SPINE Volume 33, Number 4S, pp S39–S51

The Burden and Determinants of Neck Pain in the General Population

Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders

Sheilah Hogg-Johnson, PhD,* Gabrielle van der Velde, DC,† Linda J. Carroll, PhD,‡ Lena W. Holm, DrMedSc,§ J. David Cassidy, DC, PhD,¶ Jaime Guzman, MD, MSc, FRCP(C),‖ Pierre Côté, DC, PhD,** Scott Haldeman, DC, MD, PhD,†† Carlo Ammendolia, DC, PhD,‡‡ Eugene Carragee, MD, FACS,§§ Eric Hurwitz, DC, PhD,¶¶ Margareta Nordin, PT, DrMedSc,|||| and Paul Peloso, MD, MSc,FRCP(C)***

Study Design. Best evidence synthesis.

Objective. To undertake a best evidence synthesis of the published evidence on the burden and determinants of neck pain and its associated disorders in the general population.

Summary of Background Data. The evidence on burden and determinants of neck has not previously been summarized.

Methods. The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders performed a systematic search and critical review of literature published between 1980 and 2006 to assemble the best evidence on neck pain. Studies meeting criteria for scientific validity were included in a best evidence synthesis.

Results. We identified 469 studies on burden and determinants of neck pain, and judged 249 to be scientifically admissible; 101 articles related to the burden and determinants of neck pain in the general population. Incidence ranged from 0.055 per 1000 person years (disc herniation with radiculopathy) to 213 per 1000 persons (self-reported neck pain). Incidence of neck injuries during competitive sports ranged from 0.02 to 21 per 1000 exposures. The 12-month prevalence of pain typically ranged between 30% and 50%; the 12-month prevalence of activity-limiting pain was 1.7% to 11.5%. Neck pain was more prevalent among women and prevalence peaked in middle age. Risk factors for neck pain included genetics, poor psychological health, and exposure to tobacco. Disc degeneration was not identified as a risk factor. The use of sporting gear (helmets, face shields) to prevent other types of injury was not associated with increased neck injuries in bicycling, hockey, or skiing.

Conclusion. Neck pain is common. Nonmodifiable risk factors for neck pain included age, gender, and genetics. Modifiable factors included smoking, exposure to tobacco, and psychological health. Disc degeneration was not identified as a risk factor. Future research should concentrate on longitudinal designs exploring preventive strategies and modifiable risk factors for neck pain.

Key words: neck pain, epidemiology, incidence, prevalence, risk factors, associated factors. **Spine 2008;33: S39–S51**

From the *Institute for Work and Health, Toronto, Canada; and Department of Public Health Sciences, University of Toronto, Toronto, Canada; †Institute for Work and Health, Toronto, Canada; Department of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada; Division of Health Care and Outcomes Research, Toronto Western Research Institute, Toronto, Canada; Centre of Research Expertise in Improved Disability Outcomes (CREIDO), University Health Network Rehabilitation Solutions, Toronto Western Hospital, Toronto, Canada; ‡Department of Public Health Sciences, and the Alberta Centre for Injury Control and Research, School of Public Health, University of Alberta, Edmonton, Alberta, Canada; §Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden; ¶Centre of Research Expertise in Improved Disability Outcomes (CREIDO), University Health Network Rehabilitation Solutions, Toronto Western Hospital, Toronto, Canada; Division of Health Care and Outcomes Research, Toronto Western Research Institute, Toronto, Canada; Departments of Public Health Sciences and Health Policy, Management and Evaluation, University of Toronto, Canada; ‖Department of Medicine, University of British Columbia, Canada; Occupational Health and Safety Agency for Healthcare in British Columbia, Canada; **Centre of Research Expertise in Improved Disability Outcomes (CREIDO), University Health Network Rehabilitation Solutions, Toronto Western Hospital, Toronto, Canada; Departments of Public Health Sciences and Health Policy, Management and Evaluation, University of Toronto, Canada; Division of Health Care and Outcomes Research, Toronto Western Research Institute, Toronto, Canada; Institute for Work & Health, Toronto, Canada; ††Department of Neurology, University of California, Irvine; Department of Epidemiology, School of Public Health, University of California, Los Angeles, California; ‡‡Division of Health Care and Outcomes Research, Toronto Western Research Institute; Centre for Research Expertise in Improved Disability Outcomes (CREIDO), University Health Network, Toronto, Canada; Department of Health Policy, Management and Evaluation, University of Toronto, Canada; §§Department of Orthopedic Surgery, Stanford University School of Medicine; Orthopedic Spine Center and Spinal Surgery Service, Stanford University Hospital and Clinics, Stanford; ¶¶Department of Public Health Sciences, John A. Burns School of Medicine, University of Hawaii at Mānoa, Honolulu, Hawaii; ||||Departments of Orthopedics and Environmental Medicine and Program of Ergonomics and Biomechanics, School of Medicine and Graduate School of Arts and Science, New York University; Occupational and Industrial Orthopedic Center (OIOC), New York University Medical Center, New York; and ***Endocrinology, Analgesia and Inflammation, Merck & Co., Rahway, New Jersey.

