Eur Spine J (1998) 7 : 195–200

ORIGINAL ARTICLE

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Neck sprain in patients injured in car accidents: a retrospective study covering the period 1970–1994

Received: 9 May 1997
Revised: 17 December 1997
Accepted: 10 January 1998

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Abstract During the 25-year period 1970–1994 694 patients were diagnosed with neck sprain resulting from a car accident at the Emergency Room of the University Hospital Groningen. The purpose of the present study was to analyse the prevalence, groups at risk and trends in these patients, taking into account changes in the number of cars per inhabitant and the average number of kilometres driven. We defined the population as car accident victims diagnosed with neck sprain. Binominal tests were used to obtain measures of statistical significance. Over the 25-year period a steady increase in the number of these patients was observed, from 10 in 1970 to 122 in 1994. The highest prevalence was found for the age group 25- to 29-year olds (28.3 per 100,000), followed by 40- to 44-year-olds (27.9 per 100,000). Across the life span, the male: female ratio was 1 : 0.98. Eight percent of the victims were treated as inpatients. The increase in the number of car accident victims with neck sprain appears not to be an isolated phenomenon, because a parallel rise in the number of cars per inhabitant and in the average number of kilometres driven was found. No direct relation was observed between seat belt legislation and the increase in neck sprain injuries. The effect of the media on awareness of the consequences of car accidents is discussed.

Key words Neck sprain · Whiplash · life span · Prevalence

Introduction

During the last decade, "whiplash" has been a focus of interest in both the general media and research literature. General opinion about the recent substantial increase in the number of whiplash victims has been based on one of the rare epidemiological studies on "neck sprain" resulting from car accidents [9], which showed both an increase in all road accident victims and in road accident victims with neck sprain, in the period 1982–1991 (7.7% of 929 in 1982 and 4.5% of 6149 in 1991). The diagnostic rubric "sprains and strains of the neck" of the International Classification of Diseases (ICD-9 CM) from the World Health Organization is used by the majority of the hospital-based trauma registries. In some studies "sprain of the neck" has been employed as a diagnostic rubric for acute whiplash. In contrast to the enormous bulk of whiplash literature, as far as we know, only a few studies have focused on neck sprain. More specifically, the Quebec Task Force assessed about 10,000 case reports of whiplash from 1970, of which only 346 involved compensation. In contrast, only 19 publications on neck sprain could be retrieved from Medline [15] for the same period, of which 9 focused on car accidents [3, 5, 8–10, 23, 27, 28, 30]. In general, both retrospective [5, 14] and prospective studies [1, 6, 24] show an increase in the number of patients with neck sprain (on the basis of comparing the frequency of occurrence at two different time periods).

The Quebec Task Force [25] also used the ICD-9 rubric "sprains and strains of the neck", as a diagnostic rubric for whiplash. This research group investigated different cohorts over a period of 6 years, and introduced a

new parameter to assess the effects of neck sprain namely: absence from work for which some financial compensation was paid by the Quebec Automobile Insurance Society (SAAQ). An increase in the average period of absence was found (87 days in 1987, 108 days in 1989) as well as in claims for compensation from the SAAQ. The Quebec Task Force provided the first prevalence rates of neck sprain: 70 per 100,000 in 1987. The prevalence of neck sprain was reported to be 1.5 times higher in female than in male car accident victims (respectively, 86 and 54 per 100,000). These results are in agreement with findings from previous studies on neck sprain, in which female predominance was generally reported [11, 17, 18, 25]. As far as we know, there are neither studies on trends in the diagnosis of neck sprain resulting from a car accident nor studies on the differences between inpatients and outpatients. Results from previous research suggested that the increase in the number of victims of car accidents diagnosed with neck sprain may be attributed to seat belt legislation [1, 24, 29].

The purpose of the present study was to investigate trends in patients diagnosed with neck sprain resulting from car accidents who were treated at the Emergency Room at the University Hospital Groningen during the period 1970–1994. The second concern was to analyse how the prevalence of neck sprain has been affected by the seat belt legislation of 1975. Finally, groups at risk (gender, age) were identified and trends in the number of cars and the average number of kilometres driven per car were analysed.

Materials and methods

This 25-year retrospective study (1970–1994) involved all car accident victims diagnosed with neck sprain according to the International Classification of Diseases (ICD-9, CM), who attended the Emergency Unit of the Department of Traumatology at Groningen University Hospital (n = 694). The University Hospital Groningen is a 1056-bed centre situated in the north of The Netherlands; it serves a population of approximately 2 million people, which is about 93% of the catchment area. The Groningen area represents one-third of the total area 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 standardised chart. Each case record comprises patient identification, external cause of injury, comorbidity, trauma diagnoses, use of alcohol, therapeutic procedures and other treatment characteristics. All patient maps were reviewed and completed by staff traumatologists. Sprains and strains of the neck were defined according to the N-code, 8th and 9th revision (code 847.0), of the International Classification of Diseases, which has been the same for the last 25 years [16]. We defined the population as car accident victims diagnosed with neck sprain. The binominal test was used to obtain measures of statistical significance. The probability $P < 0.01$ was taken as the level of statistical significance.

