was 40/100,000, among adolescents and adults (15-64 years) 325/100,000 and among elderly persons (≥ 65 years) 47/100,000 inhabitants and year. Incidences in 5-year intervals from 0-14 years along with comparison with some previous studies on whiplash injuries in children are presented in **Table 1**. The age-specific overall incidence rates peaked in age group 20-24 with over 450 cases per 100,000 inhabitants and year, noticeable was also that high incidence, about 400/100,000/year, occurred in age-group 15-35 after which a rapid decline begun (**Figure 2**). The mean and median age was 34 and 31 years.

Car occupants were most frequently injured (86.4%) followed by bicycle occupants (6.1%), bus occupants (1.5%) and moped occupants (1.5%). Among the car occupants, 71.6% were drivers, 19.9% were front seat passengers and 7.9% were back seat passengers. Head restraints were reported present in 77.5% of the cases but in 16.4% the information was unavailable. The share of rear-end impacts in car crashes decreased from 55.0% to 45.0% during 2000-2003 and then leveled around 45% during 2004-2009 (**Figure 3**).

Most of the crashes (65.9%) took place in urban areas. The police were present at the scene in 27.4% of the cases. Twenty per cent of the injured arrived at the ED by ambulance, the rest by personal transportation. Admission to inpatient care was performed in 5.2% of the cases, most of which for one day (80.8% of the admitted cases).

The number of whiplash claims according to SIF was approximately 18,000 in 2007 and about 16,000 in 2008 (i.e. 197/100,000 and 174/100,000 inhabitants respectively). These figures, along with the previous data from 2003 (30,000 claims) (12), were analyzed together with the number of cases of acute whiplash injuries at the ED: 328 cases in 2003, 429 cases in 2007 and 394 cases in 2008. The results show that the proportion of claims significantly decreased between 2003 and 2007 ($p<.0001$, Chi-square) and also between 2003 and 2008 ($p<.0001$, Chi-square). There was no significance between 2007 and 2008 ($p=.64$, Chi-square).

Discussion

The present study describes the annual incidence rates of road-traffic related acute whiplash injuries (WAD 1-3) treated in the ED at Umeå University Hospital (UUH) between the year 2000 and 2009. The overall incidence rate (all ages) was 235/100,000 inhabitants and year; in 15-64 year olds it was 325/100,000/inhabitant and year. The annual incidence rates were relatively stable during the period. The hospital is the only one within a 110 km radius, thus implying that most cases of trauma attend our ED. There is also a tradition in the region of seeking care at the ED following traffic crashes. These circumstances, together with our rigorous on-going trauma registration, assure a thorough collection of cases. The 10-year study period also makes the investigation strong. Since there is only one previous article with long study duration (16) and since no hospital-based epidemiology has been published during the recent years, this paper provides an update on the incidence of acute whiplash injuries in modern traffic with modern vehicles.

The incidence of acute whiplash injuries

There are few previous studies of whiplash injuries including all age groups. In the present study the overall incidence of acute whiplash injuries was high in comparison to the only previous study including all ages from UUH: the incidence was 81/100,000/year in 1985-1986 (traffic crashes, soft tissue injuries, ED) (17). Several later studies from UUH investigated adolescents and adults: incidences were 217/100,000/year in 1988-1990 (traffic crashes, 15-65 years, neck injuries AIS <3, ED) (18), 147/100,000/year in 1990-1991 (car occupants, 16-64 years, cervical strains, ED) (19) and 320/100,000/year in 1997-1998 (car- or bus occupants, 16-64 years, WAD 1-3, ED and general practitioners) (20). Taking into account all these figures along with the new findings presented in this study, the conclusion is that the yearly incidence of registered ED-visits due to acute whiplash injuries following traffic crashes increased from the mid 1980s to the late 1990s, then ~~to~~ leveled out during the last decade. There are some possible explanations that we believe may have impacted the increase: the whiplash injuries may have increased, the propensity to attend the ER following whiplash injuries may have increased and the registration in the injury register may have improved. The registration process has changed over the years with today's method in use since 1998. Before that, there was no scheduled