The device(s)/drug(s) is/are FDA-approved or approved by corresponding national agency for this indication.

Corporate/Industry, Foundation, and Professional Organizational funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Address correspondence and reprint requests to Sheilah Hogg-Johnson, Institute for Work and Health, 481 University Avenue, Suite 800, Toronto, Ontario, Canada, M5G 2E9; E-mail: shoggjohnson@iwh.on.ca

In the introduction to this report of the "Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders," Haldeman *et al*[1] state that "most people can expect to experience some degree of neck pain in their lifetime." Summarizing the epidemiology of neck pain is a natural starting point in any investigation of

neck pain. We want to describe who gets neck pain and why. Many reports describing the incidence, prevalence, risk, and associated factors of neck pain appear in the scientific literature. From these, we can better understand the magnitude of the condition to plan and provide appropriate health care. Knowledge about risk and associated factors may also suggest preventive strategies and help to identify and target important subgroups of the population at greatest risk for neck pain.

The main objective of the Neck Pain Task Force report was to systematically search the scientific literature on neck pain and produce a best evidence synthesis on the epidemiology (incidence, risk factors, prevalence and factors associated with prevalent neck pain), diagnosis, treatment, and course and prognosis of neck pain. In this article, we present the results of a systematic review of the scientific literature and our best evidence synthesis on the incidence, risk factors, prevalence, and associated factors for neck pain in the general population.

■ Materials and Methods

Design and Data Collection

The literature search and critical review strategy is outlined in detail elsewhere.[2] We systematically searched the electronic database Medline for literature published from 1980 through 2005 on neck pain and its associated disorders; we also systematically checked reference lists of relevant articles and updated the search to include key articles for 2006 and early 2007.

Relevance Screening

We screened each citation for relevance to the Neck Pain Task Force mandate, using *a priori* inclusion and exclusion criteria; however, we made no attempt to assess the scientific quality of each study when establishing its relevance. Screening criteria are reported in more detail in Carroll *et al*[2] Studies were considered relevant if they pertained to the assessment, incidence, prevalence, determinants or risk factors, prevention, course, prognosis, treatment and rehabilitation, or economic costs of neck pain; if they contained data and findings specific to neck pain and/or disorders associated with neck pain; if they included at least 20 persons with neck pain or at risk for neck pain; or if they described a systematic review of the literature on neck pain. We excluded studies on neck pain that was associated with serious local pathology or systemic disease, such as neck pain from fractures or dislocations (except where such studies inform differential diagnosis in neck pain); myelopathy; rheumatoid arthritis and other inflammatory joint diseases; or tumors.

Quality Assessment

Rotating pairs of Scientific Secretariat members performed independent, in-depth critical reviews of each article, identifying methodologic strengths and weaknesses, and made decisions about the article's scientific merit after discussions of each article. (The criteria used in the methodologic appraisal of the studies can be viewed by going to Article Plus). Our methodologic appraisal focused on sources of potential selection bias, information bias, confounding; and consideration of whether these biases would likely result in erroneous or misleading conclusions. Studies judged to have adequate internal validity were considered "scientifically admissible" and were included in our best evidence synthesis.

