

The association between exposure to a rear-end collision and future neck or shoulder pain: A cohort study

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Abstract

Neck pain is the most frequently reported feature in connection with whiplash injury, but it is also a common complaint in the general population. Therefore it is crucial to include an unexposed comparison group when evaluating the association between neck pain and a previous motor vehicle crash (MVC). To determine whether exposure to a rear-end collision, without or with whiplash injury, is associated with future neck or shoulder pain, a cohort study was conducted. The study population consisted of persons covered by traffic insurance at one of the largest insurance companies in Sweden. Claim reports were collected from the period November 1987 to April 1988. Drivers exposed to a rear-end collision were divided into two subgroups, without reported whiplash injury ($n = 204$) and with reported whiplash injury ($n = 232$). Two comparison groups, unexposed to MVCs, consisting of 1599 and 2089 persons, were selected with consideration taken to the age and gender distribution in the exposed subgroups. A questionnaire concerning neck or shoulder pain and other subjective health complaints was mailed to all the study subjects at follow-up in 1994, 7 years after the rear-end collision. The relative risk of neck or shoulder pain at follow-up was 1.3 (95% CI 0.8–2.0) in the exposed subjects without whiplash injury compared with the unexposed. The corresponding relative risk in subjects with whiplash injury was 2.7 (95% CI 2.1–3.5). We conclude that there is no increased risk of future neck or shoulder pain in drivers who did not report whiplash injury in connection with a rear-end collision 7 years earlier. In drivers with reported whiplash injury, the risk of neck or shoulder pain 7 years after the collision was increased nearly three-fold compared with that in unexposed subjects. © 2000 Elsevier Science Inc. All rights reserved.

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1. Introduction

Exposure to a motor vehicle crash (MVC) can result in a soft-tissue injury of the cervical spine which may be more likely to follow a rear-end collision [1–3]. The injury is commonly referred to as whiplash injury, and neck pain is the most frequently reported feature [4]. Neck pain constitutes a major health problem in the general population with a reported prevalence of 13.4–41.1% [5–9]. The casual relationship between neck pain and past exposure to an MVC is a controversial question [5,10], but to date only two studies have addressed this issue and used a design which includes an unexposed comparison group [11,12]. In those studies, performed in Lithuania, no significant difference regarding neck pain at follow-up was found between those exposed to a rear-end collision and an un-

exposed control group. However, the first study has been widely criticized and the reported results have been questioned [13–15]. The main criticisms have dealt with lack of power, as well as lack of subgroup analysis regarding initial whiplash injury. In our study we initially subdivided the exposed subjects into those who reported whiplash injury in connection with the collision, and those who did not. We also included a larger number of subjects with reported whiplash injury than in the Lithuanian studies.

The objective of the present study was to determine whether exposure to a rear-end collision, without or with whiplash injury, is associated with future neck or shoulder pain.

2. Methods

2.1. Design

A cohort design was used. The exposure under study was a rear-end collision, occurring during the 6-month period

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from November 1987 to April 1988. The outcome was the prevalence of neck or shoulder pain (referred to in the following as neck pain) during the preceding 3 months according to a mailed questionnaire at follow-up in 1994.

2.2 Subjects

The present study was based on subjects covered by traffic insurance at the Folksam Insurance Group (Folksam), one of the largest insurance companies in Sweden, with a 25% market share of traffic insurance. To receive financial compensation for property damage or bodily injury a claim report has to be presented. Claim reports are submitted to the insurance company in connection with an MVC, generally within a few days. The claim reports include injury- and crash-related information given by the car occupant. Claims with and without subsequent bodily injury, are administered at separate Folksam offices, located throughout Sweden.

The study population consisted of 4124 subjects and was selected from persons 18 to 65 years of age, who were living in Sweden and were covered by traffic insurance at Folksam. Claim reports for subjects involved in an MVC during the 6-month period were collected from the archives of the Folksam offices and analyzed with respect to impact direction and type of bodily injury. By examining the claim reports, subjects exposed to a rear-end collision could be identified. The exposed subjects were classified into two subgroups, without and with reported whiplash injury. Included were drivers exposed to a rear-end collision. Automobile was the vehicle type included as the struck car and this always referred to an occupied vehicle. Furthermore, comparison subjects unexposed to MVCs were selected.

2.2.1. Group 1: Exposed without whiplash injury

From a total of 31 Folksam offices where insurance claims without bodily injuries were settled, seven were chosen. The offices were selected from different regions, both urban and rural, throughout Sweden. All uninjured drivers who had been exposed to a rear-end collision during the 6-month period ($n = 204$) were identified from the claim reports at these seven offices. None of these drivers reported any type of bodily injury to the insurance company.