control of registration misses. Whiplash injuries were highlighted in the media during the early 1990s. This may have increased the attention to the issue at the ED and in the registration process thereby increasing the number of registered cases. We also know that the police since the mid 1990s sometimes recommend uninjured persons or persons with mild symptoms to attend the ED to document that a crash has occurred in case of a later insurance process. It is not clear whether or not increasing amount of traffic in the city during the 1980s and early 1990s could have affected the number of acute whiplash injuries. We only have data on traffic density between 1994-2004 when it increased by 2% per year (21). Also, overall statistics on car crashes with injured persons only reach back to 1997 and from that point in time until 2010, there was no increase in the total number of crashes or rear end crashes (22,23). Since the early 1990s there is an ongoing conversion of conventional intersections from stop sign or traffic signal control to modern roundabouts. This has been shown to have a large preventive effect on crashes and injuries (24) and may explain how traffic density has been able to increase without an increase in the number of car crashes.

One other epidemiological study within a defined population has been conducted in the city of Halmstad, Sweden, during 1993-1995. The incidence of traffic-related acute whiplash injuries (probably all ages) in that study was 1/1,000/year. The authors also included all primary health care centers in the city's area (25). One difference between Umeå and Halmstad is that the European Route 4 (E4), passes through the center of Umeå while the E6 passes outside of Halmstad. Our injury registration has shown that the E4 passage, with its many traffic lights within the city of Umeå, causes a large number of acute whiplash injuries (21). Moreover in comparison with the results of a large study based on 231,672 cases of trauma (all causes, all ages) from 66 hospitals in the USA during the year 2000, with an annual incidence of road-traffic related neck strains and sprains of 328/100,000 (26) the incidence in the present study is clearly lower. However, there are differences regarding the traffic situation in the USA and Sweden. The Vehicle Miles Travelled (VMT) per person and year is almost twice as high in the USA than in Sweden (calculation by the authors based on figures from 2006 (27,28). In their best evidence synthesis on hospital visits due to acute whiplash injuries after traffic collisions, Holm et al. found a yearly incidence of "likely at least 300 per 100,000 inhabitants" (6).

There have also been some hospital-based studies presenting lower incidences of acute whiplash injuries. Otremski et al. prospectively studied soft tissue neck injuries among car occupants in Oxford in 1983-1984 and found an incidence of 27.8/100,000/year (29). Versteegen et al. looked at the incidence of neck sprain/strain in Groningen during 1970-1994 and found that the incidence following car crashes increased from 3.4/100,000/year during 1970-1974 to 40.2/100,000/year during 1990-1994 (16). One explanation to Versteegen's low incidence might be that they used the ICD-system to find the acute whiplash injuries in their registers. In a control of 89 cases of acute whiplash injuries (car occupants, 18-70 years, WAD 1-3) at the ED of UUH in 2011, we found that 57% (95% CI: 47-68%) had an incorrect ICD-10 diagnosis. This may implicate that the incidence from Versteegen et al could be underestimated. The awareness of whiplash injuries and local traditions regarding ED attendance may also differ between different cities and different periods of time.

Acute whiplash injuries among children

There is a lack of data regarding acute whiplash injuries in children. The only previous study from our area including children showed that 24% of the injured were younger than 20 years (17). That gave an age-specific incidence of about 104/100,000/year (recalculated) compared with 145/100,000/year in the present study. Quinlan et al. and Versteegen et al. calculated the incidence of traffic-related acute whiplash injuries in 5-year intervals from 0-14 years (**Table 1**) (16,26). Our figures were lower than Quinlan's. This may indicate different patterns in the use of road transportation among children or different patterns in the parents' tendency to attend the ED with their children. Versteegen's numbers are probably lower because they are older than ours and because of their different study design. Boyd et al. conducted a study merely on children 4-16 years old in the UK during 2002. In this study, 47% (n=49) of 105 children presenting at the ED after a car crash showed symptoms of acute whiplash injuries (30).