Analysis

In the current article, we report our best evidence synthesis of scientifically admissible studies related to incidence, risk factors, prevalence, and factors associated with prevalent neck pain in the general population, pertaining to any age and including groups participating in leisure activities such as sports. The best evidence synthesis of studies pertaining to the risk of neck pain in particular occupational groups, or risk or associated factors for neck pain arising at work are reported elsewhere,[3] as are studies pertaining to risk of traffic-related whiplash-associated disorders (WAD).[4]

In this best evidence synthesis, we classified studies according to whether they provided information about incidence and/or risk factors (cohort, case/control, and twin studies) or about prevalence and/or factors associated with prevalent neck pain (cross-sectional studies). Whereas risk factors predict future neck pain, factors associated with prevalent neck pain (identified from cross-sectional studies) coexist with neck pain and therefore might be risk factors for neck pain, prognostic factors for neck pain or consequences of neck pain.

Further grouping was driven by the content of the identified evidence. For instance, several cohort and case-control studies of neck injury in sports were grouped together. Similarly, it was practical to divide the cross-sectional studies into those concentrating on children or adolescents and those including adults.

Studies of risk factors—cohort studies and case-control studies—were further classified using a methodology proposed for prognostic factors,[5–7] but also previously adapted for studies of risk.[8,9] This classification distinguishes 3 types of study:

- Phase I studies are exploratory, hypothesis generating studies characterized by descriptive exploration and demonstration of crude (unadjusted) associations.
- Phase II studies are also exploratory, but employ multivariable techniques or stratification to identify risk factors related to the onset of neck pain while adjusting for other factors.
- Phase III studies are confirmatory studies of *a priori* hypotheses which verify one or more factors as independent risk factors for the incidence of neck pain after adjusting for confounding.

In accordance with our conceptual frame work on the course and care of neck pain,[10] risk and associated factors for neck pain were organized into categories, namely Demographics/Socioeconomic Factors, Prior Health/Prior Pain/Comorbidities, Collision/Workplace Factors, Psychological and Social Factors, Compensation/Laws/Societal Factors, Genetics, Health Behaviors, and Cultural Factors.

Incidence rates, estimates of prevalence, and relative risks with confidence intervals (CIs) are presented in the tables as reported in the original articles, or when possible, as calculated from raw data provided in those articles. Exact CIs were calculated using SAS V9.1.[11]

■ Results

We critically appraised 469 studies related to the epidemiology of neck pain (incidence, risk factors, prevalence, and factors associated with prevalent neck pain), and judged 249 of these to be scientifically admissible.[2] Of

these, 17 studies were related to incidence and risk factors for neck pain and its associated disorders in the general population, and are summarized below.

Incidence and Risk Factors for Neck Pain in the General Population

Seventeen studies were related to incidence and risk factors in the general population and scientifically admissible for inclusion in our best evidence synthesis.[12–28] (These are summarized in Evidence Table 1 and can be viewed online through Article Plus.)

Nine cohort studies (below) provided estimates of incidence rates for neck pain in the general population. Target populations, based in northern European countries, Canada, and the United States, were most often defined by catchment area or by the registration lists of individual health care facilities.

Different methods were used to identify cases of neck pain. Some studies[13–15,23,25,28] identified cases when people sought care for their symptoms; 3 others[16,17,27] used survey methods involving questionnaires. Case definitions for neck pain were disparate; they included self-reported pain lasting at least a day, a diagnosis of neck sprain/strain (ICD-9 code 847.0) by a physician, neck pain/symptoms prompting a visit to a health center, neck injury prompting a visit to a hospital emergency department or hospital, and a diagnosis of soft disc protrusion demonstrated by myelography or surgery. Variations in population and setting, inclusion/exclusion criteria, method of ascertainment, and case definition likely accounted for the variability in estimated incidence rates.

Table 1 shows the incidence rates per 1000 person years (PY) or the cumulative incidence per 1000 persons ordered roughly from lowest to highest range.[13–17,23,25,27,28] The lowest rates pertain to neck injuries presenting to a hospital or emergency department, or to specific conditions such as disc protrusion/herniation. Intermediate rates arise from studies of visits for health care, while the highest rates come from self-reports of neck pain *via* survey questionnaires.