2.2.2. Group 2: Exposed with whiplash injury

This group was derived from all six Folksam offices where insurance claims with subsequent bodily injury were administered. The group consisted of all drivers who, during the 6-month period, had been exposed to a rear-end collision and had reported a whiplash injury to the insurance company in connection with the collision under study ($n = 232$). All subjects reported a soft-tissue injury to the neck without fracture or dislocation.

2.2.3. Unexposed comparison groups

These subjects were selected as a random sample from 382,000 persons who were covered by traffic insurance at Folksam throughout the whole study period from exposure to follow-up. According to the insurance database they had

not been involved in any MVC during the period of insurance by Folksam. They were selected with consideration taken to the age and gender distribution in the exposed subgroups. The comparison group consisted of 1599 subjects corresponding to group 1 and 2089 subjects corresponding to group 2.

2.3. Questionnaire

A questionnaire focusing on general health was mailed to all the study subjects at follow-up in 1994, 7 years after the rear-end collision. In the information enclosed with the questionnaire, no reference was made to the collision under study. This approach was taken to avoid the suggestion of neck pain to the subjects. In the 10-item questionnaire, questions were asked about different kinds of subjective health complaints, such as neck pain, over the last 3 months. Each item had four possible response alternatives: never, occasionally, often, and always. To make the questions easily understandable, the body regions of neck or shoulder, thoracic and low back areas were indicated on a body chart. The subjects were also asked if they had ever been involved in an MVC, as a driver or passenger, and if so, whether or not they had been injured. Because the questionnaire was designed without reference to the collision under study, the statement on past MVCs could refer to any MVC.

2.4. Statistics

The degree of neck pain at follow-up was dichotomized into two categories: neck pain absent, corresponding to the response alternative never or occasionally, and neck pain present, corresponding to the response alternative often or always.

The prevalence was calculated for the occurrence of neck pain in each subgroup. The relative risk of neck pain at follow-up in each exposed subgroup was calculated as the ratio of the prevalence among the exposed compared with the prevalence among the unexposed. In the estimation of prevalence and relative risk, the 95% confidence interval (CI) was calculated and based upon a normal distribution approximation of the binomial distribution.

The adjusted relative risk was calculated using the Mantel-Haenszel technique [16,17], when evaluating if confounding by age or gender was present in the groups compared. The 95% confidence interval (CI) was computed around the adjusted relative risk, using the variance according to Greenland and Robins and Robins *et al.* [18,19].

3. Results

After two written and one telephone reminder, a total of 3159 subjects answered the questionnaire, giving a total response rate of 77%. The response rate was 78% for the exposed group without whiplash injury and 79% for the exposed group with whiplash injury. The figures for the unexposed comparison groups were 76% and 77%, respec-

tively. Of the responding subjects in the unexposed comparison groups, 1602 subjects (57%) were excluded because of a previous MVC of some kind, both non-injury (47%) and injury producing (10%). According to the questionnaire at follow-up, 20 subjects in the exposed group without whiplash injury had been involved in a previous MVC causing bodily injury. One subject in the same exposure group and two subjects in the comparison group for the exposed subjects with whiplash injury missed the question on past MVC. These 23 subjects were excluded. A flow chart of the response procedure is shown in Fig. 1.

The prevalence of neck pain at follow-up within each exposed and unexposed group is presented in Fig. 2. Of the exposed subjects without whiplash injury 14.0% (95% CI 8.1–19.8) reported neck pain at follow-up according to the questionnaire and the figure for their unexposed comparison subjects was 11.1% (95% CI 8.4–13.9). The difference in prevalence between these groups was estimated to be 2.8% (95% CI –3.6 to 9.3). In the exposed group with whiplash injury 39.6% (95% CI 32.5–46.7) had neck pain at follow-up and the corresponding figure in their comparison group was 14.5% (95% CI 11.9–17.1). The difference in prevalence between the latter groups was 25.1% (95% CI 17.5–32.6).

The prevalence of neck pain at follow-up among the subjects excluded from the unexposed comparison groups (57%) was more or less the same as among those who remained; 11.9% vs. 11.1% regarding the comparison group for the exposed subjects without whiplash injury, and 14.5% vs. 14.5% regarding the comparison group for the exposed subjects with whiplash.