Results

During the 25-year period the number of car accident victims who were admitted to the Emergency Unit and diagnosed with neck sprain increased substantially. In 1970 10 patients were diagnosed with neck sprain, while by the year 1994, this number had increased to 122. The gradual rise started in 1984, and led to a far more rapid rise between 1990 and 1994 (Fig. 1).

Prevalence rates (the number of car accident victims with neck sprain per 100,000 inhabitants in the catchment area of the University Hospital Groningen) were presented for consecutive 5-year periods from 1970 to 1994

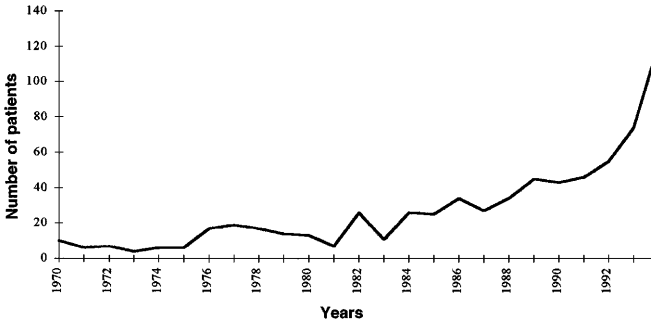

Fig. 1 Number of patients diagnosed with neck sprain resulting from a car accident at the Emergency Room of the University Hospital Groningen, 1970–1994

Table 1 Average prevalence rates (per 100,000) of patients diagnosed with neck sprain resulting from a car accident over consecutive 5-year periods, from 1970 to 1994

	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	Overall
P	3.4	9	10.1	19.6	40.2	17.1

Table 2 Number of car accident victims diagnosed with neck sprain by gender and age group during the period 1970–1994 (n = 694)

Age group	Male	Female	Total
0– 4	1	0	1
5– 9	0	2	2
10–14	6	6	12
15–19	24	35	59
20–24	80	79	159
25–29	69	55	124
30–34	43	30	73
35–39	29	33	62
40–44	27	32	59
45–49	20	23	43
50–54	8	22	30
55–59	13	16	29
60–64	12	7	19
65–69	6	4	10
70+	5	7	12
Total	343	351	694

(Table 1). The figures show an upwards trend in the prevalence figures, with a tenfold increase over the 25-year study period (from 3.4 per 100,000 inhabitants in 1970–1974 to 40.2 per 100,000 in 1990–1994).

We presented both the prevalence rate and the number of patients, because in the majority of earlier research literature only the number of patients per age group were presented. By comparing the results based on the number of victims and the results of the prevalence rates we were able to show whether the use of these two approaches identifies the same risk groups. On the basis of only the numbers of patients with neck sprain, we found the 20- to 24- and 25- to 29-year-olds to be the group at highest risk (Table 2). If only these absolute numbers had been reviewed, a "young male peak" [12] would have been detected in the age group 25–29 years.

However, analysis of the prevalence rates using the same data (Table 3) showed both 25- to 29- and 40- to 44-year-olds to carry the highest risk. Since the male: female ratio was close to one (1 : 0.98), it appeared that females and males have about the same risk of sustaining neck sprain in a car accident. The advantage of employing prevalence rates is that a correction is made for changes in the composition of a population during the study period.

With regard to the time of the occurrence of the accident, no clear peak was observed, either for the month, day or time of day.

Alcohol was present in 4.9% of the neck sprain victims (mostly male). This percentage was statistically significantly smaller ($Z = 4.3$, $P < 0.01$) than the percentage (12.2%) of the other car accidents victims who had consumed alcohol and arrived at the hospital for treatment in the same period [13].

The majority of victims with neck sprain (92%) were treated as outpatients ($n = 642$), 52 victims (8%) were treated as inpatients (Table 4). The percentage of inpatients with neck sprain who also had other injuries (84%) is significantly greater than the percentage of outpatients diagnosed with both neck sprain and other injuries ($Z = 6.2$, $P < 0.01$).

Further analysis revealed that the proportion of inpatients with multiple injuries was statistically significantly greater than the proportion of outpatients with multiple injuries ($Z = 6.5$, $P < 0.01$). These results indicate that the severity of injury was significantly greater in inpatients than in outpatients.