Risk Factors for Neck Pain

Demographics/Socioeconomic Factors. Evidence regarding age as a risk factor for neck pain varied. The only Phase II study to consider age as a risk factor reported no association between age and incidence of neck pain after controlling for other factors: compared to people aged 18 to 29 years, the relative risk (RR) for those aged 30 to 44 years was 1.0 (95% CI, 0.7–1.4); for those aged 45 to 59 years, it was 0.9 (95% CI, 0.6–1.3); and for those aged 60 or greater, it was 0.7 (95% CI, 0.5–1.1).[17]

However, 3 phase I cohort studies[14,23,25] showed that the risk for neck pain increased with age up to a peak and decreased thereafter. Peak incidence of neck pain coincided with middle-age groups peaking at ages 40 to 49,[14] and ages 35 to 44.[25] For diagnosed protrusion with radicular syndrome, the peak incidence was at 45 to 54 years.[23] On the other hand, when dichotomizing age into 20 to 46 years and >46 years, Côté *et al*[16] found the crude incidence of neck pain was lower for the older age group [incidence rate ratio (IRR) 0.60, 95% CI, 0.38–0.93].

The relationship between gender as a risk factor and neck pain varied depending on case definition for pain. Two Phase I cohort studies[23,28] showed higher incidence rates for men; one study included cases of non-MVC neck sprain/strain injuries presenting to hospital ("inci-

Table 1. Incidence Rates of Neck Complaints per Thousand Person Years in the General Population From Best Evidence Synthesis, Ordered From Lowest to Highest, With the Case Definition Used to Identify Cases

Source of Cases	Case Definition	Incidence Rate	95% Confidence Interval	
Cases identified at hospital (neck injury and disc herniation)	Soft-tissue neck injury presenting as in- or out-patient at hospital, not due to MVC[13]*	0.037	0.028	0.049
	Diagnosis of disc protrusion/herniation with radicular syndrome[23]	0.055	0.042	0.070
	Presented to hospital with neck sprain/strain, not due to MVC,* 1990s[28]	0.285	0.249	0.321
	Minor or moderate neck injuries presented in emergency room, not due to MVC[15]*	0.55	0.47	0.64
	Soft-tissue neck injury presented as in- or out-patient at hospital, all causes[13]	1.2	1.0	1.4
	Minor or moderate neck injuries presented in an emergency room, all causes[15]	2.7	2.5	2.9
Cases identified via health care visits	GP visit for new neck complaint[14]	15.5	15.1	15.9
	Visit to a health care centre for neck pain[25]	78.5†	69.9	88.0
Cases identified via self-report on questionnaire	Report of neck pain via questionnaire during past 6 mo, at 1-yr follow-up, pain free at baseline[16]	146‡	113	179
	Report of neck pain via questionnaire >1 day during the past year, initially pain-free[17]	179‡	160	197
	Report of monthly neck pain via questionnaire over past 3 mo, initially pain-free (adolescents)[27]	213‡	172	259

*Injury rates due to Motor Vehicle Collisions (MVC) are presented in another article in this volume.[4] In this chapter, overall injury rates and rates attributable to causes other than MVC are presented).
†Rate here adjusted to 1000 PY from rate provided for two-week period in original study.
‡Extrapolated to no. per 1000 from percentages reporting pain at follow-up questionnaire after being pain free at baseline, not rates per 1000 PY. Note that although only those pain-free at baseline were included, these people may have experienced neck pain prior to the baseline assessment.

dence over the whole age range showed a male predominance, statistically significant Z-values ranged from 2.2 to 3.6 $P < 0.05$)"[28]); the other included cases of disc protrusion with radicular syndrome (IRR = 1.41; 95% CI, 0.84–2.39; for men *vs.* women).[23] One phase I cohort study[15] showed similar incidence rates for men and women of minor/moderate neck injury identified in emergency departments (IRR, 1.14; 95% CI, 0.67–1.94). Women showed higher rates of visits to a health care center for neck pain (2.6 visits per 1000 for men 95% CI, 2.1–3.0, and 3.5 visits per 1000 for women 95% CI, 3.0–4.0[25]). Finally, women showed increase risk of neck pain reported *via* questionnaire[17,27] in one Phase II (RR, 1.2; 95% CI, 0.9–1.5) and one Phase I cohort (IRR, 1.98, 95% CI, 1.53–2.58), while women were at higher risk only for mild (*i.e.*, nonintense, nondisabling) neck pain in a Phase I cohort (IRR, 2.30; 95% CI, 1.27–3.87).[16]

