

The association between exposure to a rear-end collision and future health complaints

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Abstract

Different symptoms, together with neck pain, have been attributed to persons with persistent complaints after a previous motor vehicle crash (MVC) and are sometimes referred to as the “late whiplash syndrome.” A cohort study was conducted to determine whether exposure to a rear-end collision, with or without whiplash injury, is associated with future health complaints. The results regarding future neck or shoulder pain have previously been described, and the objective of the present report was to focus on outcomes other than neck pain. Included in the study were persons 18 to 65 years of age and 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: those with reported whiplash injury ($n = 232$) and those without reported whiplash injury ($n = 204$). For comparison, 3688 subjects who were unexposed to MVCs were selected, with consideration taken to the age and gender distribution in the exposed subgroups. The prevalence of different health complaints among the study subjects was estimated according to a mailed questionnaire at follow-up in 1994, 7 years after the rear-end collision. When exposed subjects with whiplash injury were compared to unexposed subjects, increased relative risks in the range of 1.6–3.7 were seen for headache, thoracic and low back pain, as well as for fatigue, sleep disturbances and ill health. No corresponding increased risks were found among the exposed subjects without reported whiplash injury. We conclude that rear-end collisions resulting in reported whiplash injuries seem to have a substantial impact on health complaints, even a long time after the collision. There is a need to identify factors that predict a non-favorable outcome in order to improve clinical management. © 2001 Elsevier Science Inc. All rights reserved.

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1. Introduction

Soft-tissue injuries of the cervical spine, generally named whiplash injuries, are a common result of motor vehicle crashes (MVCs). Objective findings are commonly not present and the diagnosis is then often based on subjective complaints. In addition to neck pain, which is the most frequently reported initial feature due to whiplash injury, various other symptoms may also be present [1]. Headache has been mentioned as being a frequent acute symptom, and other complaints such as back pain, fatigue and sleep disturbances have been reported in different magnitudes in connection with MVCs [2–4]. The figures published on the prognosis after a whiplash injury vary remarkable [3,5–7].

It is even questioned whether the injury can cause chronic symptoms [8–10]. In follow-up studies, persistent health complaints such as neck pain, headache, fatigue and other symptoms have been described [1]. A collection of concomitant persistent symptoms is sometimes referred to as the “late whiplash syndrome,” originally described by Balla [11]. Although commonly discussed there is no precise definition [10], but it is suggested that neck pain, headache and depression are symptoms that should be included. Different health complaints are also frequently reported in the general population [12], and consequently it is necessary to include an unexposed comparison group when assessing persistent complaints after an MVC. Such a design was used in the present cohort study and the results regarding future neck or shoulder pain have previously been reported [13].

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

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2. Methods

2.1. Design

In the present study a cohort design was applied. The exposure was a rear-end collision, occurring during November 1987 through April 1988. The outcome was the prevalence of different health complaints during the preceding 3 months according to a mailed questionnaire at follow-up in 1994.

2.2. Subjects

Included were 4124 subjects, who were selected from persons 18 to 65 years of age, living in Sweden and covered by traffic insurance at the Folksam Insurance Group (Folksam), one of the largest insurance companies in Sweden. The subjects were identified through the insurance database in which claims due to MVCs are registered. To receive financial compensation for property damage or bodily injury, a claim report has to be presented and submitted to the insurance company in connection with an MVC. Generally this is carried out within a few days, and in the present study 95% of the claim reports were sent in within a week after the MVC. They were later collected from the archives of the insurance company offices and analyzed to define the collision impact and the bodily injury stated by the subject. The injuries were classified according to the 1985 revision of the Abbreviated Injury Scale (AIS) [14]. This is a six-point, 1 to 6, "threat to life" scale where level "1" specifies a minor injury and level "6" a maximum injury. A part of the code gives the injury location. The injuries were hand-coded by an experienced, trained coder. The exposed subjects who were included in the study were drivers in automobiles involved in rear-end collisions. They were divided into two subgroups: exposed with and without whiplash injury, respectively. For comparison, subjects unexposed to MVCs were selected.