Acute whiplash injuries among elderly persons

Quinlan's figure for traffic-related cases ≥ 65 years was 109/100,000/year compared with our incidence of 47/100,000/year (26). Versteegen's numbers were 6/100,000/year in age group 65-69 years and 3.1/100,000/year among ≥ 70 year olds (16). The incidence among persons ≥ 60 years was about 48/100,000/year during 1985-1986 (recalculated) (all injury events, soft injury injuries) (17) to be

compared with 68/100,000/year in the present study. It is important to remember that elderly persons, due to degenerative changes, sometimes sustain cervical spine fractures from “mild” trauma such as falls (31).

Mean and median age

The mean and median age was 34 and 31 years. This is in line with other studies from our area (17,20). Our peak incidence occurred in age group 20-24 among both men and women. Quinlan et al. also found peak incidence for men and women in age group 20-24 (26) and Versteegen’s peak incidence was 25-29 years among men and 20-24 years among women (16). Many young people are injured and this raises the presumptive cost to society since some of them will experience long-term work disability (19).

Gender

Our male/female ratio was 48/52%. Other studies on ED-visits due to traffic-related acute whiplash injuries range from 48/52% (19) to a general male/female ratio of 0,9 for inpatients and 0,3 for outpatients (32). Quinlan et al found a ratio of 40/60% (26), Herrström’s ratio was 42/58% (25) and in Southampton in 2001, the females constituted 61% of acute whiplash injured at the ED (road traffic crashes, ≥ 18 years of age, no additional injuries) (33).

Direction of impact

Farmer et al. showed that drivers of cars with well-rated head restraints had 24% less likeliness to suffer neck injuries in rear-end crashes compared with drivers in cars with poorly-rated head restraints (34). In a study by Kullgren et al. the relative risk of sustaining a whiplash injury with long term symptoms was 50% lower when driving a car with a more advanced whiplash protection system than a car with standard seats (35). Finally, car construction and head restraints have improved during the last decades (13). Based on this, we formed a hypothesis that the share of rear-end crashes leading to ED-visits for acute whiplash might have declined over the past decade; the rear-end crash is the direction of impact for which the new whiplash protection systems primarily are designed. A small trend supporting our hypothesis can be observed during the first years in **Figure 3**. However, when taking into consideration previous studies from our area: 39% rear-end impacts in 1985-1986 (17), 43% among women and 38% among men in 1988-1990 (recalculated) (18), 60% in 1990-1991 (19) and 45% in 1997-1998 (20) it is not possible to

verify the hypothesis. This does not, however, contradict the finding that improved cars and head restraints may improve the late outcome for patients involved in rear-end crashes. A follow up study of whiplash-injured occupants of cars with whiplash protections systems vs. occupants of cars without whiplash protection systems would be of value to clarify this issue. There is also a need for continued improvement of car safety systems aimed at reducing the risk of whiplash trauma, especially from side- and head-on impacts.