The crude relative risk of neck pain at follow-up was estimated to be 1.3 (95% CI 0.8–2.0) for exposed subjects without whiplash injury compared with the unexposed group. The corresponding figure for subjects with whiplash

injury was 2.7 (95% CI 2.1–3.5). The adjusted Mantel-Haenszel relative risks and the 95% confidence intervals equaled the calculated crude relative risks, indicating no confounding due to age or gender. The relative risks did not substantially differ with regard to age or gender, indicating that no effect modification was present due to these factors.

Results on the other subjective health complaints asked about in the questionnaire will be published separately.

4. Discussion

According to the results in this study, no increased risk of future neck or shoulder pain was found in drivers who did not report whiplash injury in connection with a rear-end collision 7 years earlier. In drivers who reported whiplash injury, a three-fold increased risk of future neck or shoulder pain was found at follow-up, 7 years after the collision.

Neck pain is the most frequently reported feature in connection with whiplash injury, but it is also a common complaint in the general population. Therefore it is crucial to include an unexposed comparison group when evaluating the association between an MVC and neck pain. An unexposed comparison group is intended to provide information about the proportion of neck pain that would be expected in the exposed groups if they were unexposed. Whiplash injury may be more likely to follow rear-end collisions but may also follow other impact directions [1–3]. This is why we selected comparison subjects who had never been involved in MVCs and consequently the proportion of neck pain in the unexposed groups may be explained by other factors (e.g., work related).

In contrast to the studies conducted in Lithuania [11,12], we made an initial distinction between the presence and absence of whiplash injury in our exposed groups. At follow-

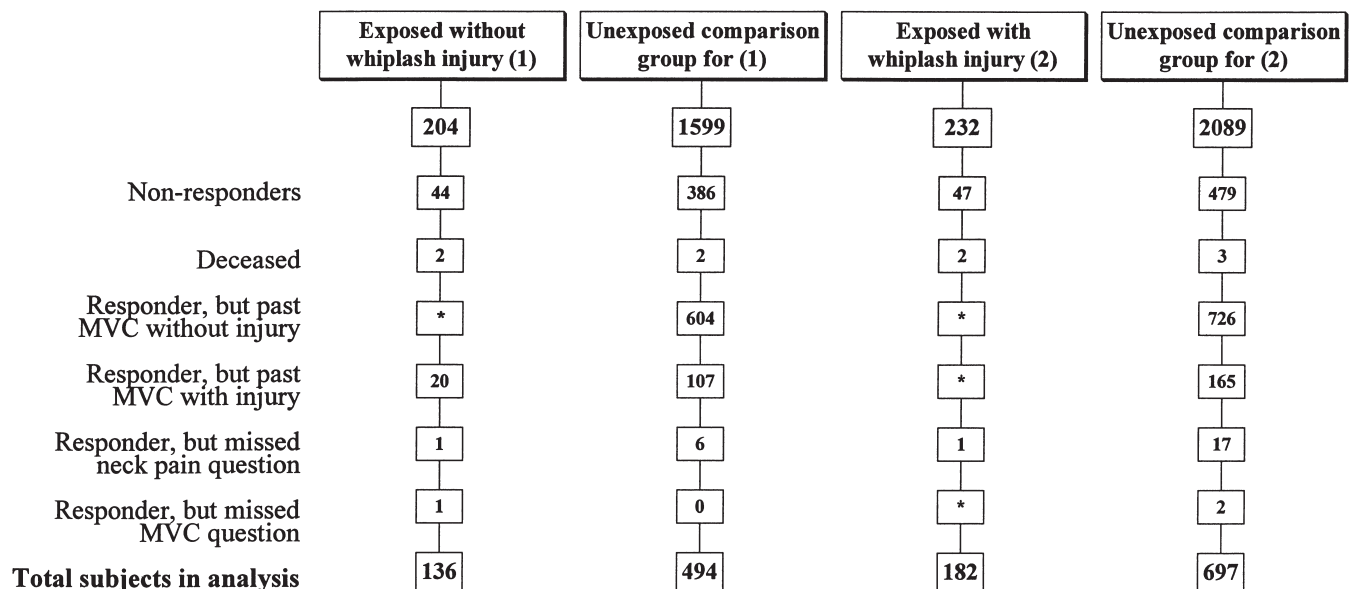


Fig. 1. Flow chart showing the number of subjects per response procedure. (* = Not relevant).