The increase in the number of victims with neck sprain does not seem to be an isolated phenomenon, because during the last 25 years the use of cars and the average number of kilometres driven increased substantially. Table 5 shows a rise both in the number of cars and in the average number of kilometres driven, as well as an increase in the population. From 1980 to 1994, the average number of kilometres driven rose proportionally more (1.7-fold) than did the number of cars (1.3-fold).

Table 3 Average prevalence rates by age group of car accident victims diagnosed with neck sprain in Groningen per 100,000 inhabitants during the period 1970–1994 ($n = 694$)

Age group	Male	Female	Overall
0–4	0.9	0.0	0.5
5–9	0.0	1.0	0.5
10–14	5.1	5.4	5.2
15–19	15.2	21.2	18.2
20–24	26.6	27.6	27.1
25–29	29.7	26.7	28.3
30–34	26.6	20.7	23.7
35–39	23.6	28.0	25.8
40–44	25.1	30.8	27.9
45–49	21.4	23.4	22.5
50–54	8.9	22.5	16.0
55–59	13.9	16.2	15.1
60–64	14.9	7.1	10.6
65–69	8.5	4.2	6.0
70+	3.1	3.0	3.1
Overall	17.2	17.0	17.1

Table 4 Number of car accident victims diagnosed with neck sprain at the University Hospital Groningen during the period 1970–1994, according to the extent of injuries – single (neck sprain only) or multiple – and whether they were treated as inpatients or outpatients

Injury	Inpatients		Outpatients		Total	
	n	%	*n*	%	*n*	%
Single	10	20%	417	65%	427	62%
Multiple	42	80%	225	35%	267	38%

Table 5 Number of passenger cars, average number of kilometers driven and prevalence rates of cars (per 1000 inhabitants) in the Netherlands during the period 1970–1994

	1970	1975	1980	1985	1990	1994
No. of cars	2,465,000	3,399,000	4,515,000	4,901,000	5,509,000	5,884,000
Prevalence of cars	186	250	320	339	370	386
Average no. of kilometres per car[a]			15,180	15,220	16,080	16,300

[a] Source: Bovag 1995 [4]

Discussion

The results of the present study show that the number of car accident victims diagnosed with neck sprain increased markedly over the last 25 years. In general, there appears to be an increasing trend, not only at our hospital and not only in the Netherlands. As far as we know, no epidemiological studies have be conducted in the Netherlands on this subject. The results of our study are in agreement with findings from previous research [2, 7, 11, 17–20, 22, 25]. In our 25-year retrospective study on trends, we took into account changes in the composition of the population by employing prevalence rates. The advantage of presenting prevalence rates of neck sprain by age group is that it enabled us to pinpoint the groups at risk. The 25- to 29-year-old age group was shown to be the group at highest risk, followed by the age group 40–44 years old. In contrast, we found that by employing absolute numbers only, as in most research on neck sprain, only the 25- to 29-year-olds were identified as at high risk, whereas the age group 40–44 years was not identified as a group at risk. Therefore, we may conclude that prevalence rates by age group are to be preferred for identification of groups at risk. Although the male: female ratio fluctuated according to age group, neither male nor female predominance was observed for the total number of victims. Our results disagree with findings from previous research [2, 7, 11, 17–20, 22, 25], in which female predominance has been shown. A possible explanation for these different results may be attributed to different inclusion criteria both of age and category of patient. In previous research only persons in the age range of 18–55 years were included (Radanov-group [19–23]). Therefore, the male: female ratio is not easily comparable. The present study covered the whole life span, enabling us to show that 16% of the victims were excluded when the restrictive inclusion criteria of Radanov were employed. In addition, we included both inpatients and outpatients, whereas in previous studies no clear distinction was made. In order to compare our prevalence rates of neck sprain in the present study with the prevalence found by the Quebec Task Force, we need to take into consideration the difference between the data from the two studies. In the present study, the hospital-based registry of both inpatients and outpatients was used. The patients arrived at the Emmergency Room immediately after their car accident. The Quebec Task Force [25] investigated the amount of time taken off work by the patient with whiplash associated disorders (WAD) basing their information on claims lodged at the Quebec Automobile Insurance Society (SAAQ). The Task Force showed an increase in average duration of absence from 87 days to 108 days. In 1987 the prevalence was 70 per 100,000 in Quebec. In the same period we described a prevalence of 19.6 per 100,000 inhabitants in the catchment area of the University Hospital Groningen. A possible explanation for the difference in prevalence rates may be the so-called numerator-denominator problem. In our population, both denominator (number of inhabitants of the catchment area of the hospital over the whole life span) and numerator are different from the measures used by the Quebec Task Force (total number of car accident victims with neck sprain with driving licence and claimant at the SAAQ), as shown in the formula below:

$$\text{Prevalence}_{\text{Quebec}}: \frac{\text{total number of car accident victims with neck sprain with driving licence and claimant at the SAAQ } (\geq 16 \text{ year olds})^{a}}{\text{total number of persons with driving licence } (\geq 16 \text{ year old})}$$