One Phase II cohort[17] found that the risk of neck pain in adults increased with how many children they had [this emerged as an independent risk factor for neck pain; odds ratios (OR) and 95% CI relative to no children are 1.2 (0.9–1.8) for one child, 1.2 (0.9–1.7) for 2 children, 1.5 (1.0–2.1) for 3 children and 1.6 (1.1–2.4) for 4 or more children]. In the same study, marital status and car ownership were considered, but were not found associated with neck pain in adults.

Croft *et al*[17] also investigated employment status as a potential risk factor for neck pain and found no relationship after adjusting for other factors of interest— except for a higher rate of incident neck pain among those not working due to ill health and/or disability at baseline (compared to those working full time, unadjusted RR, 1.9; 95% CI, 1.2–2.9).

Prior Health/Prior Pain/Comorbidities. A Phase III cohort found that health care visits for a variety of health issues were predictive of neck pain 25 years later.[18] One phase II cohort[17] identified a history of neck pain (RR, 1.7; 95% CI, 1.2–2.5), poor self-assessed health (compared to excellent health, RR for good health 1.0; 95% CI, 0.7–1.4; fair health 1.3; 95% CI, 0.9–1.9; poor health 1.3; 95% CI, 0.7–2.3) and a history of low back pain (RR, 1.7; 95% CI, 1.3–2.1) as independent risk factors for neck pain. Body mass index (BMI) was not identified as an independent risk factor in one Phase II study.[17]

Collision/Workplace Factors. Collision and workplace factors as they pertain to neck pain are considered elsewhere in the Neck Pain Task Force report.[3,4] However, we included one finding from Berglund *et al* about collisions as it relates to neck pain in the general population and not specifically to whiplash-associated disorders (WAD). Previous trauma to the neck *via* exposure to a motor vehicle collision was associated with subsequent neck pain prevalence at 7-year follow-up only when there had been a report of WAD following the collision (RR, 2.7; 95% CI, 2.1–3.5). Those who had been involved in a collision but did not report WAD as a result of that collision had no higher prevalence of neck pain 7 years later than those who had not been in a collision (RR, 1.3, 95% CI, 0.8–2.0).[12]

Psychological and Social Factors. There was consistent evidence from 2 cohorts that psychological factors are risk factors for neck pain. Siivola *et al*[26] found psychosomatic symptoms in adolescence predictive of newly reported neck pain in young adulthood (for one unit change in psychosomatic score OR 1.0; 95% CI, 1.0–1.1). One Phase II cohort[17] identified poor psychological status, as measured by the General Health Questionnaire (GHQ), as an independent risk factor for neck pain (compared to GHQ score 0–7, RR of GHQ 8–12, 1.1; 95% CI, 0.8–1.5; GHQ 13–17, 1.6; 95% CI, 1.1–2.3; GHQ 18–36, 1.5; 95% CI, 1.0–2.7).

Compensation/Laws/Societal Factors. We found no study or studies that reported on compensation factors, laws or societal factors as risk factors for neck pain in the general population.

Genetics. Three twin studies provided evidence about genetics showing an interaction between the heritability of neck pain and age. MacGregor *et al*[24] showed excess concordance of neck pain in monozygotic as compared to dizygotic twins aged 45 to 79. Heritability was estimated at 48% (95% CI, 29–67) for any lifetime neck pain and 35% (95% CI, 9–61) for severe disabling neck pain. Hartvigsen *et al*[21] reported that dominant genetic or common environmental effects did not affect the overall occurrence of neck pain among Danish twins aged 75 years and over. Finally, Fejer *et al*[20] reported overall heritability of lifetime neck pain as 45% (95% CI, 40–49) in young and middle-aged Danish twins; however, heritability was negligible in the oldest age group.

Health Behaviors. A Phase III cohort[19] found that Norwegian nurses' aides exposed to environmental tobacco smoke in childhood had an increased risk of neck pain compared to those with no such exposure (adjusted odds ratios of 1.37 (95% CI, 1.03–1.84) and 1.32 (95% CI, 1.00–1.74) for those sometimes and often exposed, respectively).