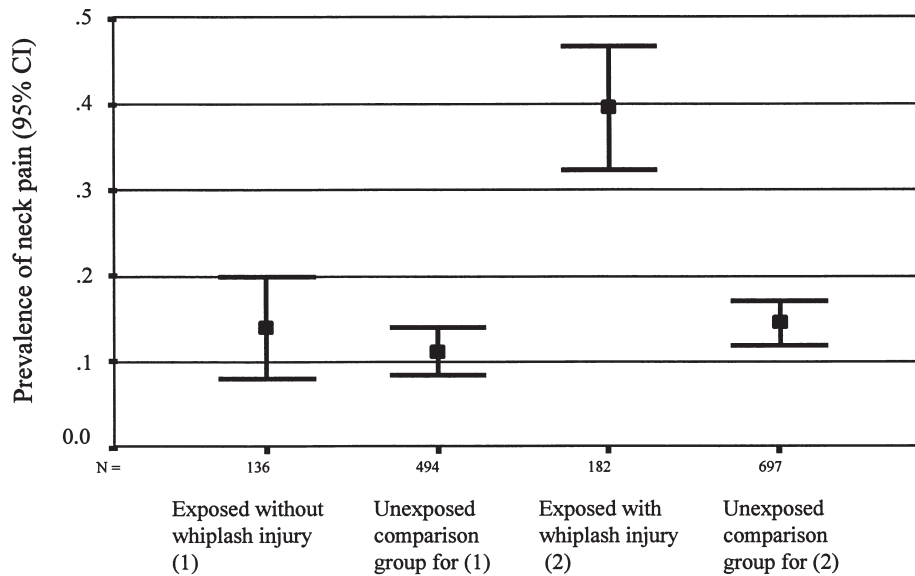


Fig. 2. Prevalence of neck pain in each exposed and unexposed group according to a mailed questionnaire completed 7 years after the rear-end collision.

up in the study by Schrader *et al.* [11], where no such distinction was made, only 31 of 202 exposed subjects remembered having had neck pain in connection with the collision. Considering that most persons with neck pain after MVCs have a relatively benign disorder that resolves itself within a short period, and that neck pain at follow-up most likely occurs among those who had initial neck pain, the absolute number, as well as the proportion of initially affected subjects among the exposed (31/202), is probably too small to detect an increased risk of neck pain 1–3 years after the exposure. These shortcomings also apply to the later Lithuanian study [12].

In the present study, selection bias will probably be of minor importance. Both exposed and unexposed subjects were recruited from the population of persons covered by traffic insurance at Folksam. The response rate was considered to be acceptable, and within the compared groups the nonresponders did not differ substantially with respect to age or gender. The selection of comparison subjects might introduce a “healthy driver effect” which could lead to a slight underestimation of the prevalence of neck pain among the unexposed (e.g., some subjects might have stopped driving a car for health reasons). We chose to include comparison subjects who were covered by traffic insurance at the same insurance company (Folksam) throughout the whole study period. This enabled us to keep track of exposure to verified MVCs through the Folksam insurance. Furthermore, data was obtained from the questionnaires at follow-up, which gave information on MVCs other than those covered by Folksam. The comparison subjects excluded because of previous MVCs did not differ from those who were included regarding the prevalence of neck pain.

The most obvious potential confounding factors in our opinion are age, gender, and previous neck pain. No con-

founding from age or gender was found when examined by means of stratified analysis. As regards previous neck pain, we had no information on this; questions about this issue were not asked in the questionnaire, as this would have necessitated mentioning the collision under study. Potential recall bias might then have arisen, because exposed individuals with whiplash injury in connection with the collision probably under-reported neck pain prior to the MVC to some extent (because of potential compensation associated with insurance claims). To be a confounder, the variable must be associated with the exposure under study in the source population and, independent of that exposure, be a risk factor for the disease under study. If neck pain prior to the exposure under study is truly positively associated with this exposure, the observed relative risk may then be an overestimate. There is no reason to believe, however, that individuals with neck pain are more liable to rear-end collisions than others. Consequently, we do not consider neck pain prior to the rear-end collision to be a confounding factor in that sense. For a discussion of neck pain as a confounding factor, as a consequence of misclassification of whiplash injury, see below. To our knowledge there is no reason to believe that factors other than age, gender, and prior neck pain should be considered for potential confounding. Nevertheless, there is a possibility that subjects who are involved in MVCs differ in some respects (for instance in lifestyle factors) from those who are not. If such factors also are causes for subsequent neck pain, then our results can be biased.

