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Neck sprain after motor vehicle accidents in drivers and passengers

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Abstract Neck sprain is a general term denoting a soft tissue injury of the neck, which seldom causes major disability but is considered a modern epidemic. The purpose of the present study was to determine the prevalence of sprain of the neck injury due to motor vehicle accidents (MVAs) in both drivers and passengers. In addition, the degree of seat belt wearing in both driver and passenger was analysed. A second aim was to identify groups at risk by analysing the age and gender distribution of patients with neck sprain. The results of this population-based study revealed a sharp increase in neck sprain from 1989 through 1995, whereas a more or less stable pattern

was found for seat belt use. The sharp increase was found to be attributable to outpatients. Finally, we found a driver predominance as well as a female predominance; groups at risk were the 20- to 24-year-olds for drivers and 15- to 19-year-olds for passengers.

Key words Prevalence · Neck sprain · Whiplash · Drivers and passengers

Introduction

Neck sprain due to motor vehicle accidents (MVAs) is considered a modern epidemic [8]. Neck sprain is a general term denoting a soft tissue injury of the neck [21]. The injury evolves into a whiplash-associated disorder (WAD) in 30–40% of sufferers [5]. WAD is a major cause of disability following MVAs [6]. The frequency of neck sprain injury in the United Kingdom was noted to rise following the introduction of compulsory seat belt wearing in January 1983 [1, 4, 13, 21, 23]. More specifically, Allen et al. [1] and Trinca [24] observed a general decrease in injuries due to MVAs immediately following the seat belt legislation, with the exception of sprain of the neck. In contrast, more recently, Versteegen et al. [25] found no sharp increase in sprain of the neck (code 847.0 ICD-9 CM) immediately after seat belt legislation in the

Netherlands in 1975, but they did find a sudden increase in sprain of the neck injuries 10 years later. A similarly confused picture about the effect of wearing seat belts on neck sprain was reported by the Quebec Task Force [5]. Galasko et al. [8] reported an increase in all forms of neck sprain after the introduction of compulsory seat belts, but they also discuss several other factors that may affect the extent of the phenomenon (e.g. litigation, medical check-up for insurance purposes, driving habits etc.). It should also be recognised that, in practice, the introduction of seat belt legislation may not necessarily be directly reflected in a high degree of actual fastening of seat belts. Furthermore, although the extent of seat belt wearing may gradually rise after the introduction of such legislation [11], this cannot explain the sudden rise in incidence of neck sprain 10 years later, as happened in the Netherlands [25].

Information about both the degree of seat belt wearing among drivers and passengers [11] and the frequency of occurrence of neck sprain due to MVAs in the same time period may provide new insight into the effect of using a seat belt on the incidence of neck sprain.

The prevalence of neck sprain among drivers and passengers is unknown. Although Cassidy et al. [5] and Versteegen et al. [25] reported on the prevalence of neck sprain in victims of MVAs, no distinction was made between prevalence rates for drivers and passengers. In the majority of neck sprain studies, no age group distribution of the patients is provided [11, 20]. To identify risk groups, both the age distribution and the gender of the patients ought to be reviewed.

The purpose of the present research was to determine the prevalence of sprain of the neck (ICD-9 code 847.0) due to MVAs (in both drivers and passengers) by means of a population-based study. In addition, the degree of seat belt wearing in both driver and passenger was analysed. A second aim was to identify groups at risk by analysing age and gender distribution of neck sprain patients.

Materials and methods

This 14-year retrospective study involved two population-based groups of patients with neck sprain due to MVAs. Patients were included in this study if their diagnosis was coded as "sprains and strains of the neck" (ICD-9 code 847.0), according to the hospital discharge registry data and the trauma registry. The data of the first group of patients was retrieved from the database of the Institute of Information on Healthcare (Stichting Informatiecentrum voor Gezondheidszorg, SIG), which covered all inpatients of 99.6% of hospitals in The Netherlands during the period 1982–1994. The codes are based on the hospital discharge registry. The data from

the second group (both inpatients and outpatients) came from the registry of the Department of Traumatology of the University Hospital Groningen (UHG). This registry is based on the trauma code. These patients attended the Emergency Unit of the Department of Traumatology between January 1982 and December 1995. The University Hospital is a 1056-bed centre, situated in the north of The Netherlands. The Accident and Emergency Department is freely accessible and maintains a 24-h service. All trauma visits of both inpatients and outpatients are recorded on a standardized chart [14]. The city of Groningen and its vicinity comprise 94% of the catchment area of the UHG for trauma patients. Since the health care system in The Netherlands is easily accessible, and general practitioners tend to admit injured patients to emergency units for further diagnosis and treatment, the population of patients of the second group presented here is a representative sample of the population at risk. It is noteworthy that the trauma registry of the UHG is the only registry in The Netherlands in which data of outpatients with sprain of the neck have been recorded.