Insurance claims

A summary of collected statistics from the major Swedish insurance companies gave an approximate figure of 30,000 whiplash claims in 2003 (12). The new statistics from 2007 and 2008 indicate that the number of claims may have declined by at least one third. These results are supported by the overall statistics of claims due to personal injury after traffic crashes: 53,925 claims were reported in 2003 (36) and 31,339 in 2008 (37). This contradicts our finding that ED visits have been relatively stable. There are however some possible explanations. Firstly, there are probably several factors that impact people's tendency to report their injuries to insurance companies; factors that could be influenced by change over time. Our belief is that whiplash injuries have been discussed less in the Swedish media during the last 7-8 years. This may have reduced awareness about whiplash injuries. There has also been less of a debate regarding insurance policies and the necessity of reporting whiplash injuries to the insurance companies. Secondly, as mentioned above, head restraints and car construction have improved during the study period (13). Better protection may have a preventive effect on the development of chronic WAD, thereby reducing the number of insurance claims. The pattern of less insurance claims is however not seen in Great Britain. According to the Association of British Insurers, the number of claims due to whiplash injuries has increased by 25% between 2002 and 2008 and translates to an incidence of 714/100,000/year (14). This suggests that the findings in the present study must be interpreted carefully as they are true only in the original context. Our findings also show that insurance claims and ED-based incidence of whiplash injuries does not necessarily correlate.

Limitations of the study

Many cases of acute whiplash injuries occur in low speed crashes (12) and it is reasonable to assume that some of the persons with mild, passing neck symptoms do not attend the ED. There can also be cases of acute whiplash injuries that are primarily treated by general practitioners. Our results can therefore not be interpreted as the total incidence of acute whiplash injuries but rather as the incidence of ED-visits.

The questionnaire used at the ED has not been validated. Since the purpose of the questionnaire is to register information about all types of injury events, specific questions about whiplash are not included. Furthermore, since the questionnaire is self-reported, severely injured persons as well as persons affected by alcohol or drugs may not be able to fill out the form. Relatives, friends or sometimes the medical staff can often assist in those cases. Umeå is a city with a low mean age and a high proportion of well-educated citizens due to the presence of a university. There are also a significant number of bicyclists. This makes the demography and the composition of traffic different from other Swedish cities. Our results regarding age and gender distribution along with the share of bicyclists being injured may therefore not be fully applicable to other cities. It is however likely to assume that the main finding of the article (that the number of ED-visits due to acute whiplash injuries have been relatively stable during the last decade) is generalizable to the whole of Sweden. In order to draw conclusions regarding other countries, ED-based studies need to be performed in those countries. The calculation on the proportion of insurance claims in 2003 vs. 2007 and 2008 was performed using national data combined with local data; a more proper way to make this calculation would have been to use national data combined with national data or local data combined with local data. These results need to be confirmed in future investigations before further conclusions can be drawn.

Conclusion

We have described the annual incidence rates of ED-visits due to acute whiplash injuries following road traffic crashes in a defined population during 2000-2009. Our results show that the annual incidence rates of acute whiplash injuries treated at our ED have been relatively stable during the past decade, except in 2007 and 2008 when a peak occurred. Interestingly, data from the insurance companies show a different trend with a rapid decrease of whiplash-related claims during the past 7-8 years. The share of rear-end

collisions is below 50% thus implying that whiplash protection systems in cars should be designed to manage impacts from all directions.

This study will provide an update on the incidence of whiplash injuries in Sweden, valuable for policymakers, traffic planners and health care professionals.

Conflicts of interest

None.

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Tables

Table 1

The incidence of acute whiplash injuries following traffic crashes among children in the present study and in previous studies.

	Present study	Versteegen et al., 1998	Quinlan et al., 2004
0-4 years	4/100,000/year	0,5/100,000/year	20/100,000/year
5-9 years	35/100,000/year	0,5/100,000/year	67/100,000/year
10-14 years	73/100,000/year	5/100,000/year	120/100,000/year

Figures

Figure 1

The incidence rate of road traffic whiplash injuries in Umeå 2000-2009.

Figure 2

The average incidence rates of whiplash injuries in different age groups.

Figure 3
Direction of impact in car crashes.

(explanatory legend of figure 3)

“Rear-end”, “Head-on”, “Right” and “Left” include cars colliding with other vehicles. “Other” includes e.g. rollovers and collisions with animals or objects.

671   **Appendix legend**

672

673   **Appendix A**

674   **The questionnaire used at the Emergency Department of Umeå University Hospital to monitor all**
675   **cases of injury.**