Two Phase II cohorts[17,22] investigated a variety of health behaviors including cigarette smoking, other kinds of tobacco use, alcohol consumption, time spent in automobiles or on motorcycles and the wearing of high-heeled shoes. There was consistent evidence from 2 studies for current smoking as a risk factor for neck pain. One study of disc herniation (confirmed by radiograph of myelogram)[22] reported an elevated risk for current smokers compared to those who had never smoked (age- and sex-matched controls; OR = 2.1, 95% CI, 0.9–5.0); another study of self-reported neck pain[17] found an age- and sex-adjusted RR for current smokers of 1.2 (95% CI, 0.9–1.5) compared to those who never smoked.

Kelsey *et al*[22] reported an increased risk for neck pain related to motorcycle riding (cases 0.5 hours/wk *vs.* con-

trols 0.04 hours/wk, *P* value 0.06). Finally, there was no increased risk of neck pain associated with wearing high-heeled shoes.[22]

Cultural Factors and Neck Pain. We found no study or studies reporting on cultural risk factors for neck pain in the general population.

Incidence of Sports-Related Neck Pain

Seventeen studies (on 15 separate cohorts of subjects) reporting incidence and risk of neck pain related to participation in sports were judged scientifically admissible and are described in Evidence Table 2 (available online through Article Plus).[22,29–43]

Twelve studies (10 distinct cohorts of study participants)[30–38,40,41] provided incidence rate estimates for neck pain while people were participating in some kind of sports activity. All but one of these studies[38] were based in North America. These included 4 cohorts of people playing ice hockey[30–33] and one each of those engaged in football,[34,35] lacrosse,[36] luge,[37] Tae-kwon-do,[40] wrestling,[41] and car racing.[38] Incidence rates of neck pain, ordered roughly from lowest to highest, are noted in Table 2.

Risk Factors for Sports-Related Neck Pain

Demographics/Socioeconomic Factors. Information about neck pain risk associated with age and gender during sports is sparse because most studies included a narrow age range, and some included only male athletes. However, Lorish *et al*[41] in a phase I cohort noted an increased risk of injury with increasing age among young wrestlers (aged 6–16 years), after controlling for body weight (from logistic regression, *P* value for age 0.01). Hinton *et al*[36] reported a higher risk of neck injury among male *versus* female high school lacrosse players (a Phase I cohort, IRR, 3.89; 95% CI, 1.13–20.73).

Prior Health/Prior Pain/Comorbidities. A Phase II cohort study found that varsity football players with a history of neck injury were more likely to sustain a new neck injury than were players with no previous neck injury (RR, 5.04; 95% CI, 3.1–8.2).[34]

Collision/Workplace Factors. Collision and workplace factors as they pertain to neck pain are considered elsewhere in the Neck Pain Task Force report.[3,4]

Psychological and Social Factors. We found no study or studies that examined psychological or social factors as risk factors for neck pain during sporting activities.

Compensation/Laws/Societal Factors. One Phase I cohort study[33] showed a large reduction in risk for neck injury (from 2.37 to 0.56 neck injuries per 1000 player games) among people who played hockey after officials implemented a new system of stiffer penalties on players who checked other players from behind (IRR 0.24, 95% CI, 0.05–1.08). No other scientifically admissible studies considered legal or rule changes in sport.

Genetics. We found no study or studies that examined genetic factors as risk factors for neck pain during sporting activities.

Health Behaviors. Three studies investigated the relationship between neck injury and sporting equipment, and generally found no increase in neck pain associated with the equipment under study. In a Phase I cohort study of bicyclists with injuries, neck sprain was not associated with helmet use (OR, 0.9; CI, 0.6–1.5).[29] Helmet use was also investigated in a Phase III study of skiers to see whether helmet use would reduce head injuries without any concurrent rise in neck injuries.[39] The odds of sustaining a head injury were reduced with a helmet; the odds ratio of sustaining a neck injury with a helmet, compared to no helmet, was 0.62 (95% CI 0.33–1.19). A Phase III study of ice hockey players found the risk of neck injury was similar, whether players wore a full face-shield or a half face-shield (RR of half-shield 1.16; 95% CI, 0.43–3.16).[30] However, the risk for facial and dental injuries was greatly reduced among players who wore the full face-shields (RR of half-shield 2.52; 95% CI, 1.73–3.68).