From both databases, information about neck sprain in drivers and passengers of cars was retrieved across the life span to identify groups at risk. Prevalence rates were also employed to analyse trends over the 14-year period. In addition, trends in the degree of seat belt wearing, obtained from the Foundation for Scientific Research for Traffic Safety (SWOV), were compared with trends in the sprain of the neck phenomenon.

Results

With regard to the inpatients ($n = 409$) from all Dutch hospitals with injuries resulting from MVAs, the prevalence rates of sprain of the neck dropped sharply for both drivers and passengers from 1983 (Table 1), and have remained more or less stable in more recent years (1989–1995). The prevalence rates of neck sprain among the inpatients admitted to the UHG following an MVA fluctuated. In 1994 and 1995 an increase was recorded only for the drivers. For the outpatients, an increase in

Table 1 Prevalence of sprain of the neck due to car accidents: rates per 100,000 inhabitants during the period 1982–1995 (UHG University Hospital Groningen)

Year	Inpatients all Dutch hospitals		Inpatients UHG		Outpatients UHG	
	Drivers ($n = 253$)	Passengers ($n = 156$)	Drivers ($n = 33$)	Passengers ($n = 17$)	Drivers ($n = 433$)	Passengers ($n = 196$)
1982	0.46	0.18	0.00	0.00	12.11	3.36
1983	0.60	0.15	1.8	0.00	4.79	0.00
1984	0.09	0.09	0.00	1.19	12.51	1.79
1985	0.03	0.08	0.00	1.19	8.33	5.35
1986	0.08	0.06	1.19	1.79	9.52	7.74
1987	0.05	0.03	1.79	0.00	9.52	4.76
1988	0.07	0.05	2.38	0.60	11.31	5.95
1989	0.06	0.09	0.00	0.00	22.05	4.77
1990	0.05	0.05	1.19	0.00	15.49	8.94
1991	0.11	0.07	1.19	0.59	15.41	10.08
1992	0.06	0.10	1.18	1.18	18.30	11.81
1993	0.03	0.08	1.18	0.00	30.58	11.76
1994	0.05	0.05	4.1	2.93	47.50	17.01
1995			3.52	0.59	38.70	22.28
Average prevalence	0.13	0.08	1.40	0.72	18.37	8.32

Table 2 Prevalence of sprain of the neck among drivers and passengers by age group: rates per 100,000 inhabitants

Age group	Inpatients all Dutch hospitals		Inpatients UHG		Outpatients UHG	
	Drivers (<i>n</i> = 253)	Passengers (<i>n</i> = 156)	Drivers (<i>n</i> = 33)	Passengers (<i>n</i> = 17)	Drivers (<i>n</i> = 433)	Passengers (<i>n</i> = 196)
0-4	0.01	0.00	0.00	0.00	0.90	0.00
5-9	0.05	0.02	0.00	0.00	0.00	2.99
10-14	0.03	0.08	0.00	1.82	0.91	9.11
15-19	0.07	0.26	0.6	2.98	5.96	21.47
20-24	0.34	0.15	2.89	0.28	31.97	9.34
25-29	0.17	0.07	1.78	0.71	32.31	8.17
30-34	0.17	0.03	2.89	0.00	27.95	5.78
35-39	0.19	0.04	1.20	0.00	25.79	9.60
40-44	0.19	0.07	1.51	0.76	30.23	11.34
45-49	0.17	0.08	1.83	1.83	21.92	13.7
50-54	0.07	0.16	0.00	0.00	21.27	9.12
55-59	0.14	0.04	1.01	0.00	12.11	11.1
60-64	0.14	0.03	1.01	2.01	10.06	6.04
65-69	0.03	0.05	0.00	0.00	5.33	3.2
70+	0.06	0.04	1.33	0.89	1.77	1.77
Total	0.13	0.08	1.40	0.72	18.37	8.32

prevalence rates was observed (*n* = 629) for drivers from 1988 and for passengers from 1990.