2.2.1. Exposed with whiplash injury

This group was derived from all Folksam offices administering insurance claims where a bodily injury was present. Of all drivers ($n = 272$) who had been exposed to a rear-end collision and had reported a bodily injury to the insurance company during the 6-month period November 1987 to April 1988, four subjects were coded as having a moderate injury (AIS 2) and one subject as having a serious injury (AIS 3). All others were classified as having minor injuries (AIS 1). According to the Abbreviated Injury Scale, a whiplash injury (i.e., a soft-tissue injury to the neck without fracture or dislocation) was classified as a minor injury (AIS 1).

Of the 272 drivers, 232 reported a whiplash injury, and of these, 157 (68%) subjects reported a whiplash injury alone and 75 (32%) a whiplash injury together with one or more other injuries. Of the 75 subjects who also reported other injuries, all except one (who was coded as having a moderate injury; i.e., contusion to lower extremity) were coded as having minor injuries (AIS 1). Forty-six of them

reported an injury to the lumbar spine (AIS 1) and this was the most common injury reported together with whiplash injury. The second most common injury reported together with whiplash injury was an injury to the skull/brain. Twelve subjects reported this injury, of whom 11 were coded as having minor injuries and one as having a moderate injury. Injuries other than those to the lumbar spine or to the skull/brain reported together with whiplash injury were few in number and spread over the body regions.

The exposed group with whiplash injury thus comprised all drivers who, during the 6-month period, had been exposed to a rear-end collision and had reported a whiplash injury (alone or together with other injuries) to the insurance company ($n = 232$).

2.2.2. Exposed without whiplash injury

The group was recruited from seven of the 31 Folksam offices that settled insurance claims without bodily injuries. The offices were selected from different regions, both urban and rural, throughout Sweden. Those who were recruited were all uninjured drivers who had been involved in a rear-end collision during the 6-month period ($n = 204$).

2.2.3. Unexposed comparison group

The 3688 unexposed subjects were covered by traffic insurance at Folksam throughout the whole study period from November 1987 to follow-up, 7 years later. According to the insurance files the subjects were unexposed to MVCs during this period. The comparison subjects were randomly selected from 382,000 eligible subjects in the insurance database and were chosen with consideration taken to the age and gender distribution in the exposed subgroups.

2.3. Questionnaire

A postal questionnaire concerning overall health complaints was sent to all the study subjects, and to avoid biased answers the rear-end collision under study was not referred to. The 10-item questionnaire concerned general health, fatigue, depressive mode, sleep disturbance and headache, as well as pain or ache in the neck or shoulder, thoracic spine, low back area and stomach during the preceding 3 months. Possible response alternatives on general health were "good," "acceptable," "not too good" and "poor." The four response alternatives on the other eight health complaints asked about were "never," "occasionally," "often" and "always." To make the questions easily understandable the neck or shoulder regions and the thoracic and low back areas were indicated on a body chart. A question about past history of MVCs, with or without bodily injury, was also included.

2.4. Statistics

In the analysis of general health the answers were dichotomized: good health if the response category was "good" or "acceptable," and ill health if the response category was "not too good" or "poor." The seven other complaints of in-

terest were also dichotomized into two categories: symptoms absent, equivalent to the response category “never” or “occasionally,” and symptoms present, equivalent to the response category “often” or “always.”

The prevalence together with the 95% confidence interval (CI) of different health complaints at follow-up was calculated in each group. The age- and gender-adjusted relative risk of health complaints at follow-up was calculated for subjects in each exposed subgroup as compared with unexposed subjects, using the Mantel–Haenszel technique [15,16]. In the estimation of relative risk, the 95% as well as the 99% confidence interval (CI) was calculated and based upon a normal distribution approximation of the binomial distribution.

3. Results

Of the 4124 study subjects, a total of 3159 answered the questionnaire, giving an overall response rate of 77%. The response rate was 79% for the subjects with whiplash injury, 78% for the exposed subjects without whiplash injury and 77% for the unexposed subjects. Non-responders were similar to responders, with regard to age and gender in the different groups. In the unexposed comparison group, 1602 responding subjects (57%) were excluded because they reported involvement in a previous MVC of some kind, both non-injury (47%) and injury producing (10%). Of the exposed subjects without whiplash injury, 20 stated in the questionnaire at follow-up that they had been involved in a previous MVC causing bodily injury. Three subjects, one in the group without whiplash injury and two in the comparison group did not answer the question on past MVCs. These 23 subjects were also excluded.