[a] It remains unclear whether the victims were passengers or drivers

$$\text{Prevalence}_{\text{Groningen}}: \frac{\text{total number of car accident victims who arrived at the Emergency Room of the UHG (across the life span)}^{b}}{\text{total number of persons in the catchment area of the UHG (across the life span)}}$$

[b] Both passengers and drivers

Because we included victims of all ages, our data included 16% more victims than would have been the case had we looked only at those aged 16 years and more, as did the Quebec study. In spite of these discrepancies, both studies showed converging evidence: neck sprain has been increasing during the last few decades. Using parameters such as claimants on the insurance, average duration of absence from work and hospital-based registration may underestimate the extent of the phenomenon of neck sprain resulting from car accidents. The hospital-based registry does not include the whole spectrum of patients with neck sprain. Some patients will have gone to their general practitioner or will have failed to visit the physician at all after having neck complaints or headaches following a car accident. Similarly, the Quebec data may also underestimate the extent of the phenomenon, because not all persons with neck sprain are included; for example passengers, children under 16 and persons not insured at the SAAQ. Furthermore, not all car accident victims with neck sprain claim on their insurance. Notwithstanding, the possible underestimation of the extent of the phenomenon in both types of data, the results of both studies show an increase in neck sprain from car accidents. In addition, we showed that the majority of the victims were treated as outpatients (92%). It remains unclear whether outpatients as well as inpatients develop whiplash-associated disorders.

The increase in the number of victims with neck sprain (also called soft tissue injury) is ascribed to seat belt legislation by some researchers [1, 3, 24, 28]. Allen et al. [1]

described a decrease in almost all kinds of injuries resulting from car accidents immediately after the introduction of seat belt legislation, with the exception being soft tissue injuries of the chest and neck. Trinca [29] presented similar results in an Australian study: a decrease of 6% in head injuries and significant, 26%, increase in soft tissue injuries of the chest and neck. Apparently, the seat belt protects against serious injuries but not against neck sprain. Such a sudden change could have been expected in the Netherlands in 1975, when seat belt legislation was introduced. However, our research showed no sharp increase in neck sprain starting in 1975. A sharp increase was not observed until 1984. It would appear that wearing a seat belt at the time of the car accident is not the only factor to cause neck sprain. This finding was also reported by Galasko et al. [9], though the combination of factors involved remains unclear, as was reported by the Quebec Task Force [25].

We showed that the increase in prevalence rates of neck sprain over the period 1970–1994 was not an isolated phenomenon, but was closely related to other developments in society. The number of cars per inhabitant also rose in the same period. Above all, the average number of kilometres driven per car increased, implying an increase in the intensity of car use. This means an increase in the exposure time for accidents, so raising the probability of becoming involved in an accident. High-risk times could be expected to be at rush hour, in the evening and at the weekend (both exposure time and degree of participation increase by non-resident traffic) and winter months (bad weather conditions). However, our results did not show these predicted peaks of incidence of neck sprain associated with accidents.

Besides the increase in cars per inhabitant and average number of kilometres driven, there was a third factor, the media, that may have played an important role in the increase in this phenomenon. Over the last decade the media has paid a lot of attention to whiplash-associated disorders (WAD), both to their causes (car accidents) and their long-term consequences, which has made people aware of the potential impact of car accidents. Recently, it has been shown that the degree of general knowledge about WAD may affect the number of diagnosed cases of neck sprain. Schrader et al. [26] found that diagnosed cases of WAD were less common in newly independent Lithuania than in western countries. It appeared that in Lithuania there was little public awareness about WAD and its potential to cause disability. In addition, Lithuanian doctors were also less aware of WAD than were western doctors. Consequently, the expectation of symptom presentation and expectation of disability due to neck sprain were negligible. In general, we may conclude that the degree of knowledge about neck sprain (WAD) is an important factor in both patients' complaints and doctors' attitudes to its diagnosis. In summary, these three factors – degree of participation, exposure time and media effect – may have interacted to result in the observed increasing trend in neck sprain in car accident victims over the period 1970–1994.

It is reasonable to suppose that raising general awareness about the long-term consequences of neck complaints (neck sprain and WAD) may lead to an increase in the diagnosis of neck sprain not only in victims of car accidents, but also among those whose neck sprain has resulted from other types of accidents. To answer this question further research into trends in neck sprain due to causes other than car accidents is needed.

Acknowledgements This research was supported by a grant from the Ministry of Health, Welfare and Sports (VWS). The authors appreciate the help of Rob Bieringa in the date management.

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