The prevalence of neck sprain among inpatients admitted to the UHG following an MVA (1.16: weighted average) was greater than that among inpatients recorded in the data of all Dutch hospitals (0.11: weighted average).

For the whole period (1982 through 1995), the average prevalence of neck sprain for injured drivers was 0.13 for inpatients of all Dutch hospitals, 1.4 for the UHG inpatients and 18.37 for the UHG outpatients (Table 1). A similar picture was observed for passengers with neck sprain;

the average prevalence was 0.08 for all Dutch hospitals, 0.72 for UHG inpatients and 8.32 for UHG outpatients. These results clearly showed an outpatient predominance in the neck sprain epidemic. In addition, a driver predominance among those suffering neck sprain injury was found for both inpatients and outpatients. The driver/passenger ratio was 1.6 for inpatients of all Dutch hospitals, 1.9 for UHG inpatients and 2.2 for UHG outpatients across the whole period.

Turning to the identification of risk groups, among drivers, 20- to 24-year-olds were found to be the group at highest risk among inpatients taken from both the UHG and the all Dutch hospitals data. Among outpatients, the 25- to 29-year-olds were found to be at greatest risk (Table 2). For passengers, the group at highest risk was the 15- to 19-year-olds in all the groups (inpatients and outpatients from the UHG and all Dutch hospitals data).

Fig. 1 The percentage of seat belt use among car drivers within and outside city limits in the Netherlands during the period 1979-1995. Source: Beveiligingsmiddelen in personen auto's in 1995 (Safety measures in automobiles in 1995). J. A. G. Mulder, Leidschendam. Copyright: SWOV 1995. Reprinted with permission [15]

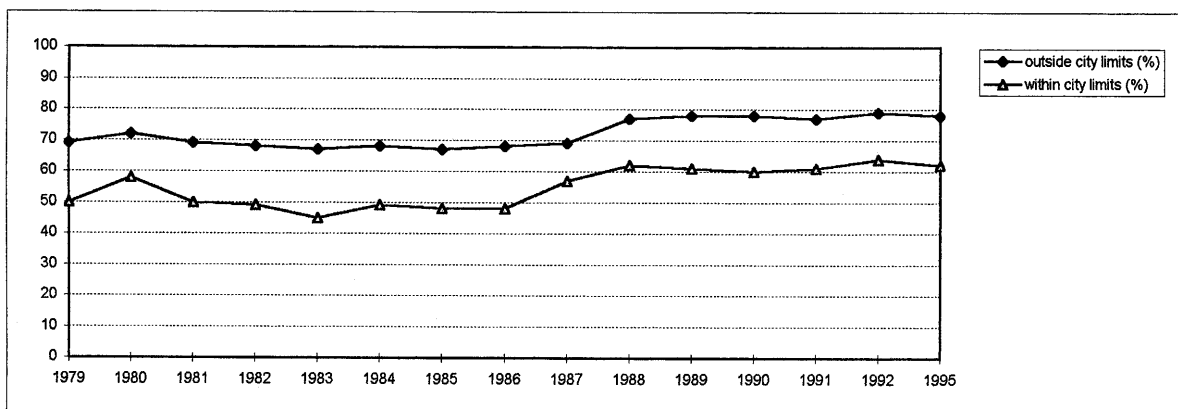


Table 3 Percentage of drivers and passengers wearing seat belts during the period 1989–1995

Year	Drivers (%)	Passengers (%)
1989	69	73
1990	68	73
1991	68	72
1992	72	75
1995	70	76

Source: Beveiligingsmiddelen in personenauto's in 1995 (Safety measures in automobiles in 1995). J. A. G. Mulder, Leidschendam. Copyright: SWOV 1995. Reprinted with permission [15]

In general, a female predominance was found for both inpatients and outpatients: the male/female ratio was 0.9 for inpatients and 0.3 for outpatients. For drivers with neck sprain, only a slight male predominance was found for outpatients (male/female ratio 1.3), but a larger male predominance was found for the inpatients (1.8). For passengers, we found a female predominance in both inpatients (male/female ratio 0.8) and outpatients (0.3).

In order to compare the general level of seat belt use in the Netherlands with our observed trends in neck sprain patients, data from the Foundation for Scientific Research for Traffic Safety (SWOV) were retrieved. It can be seen from Fig. 1 that, from 1979 through 1986, seat belt use remained more or less stable. From 1986 to 1989, a gradual increase in seat belt use may be observed, after which the level remained stable.