Table 1 displays the prevalence of reported health complaints at follow-up, 7 years after the rear-end collision. The number of subjects with each complaint is shown, as well as the total numbers in each group. The prevalence of self-reported health complaints is consistently higher among the exposed subjects with whiplash injury compared with the unexposed, whereas there are no significant differences in

prevalence between the exposed subjects without whiplash injury and the unexposed comparison subjects.

The prevalence of the different health complaints at follow-up among the subjects excluded from the unexposed comparison group due to a previous MVC (57%) was more or less the same as among those who remained.

The crude and adjusted relative risks of having different health complaints at follow-up are presented in Table 2. Exposed subjects with and without whiplash injury, respectively, are compared with unexposed subjects at follow-up after 7 years. The crude and adjusted relative risks generally did not differ, indicating that there was no confounding from age or gender. In the exposed group with whiplash injury the relative risks were increased for headache, thoracic and low back pain, as well as for fatigue, sleep disturbances and ill health, but not for stomachache and depressive mode. When the 99% confidence intervals for the relative risks were calculated, all relationships were still significant, except for fatigue. None of the age- and gender-specific relative risks differed substantially, indicating that no effect modification was present due to these factors.

For subjects without whiplash injury the relative risks were not increased regarding any of the studied outcomes.

Of the 183 subjects who were included in the analysis, 32 also reported injuries to the lumbar spine (AIS 1) in connection with the MVC. The age- and gender-adjusted relative risk of future low back pain among subjects who together with whiplash injury also reported an injury to the lumbar spine was 2.9 (95% CI 1.6–5.2). The corresponding relative risk for subjects without reported lumbar spine injury together with whiplash injury was 1.5 (95% CI 1.1–2.2). Of the 183 subjects who were included in the analysis, six were classified as having a minor skull injury (AIS 1) together with whiplash injury in connection with the MVC. We excluded these six subjects, re-analyzed the outcomes, but the results did not differ from before.

Four subjects in the exposed group with whiplash injury reported the collection of symptoms suggested for inclusion in the “late whiplash syndrome” (i.e., neck pain, headache and depressive mode). One subject, belonging to the com-

Table 1

Prevalence of different health complaints over the last 3 months, according to a mailed questionnaire, together with the 95% confidence interval (CI).^a

Complaint	Prevalence (95% CI) ^b								
	Exposed with whiplash injury			Exposed without whiplash injury			Unexposed comparison group		
	%	(95% CI)	No.	%	(95% CI)	No.	%	(95% CI)	No.
Headache	22.5	(16.7–29.3)	41/182	7.4	(3.6–13.1)	10/136	5.1	(3.9–6.5)	61/1190
Thoracic pain	15.3	(10.4–21.5)	27/176	6.7	(3.1–12.3)	9/135	4.4	(3.3–5.8)	52/1173
Low back pain	20.3	(14.7–27.0)	36/177	10.4	(5.8–16.8)	14/135	11.8	(10.0–13.8)	139/1179
Ill health	17.9	(12.5–24.5)	31/173	4.4	(1.6–9.4)	6/135	5.4	(4.2–6.9)	64/1177
Sleep disturbance	12.4	(8.0–18.2)	22/177	4.4	(1.6–9.4)	6/136	5.6	(4.4–7.1)	67/1187
Stomachache	4.0	(1.6–8.1)	7/174	1.5	(0.2–5.3)	2/134	1.9	(1.2–2.8)	22/1172
Fatigue	15.5	(10.5–21.6)	28/181	6.0	(2.6–11.5)	8/133	9.1	(7.5–10.9)	108/1184
Depressive mode	6.2	(3.1–10.8)	11/177	2.2	(0.5–6.4)	3/135	3.8	(2.8–5.1)	45/1182

^aNumber of subjects with each complaint and total number of subjects in each group are displayed. Different totals are due to number of responders on each question.

^bBinomial exact.

Table 2

Relative risks (RR) together with 95% confidence intervals (CI) of future health complaints for subjects exposed to a rear-end collision, with and without whiplash injury, compared with unexposed subjects.