It has been debated whether an acute whiplash injury can result in chronic symptoms [10–12], and whether persistent neck pain and associated disorders after a whiplash injury can be related to certain psychological and social factors. Conclusions in the literature seem to agree that these factors

are a consequence rather than a cause of chronic pain [20–23]. However, theoretically, if subjects who report whiplash injuries for psychological reasons also were more inclined to report neck pain at follow-up than others, then the observed relative risk would be overestimated. The literature in this area is sparse, but in an epidemiological study of musculoskeletal disorders the rating behavior was studied in subjects who rated both exposure and outcome. No evidence was found for the existence of a systematic high and low rating behavior, and consequently no bias with regard to relative risk due to rating behavior is introduced [24].

The exposure classification concerning the MVC in this study can be regarded as satisfactory. Information on exposure was obtained from two different sources. Primarily, from the claim reports, which identified MVCs covered by traffic insurance at Folksam. Secondly, information was obtained from the questionnaires at follow-up, which gave information on MVCs other than those covered by Folksam. Subjects were excluded according to the flow chart in Fig. 1.

The classification regarding whiplash injury reported in connection with the collision may not be perfect. Some subjects in the exposed group without whiplash injury might have had neck pain in connection with the rear-end collision, but omitted to make a claim to the insurance company. This may lead to an overestimation of the relative risk of future neck pain in the group. Besides experiencing “true” neck pain, subjects in the exposed group with whiplash injury might either have simulated or had previous neck pain that was reported as a new condition. In the latter case prior neck pain could act as a confounding factor. Malingering would lead to a bias toward the null value and already existing neck pain reported as a whiplash injury could potentially bias the observed relative risk away from the null value. Information about previous neck pain was not available for the exposed subjects included in the study. Of the unexposed groups in the present study 11.1% and 14.5%, respectively, reported neck pain. Approximately the same proportion would be expected in the exposed subgroups prior to the rear-end collision (which is the rationale for using the comparison groups). It is not likely that the excess risk observed in the exposed subgroup with whiplash injury is explained entirely by previous neck pain. If so, a great proportion of the exposed group with whiplash injury would have to have had neck pain prior to the collision under study, and the relative risk of neck pain after 7 years for those with neck pain compared to those without, would have to be quite high. Assuming that this relative risk is 4, then the proportion of subjects with pre-existing neck pain would have to have been 57% to explain entirely the observed excess risk.

If previous neck pain is not considered a confounding factor, it may act as an effect modifier for future neck pain, meaning that subjects with pre-existing neck disorder are more vulnerable. The evidence in the literature is sparse concerning the association between neck pain prior to an MVC and future complaint. Further prospective studies are needed to address this issue.

The mass media has given substantial coverage to whiplash injuries. For this reason the study information enclosed with the questionnaire did not refer to the exposure under study. Also, the questions did not concern neck pain alone, but different subjective health complaints. One potential source of misclassification of the outcome was thus considered. The method of measuring the outcome with a self-report questionnaire may have different degrees of validity. It is not likely that exposed subjects with whiplash injury would over-report their neck complaints at follow-up, 7 years after the collision, as practically all compensation claims are settled within a few years after the MVC, generally within 1–3 years. Secondary gain due to having neck pain can occur for reasons other than compensation. But in our opinion this potential over-reporting would be evenly distributed among the groups. The potential misclassification of the outcome is thus likely to be non-differentially distributed among the exposed and unexposed subjects, and the observed relative risk will probably be unbiased or biased toward the null value. Taking methodological considerations into account, the obtained results are likely to be real and not due to bias.

We found that 39.6% of the subjects with whiplash injury in connection with the rear-end collision reported neck pain at follow-up, compared with 14.5% of the unexposed comparison subjects. The difference of 25.1% can most likely be attributed to the rear-end collision. The figures reported in the available whiplash literature on prognosis vary considerably. Hildingsson and Toolanen [2] reported that 29% of their subjects complained of neck pain 2 years, on average, after an MVC. Norris and Watt [25] found that 66% of their subjects still suffered from neck pain approximately 2 years after a rear-end collision. In the study by Radanov *et al.* [26], 24% had persistent injury-related symptoms after 1 year and 18% after 2 years. Borchgrevink and colleagues [27] noted that 58% reported chronic symptoms as a result of an MVC at least two and a half years earlier.

Neck pain is a frequent complaint in the general population and may be explained by many different factors. Therefore it is crucial to include an unexposed comparison group, when evaluating the association between an MVC and future neck pain. Such a design was used in this study and no increased risk of future neck pain was found if whiplash injury was not reported in connection with the collision. The potential clinical implications of the results are of major importance. Given that our observations are true, health care professionals should inform persons seeking medical care due to an MVC that there is no increased risk of future neck pain because of the MVC if whiplash injury was not reported in connection with the rear-end collision.

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