During the period 1989 through 1995, seat belt use varied between 68 and 70% for drivers, and between 72 and 76% for passengers, so these figures remained more or less stable (Table 3). A comparison of the data on seat belt use and the prevalence rates of neck sprain (Table 1) revealed no association, except for the prevalence among drivers (outpatients UHG data), which increased sharply from 1989 through 1995. In other words, the strong increase in neck sprain among drivers (outpatients UHG data) was preceded by a slight increase in seat belt use during the years 1986–1988. Among passengers, levels of seat belt use increased by 3% between 1989 and 1995, while the increase in prevalence of neck sprain among

passengers (outpatients) over the same period was even greater: from 4.77 in 1989 to 22.8 in 1995.

Head-on (front-end) or rear-end collisions are thought to be the main cause of neck sprain in MVAs [17]. We therefore retrieved population-based data from the Netherlands Central Bureau of Statistics about MVAs (Table 4).

During the period 1989 through 1994, for the category front-end accidents, an increase in the prevalence of victims "injured but not treated as inpatients" can be observed (Table 4). The prevalence rose gradually, from 13.8 in 1989 to 24.6 in 1994. In contrast, in the same category (front-end collisions), the prevalence of victims treated as inpatients did not show any systematic increase from 1989. Prevalence rates have fluctuated since 1989, at around 2.9.

With regard to victims from all other categories of MVA who were treated as outpatients, prevalence rates fluctuated between 66.6 and 72.9 during the observation period (1989–1994). In contrast, prevalence rates of inpatients decreased from 1990 through 1992, after which they remained "stable". So, the only consistently increasing trend during the whole period (1989–1994) was found for victims who were involved in front-end collisions who were treated by a general physician or as outpatients at the Emergency Unit of a hospital.

Discussion

Neck sprain is a ligamentous injury of the neck, which seldom causes major disabilities. The incidence has been described as on the increase over the last two decades, and the injury has a major relation to MVAs. Results from previous research suggest that the increase in neck sprain injuries caused by MVAs may be attributed to an increase in the level of seat belt use following the introduction and enforcement of seat belt legislation [6]. However, Versteegen et al. [25] did not find a significant increase in neck sprain injuries immediately after seat belt legislation in the Netherlands, but only 10 years later. This discrepancy was the reason for further analysis of this phenome-

Table 4 Prevalence per 100,000 inhabitants of victims injured in car accidents during the period 1989–1994

Category of car accident/ type of victim	Year					
	1989	1990	1991	1992	1993	1994
Front end collision						
Injured but not treated as inpatient ^a	13.8	14.7	15.6	18	19.9	24.6
Injured and treated as inpatient	2.9	3	2.4	2.8	3.3	2.9
Death	0.3	0.3	0.2	0.2	0.2	0.2
Other car accidents						
Injured but not treated as inpatient ^a	66.6	72.9	69.2	69	69.4	68.6
Injured and treated as inpatient	30.4	31	27.9	26.2	26.6	26.4
Death	4.3	4.5	4	4	3.8	3.8

Source: Central Bureau for Statistics (CBS), The Netherlands

^aThese victims were treated either by a general physician or at the Emergency Unit of a hospital

non. The results of this population-based study revealed, after a relatively stable pattern before 1989, a sharp increase in neck sprain due to MVAs in both drivers and passengers treated at the UHG from 1989 through 1995. A comparison with the data of the Foundation for Scientific Research for Traffic Safety (SWOV) revealed a small increase in seat belt use over that period. This small increase was not reflected in an increase in neck sprain among both outpatients and inpatients in the same period. The inpatient database of the Institute of Information on Healthcare (SIG) showed no increasing trend over the years, while among UHG inpatients a small increase in prevalence was observed.

In contrast, the observed overall sharp increase in neck sprain prevalence is attributed to the outpatient population. Any analysis restricted to inpatient data only (e.g. the data held by the SIG), would fail to detect the increase in victims of neck sprain. As far as we know, the pathology of inpatients in comparison with outpatients has not been investigated, so further research is needed on this issue.

The prevalence of neck sprain among the UHG inpatients was greater than that recorded for inpatients from all Dutch hospitals. These remarkable differences can possibly be ascribed to the fact that the UHG trauma registry is based on the diagnosis made at the Emergency Unit, whereas the data from the SIG is based on hospital discharge registries. Furthermore, there is a bias in the figures of the SIG, because all hospitals in the Netherlands send their discharge registry data to the SIG, so the (discharge) figures from Groningen are incorporated in the data from the SIG. Additionally, the UHG acts as a centre of excellence for medical care.