Complaint	Exposed with whiplash injury/Unexposed comparison group		Exposed without whiplash injury/Unexposed comparison group	
	Crude RR (95% CI)	Adjusted ^a RR (95% CI)	Crude RR (95% CI)	Adjusted ^a RR (95% CI)
Headache	4.4 (3.1–6.3)	3.7 (2.6–5.3)	1.4 (0.8–2.7)	1.4 (0.7–2.8)
Thoracic pain	3.5 (2.2–5.4)	3.1 (2.0–4.8)	1.5 (0.8–3.0)	1.7 (0.8–3.5)
Low back pain	1.7 (1.2–2.4)	1.7 (1.3–2.4)	0.9 (0.5–1.5)	0.9 (0.5–1.6)
Ill health	3.3 (2.2–4.9)	3.3 (2.2–5.0)	0.8 (0.4–1.9)	0.9 (0.4–2.1)
Sleep disturbance	2.2 (1.4–3.5)	2.4 (1.5–3.9)	0.8 (0.3–1.8)	0.8 (0.4–1.9)
Stomachache	2.1 (0.9–4.9)	1.9 (0.8–4.4)	0.8 (0.2–3.3)	0.7 (0.2–2.9)
Fatigue	1.7 (1.2–2.5)	1.6 (1.1–2.3)	0.7 (0.3–1.3)	0.7 (0.3–1.4)
Depressive mode	1.6 (0.9–3.1)	1.6 (0.8–3.0)	0.6 (0.2–1.9)	0.6 (0.2–2.2)

^aAdjusted for age and gender.

parison group, reported all of the subjective health complaints asked about in the questionnaire.

4. Discussion

According to the results in the present report there was no association between exposure to a rear-end collision and any of the eight outcomes studied, if whiplash injury had not been reported in connection with a rear-end collision 7 years earlier. When, on the other hand, exposed subjects with reported whiplash injury were compared to unexposed comparison subjects, increased risks were seen for headache, thoracic and low back pain, as well as for fatigue, sleep disturbances and ill health, but not for stomachache and depressive mode.

The results regarding the association between exposure to a rear-end collision and future neck or shoulder pain in the present cohort have previously been reported [13]. The relative risk of neck or shoulder pain at follow-up was 2.7 (95% CI 2.1–3.5) in exposed subjects with reported whiplash injury compared with unexposed subjects. The corresponding relative risk in exposed subjects without reported whiplash injury was 1.3 (95% CI 0.8–2.0).

Only four subjects with reported whiplash injury experienced the collection of persistent symptoms said to be included in the “late whiplash syndrome” (i.e., neck pain, headache and depressive mode). One single subject, belonging to the comparison group, reported all the health complaints asked about in the questionnaire at follow-up. It is possible that earlier descriptions in the literature of the “late whiplash syndrome” are too limited or too imprecise, and different combinations of persistent complaints may exist, such as neck pain alone, neck pain together with headache or thoracic pain, or other constellations. Thus, it seems inappropriate to consider long-term consequences due to whiplash injuries as a syndrome, since the meaning of the expression is a group of symptoms and other changes in the body’s function which, when taken together, show that a particular disease is present.

It has been questioned whether chronic symptoms (i.e., symptoms continuing 6 months or more after a collision) can be related to certain psychological and social factors. The evidence in the literature seems to be concordant, that these factors are secondary to chronic pain [17–20]. The effect of neurosurgical treatment on psychological distress was studied among patients with chronic whiplash-associated neck pain, and the pre-operative psychological distress resolved in all patients who became pain-free [21]. Similar psychological profiles have been found in patients with chronic neck pain after whiplash injuries, and in patients suffering from other musculoskeletal disorders [22]. However, theoretically, if subjects who report whiplash injuries for psychological reasons also were more inclined to report complaints at follow-up than others do, then the observed relative risks 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 was observed [23].

Health complaints are frequently reported in the general population. The prevalence of subjective health complaints was evaluated in the general population in four Nordic countries: Denmark, Finland, Norway and Sweden [12]. The prevalence of substantial complaints regarding low back and upper back pain was 14% and 9%, respectively. The figure for neck pain was 12%, and for depressive mode and headache 7%. In a Norwegian population-based study, 6.0% of males and 13.1% of females reported headache weekly or more often [24]. Symptom prevalence over the last 4 weeks was assessed in a health survey performed in Switzerland, and among the different symptoms asked about in the questionnaire, back pain was reported by 9.6%, fatigue by 8.1% and abdominal pain by 2.7% [25]. Self-evaluated health was measured in a questionnaire-based population study performed in Norway, and 2.9% of males and 2.8% of females reported poor health [26]. An association was found between reduced self-reported health and

neck/shoulder pain as well as low back pain. The magnitude of symptoms reported in the literature corresponds roughly to those in the present report, with the exception of the prevalence reported by the exposed subjects with whiplash injury, where the figures were consistently higher.