It would appear that the sharp increase in neck sprain victims (outpatients) cannot only be ascribed to higher levels of seat belt wearing. This proposition has also been suggested by Galasko [8], while the Quebec Task Force [5] believes the issue remains unclear. A possible explanation for the increase (outpatients) may be attributed to the media, which has paid a lot of attention to whiplash-associated disorders (WAD), both to their causes (MVAs) and their long-term consequences. Media interest has made people more aware of the impact of MVAs [25].

Schrader et al. [22] found that WADs were less extensive in the newly independent country of Lithuania. In line with this observation, it appeared that Lithuanian doctors were also less aware of WAD than Western doctors. The expectation of symptom presentation and expectation of disability due to neck sprain would, therefore, be negligible. Obelieniene et al. [12] found that in Lithuania, where there is no preconceived notion of chronic pain arising from rear-end collisions, and thus no fear of long-term disability, symptoms of whiplash injury resolve spontaneously and usually do not seem to evolve into so-called WADs. In contrast, people in Western countries are more aware of WAD, and therefore they visit their general

physician or the Emergency Unit (which is freely accessible in the Netherlands) shortly after any accident for a check-up, just to be sure or to get advice. However, it should also be recognized that there may be a group of patients who will not visit a general physician or the Emergency Unit after an accident, so the number of victims presented may possibly be an underestimation, not only in this study but also in other research.

Our results showed a driver predominance for both groups (UHG and all Dutch hospitals) of inpatients and outpatients. Unfortunately, neither our hospital-based registry nor the registry of SIG records whether the drivers and passengers were in the same car when they became injured. Thus, the number of people involved in a given car accident and whether the neck sprain victims were involved in the same accident or in the same car is also not known. A possible explanation for the driver predominance may be that there are only drivers in the vehicle in road transport and haulage and non-resident traffic.

The highest groups at risk for drivers were found to be the 20- to 24-year-olds (both UHG and all Dutch hospitals inpatients) and 25- to 29-year-olds (outpatients). In the trauma literature, this age group is generally found to be a group at risk, and is described as the "young male peak" [9].

A female predominance was found for passengers with neck sprain, whereas only a slight male predominance was found for drivers. The male predominance among drivers may possibly be attributed to road transport, which is still mostly male business. Furthermore, it is reasonable to suppose that when a family is going out or more people are travelling together in one car, in general men are the drivers. As far as we know, there are no studies in which the distinction between driver and passenger has been made. In general, there was a female predominance in the entire group. Although the female predominance is in agreement with previous studies [3, 5, 7, 13, 16–19], the difference between the data used in these studies needs to be borne in mind. The female predominance may be ascribed to the fact that, in general, women report more health complaints [2, 10], or to the smaller diameter of the neck in women, which makes them more vulnerable. However, these are only assumptions.

The population-based data from the Central Bureau of Statistics of the Netherlands during the period 1989 through 1994 showed an increase in the number of victims with neck sprain due to front-end MVAs and treated as outpatients. However, in the same database there was no increase in victims treated as inpatients for the same category of injury. Furthermore, the SIG registered inpatient data from all Dutch hospitals and these also demonstrated stable prevalence rates. In contrast, the results of the Central Bureau of Statistics showed an increase in neck sprain patients treated as outpatients, as did the UHG data. The UHG data included both inpatients and outpatients, enabling us to show that the majority of the increase in neck sprain victims were treated as outpatients.

In conclusion, we found a sharp increase in neck sprain from 1989 through 1995, while a more or less stable pattern was found for seat belt use. Secondly, the sharp increase was attributed to outpatients. Third, we found a driver predominance as well as a female predominance. Groups at risk were the 20- to 24-year-olds for drivers and the 15- to 19-year-olds for passengers.

“Sprain of the neck” is a diagnostic rubric of the International Classification of Diseases, whereas whiplash-associated disorders (WAD) is a description of symptoms as a result of sprain of the neck. It remains unclear whether outpatients as well as inpatients develop whiplash-associated disorders. To answer this question, further research about neck sprain is needed, using a hospital-based registry.

It remains unclear whether outpatients as well as inpatients develop whiplash-associated disorders. To answer this question, further research about neck sprain is needed, using a hospital-based registry.

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