Different potential systematic errors and their implications on the observed result have previously been debated when reporting on future neck or shoulder pain [13], and the same principles are also relevant in the present report when focusing on other outcomes. Selection bias is most probably of a limited extent. All study subjects, both exposed and unexposed, were taken from the population of persons covered by traffic insurance at Folksam. The response rate was of the same magnitude in the different groups, and the non-responders did not differ substantially among the compared groups with respect to age or gender. The selection of comparison subjects might have introduced 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 due to illness).

It is possible that subjects in the exposed group with whiplash injury had been exposed to MVCs other than the collision under study. Because the questionnaire was designed without reference to the MVC of interest (to avoid biased answers), the statement on past MVCs could refer to any MVC. Consequently, if any exposed subjects with whiplash injury had been involved in previous MVCs, it was not possible to exclude them. The prevalence of neck or shoulder pain [13] and other health complaints reported at follow-up was approximately the same among the comparison subjects excluded because of previous MVCs and those who were included. Hence, since a previous MVC is not related to the outcomes here in question, it is not probable that involvement in preceding MVCs seriously biases the effect estimates in our study.

To our knowledge there is no reason to believe that factors other than age, gender and different pre-existing complaints should be considered for potential confounding. No confounding from age or gender was found, when examined by means of stratified analysis. As regards previous complaints such as neck pain and headache, etc., it is not probable that individuals with these symptoms are more liable to rear-end collisions than others are. Thus, we do not consider pre-existing disorders to be a potential confounding factor. For a discussion of neck pain as a confounding factor, as a consequence of misclassification of whiplash injury, see below. However, it is possible that subjects with various health complaints prior to the rear-end collision are more vulnerable. If this is the case, these symptoms may act as an effect modifier for future neck pain, as well as for other health complaints. The present understanding of this issue is limited and further studies are needed. Subjects exposed to MVCs may differ from unexposed subjects with respect to lifestyle factors. If such factors also are associated with different health complaints, then there is a possibility that our results can be biased.

There might have been subjects in the exposed group without whiplash injury, who actually experienced neck pain due to the rear-end collision, but did not make a claim. Neck pain is shown to be associated with headache [24] and most likely also with thoracic pain, although to our knowledge this is not shown in the literature. This potential misclassification regarding whiplash injury may lead to an overestimation of the relative risk of headache and thoracic pain in this group. In the exposed group with whiplash injury a misclassification might have been introduced. The subjects in this group either suffered a “true” whiplash injury, simulated or actually had pre-existing neck pain that continued but reported it as a new condition. However, it is not likely that the excess risks observed in the exposed subgroup with whiplash injury, regarding the outcomes focused on in the present report, are entirely explained by previous neck pain or other symptoms. The potential impact of pre-existing neck pain on future neck pain has been estimated previously [13]. It was found that the proportion of subjects with prior neck pain would have to have been unrealistically high (57%) to entirely explain the observed excess risk of future neck pain.

The “problem” of multiple comparisons has been widely debated in the epidemiological literature [27]. This has led to a better understanding of the meaning of the confidence interval. Even if we use a perfectly valid 95% confidence-interval method, we should expect some of the intervals to miss their target. Therefore, before making a “final” conclusion, *a priori* knowledge regarding the relationship in question also has to be taken into consideration. If a 95% “confidence” is felt to be too low, one alternative is to increase the degree of “confidence” [28]. When we calculated the 99% confidence intervals for the relative risks in question, all relationships were still significant, except for fatigue.

Different health complaints are frequently reported in the general population and in consequence it is necessary to include an unexposed comparison group, when assessing persistent complaints after a motor vehicle crash. According to the present results, subjects who reported a whiplash injury in connection with a rear-end collision 7 years earlier not only had an increased risk of future neck pain, but also an increased risk of other health complaints compared with an unexposed group. These additional complaints included headache, thoracic and low back pain as well as fatigue, sleep disturbances and ill health with relative risks in the order of 1.6–3.7. We conclude that rear-end collisions resulting in reported whiplash injuries seem to have a substantial impact on health complaints even a long time after the collision. There is a need to identify factors that predict a non-favorable outcome in order to improve clinical management.

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