Three studies investigated whether participation in a range of physical activities is a protective factor for neck pain,[22,42,43] and the evidence varies. The Phase III

Table 2. Incidence Rates of Neck Injury per Thousand Exposures During Sporting Activities From Best Evidence Synthesis, Ordered Roughly From Lowest to Highest, With Definition of Exposure

Sport	Setting	Rate per 1000	95% Confidence Interval	Exposure
Lacrosse	US High School 1999–2001[36]	0.02 (female), 0.08 (male)	0.007, 0.05; 0.05, 0.12	Game or practice
Ice hockey	US College[32]	0.20	0.08, 0.45	Hour of practice/game
	Cdn University 1997/98[30]	0.29 (half shield), 0.34 (full shield)	0.14, 0.54; 0.18, 0.60	Game or practice
	Cdn University 1990/92[33]	0.56 (check-from-behind penalty)	0.17, 1.56	Game
	US Junior A[31]	0.60	0.15, 2.26	Hour of game
	Cdn University 1986/89[33]	2.37 (no check-from-behind penalty)	1.30, 4.05	Game
Luge	US national[37]	0.91	0.68, 1.2	Run
Football	Cdn University 1993–1997[34,35]	0.98	0.81, 1.19	Game or practice
Tae-kwon-do	US national 1989/90[40]	1.30 (female), 1.48 (male)	0.40, 3.62; 0.79, 2.60	Match
Wrestling	US international 1987[41]	4.6	3.3, 6.3	Match
Race car driving	Japan, professional drivers 1996–2000[38]	16.5 (single seat), 21 (saloon cars)	10.4, 25.2; 14.9, 28.6	Competitor races

study[43] found that regular participation in a sport for at least 10 months a year was protective for neck pain (OR, 0.82; 95% CI, 0.67–0.99). This was a strong study with a sophisticated analysis; however, the sample at baseline included those with and without neck pain at baseline, raising the possibility of prevalence-incidence bias, and so it should be interpreted with caution. The other two studies—small case-control studies, both Phase II, and very similar in population, design, and measurement—reported conflicting findings on whether participation in sports activities was associated with risk of disc herniation.

Cultural Factors. We found no study or studies that examined cultural factors as risk factors for neck pain during sporting activities.

The Prevalence of Neck Pain and Associated Factors in the General Population

Evidence is presented separately for studies of adults or entire populations (*i.e.*, children and adults) (Evidence Table 3 available online through Article Plus) and for those which focused on children and adolescents (Evidence Table 4 available online through Article Plus). For adult general populations, we judged 54 studies (reporting on 45 separate samples of participants) to be scientifically admissible.[20,24,45–96] For children/adolescents, we judged 18 studies (13 separate samples of participants) to be scientifically admissible.[26,53,97–112] Studies of adults came from countries around the world, although the vast majority were from North America, Scandinavian and northern European countries. Except for one study from New Zealand and one from Canada, all studies of children and/or adolescents were based in Scandinavian or northern European countries.

Studies relating to the general population show large variations in prevalence estimates. Variations in population, inclusion/exclusion criteria, case definition and case ascertainment all likely contributed to these differences. Case definitions varied with respect to the time period of interest (point prevalence, 1-month, 6-month, 12-month, or lifetime). The studies also varied in the intensity, frequency and duration of neck pain, the types of symptoms included, and whether or not neck pain interfered with daily activities. Finally, studies differed on how data were collected—for example, whether neck pain was the main focus of study or one of a long list of conditions, whether data were collected *via* questionnaire, and whether cases were confirmed by physical examination.

Prevalence estimates for lifetime, 12-month and 1-month prevalence of neck pain are presented in Figure 1. Prevalence estimates for other periods are presented in the evidence tables (Evidence Tables 3 and 4, available online through Article Plus).

- As the period of time increased, from point-prevalence to lifetime-prevalence, the prevalence of neck pain generally increased.
- Measures of any pain not qualified by frequency, duration and/or accompanying interference with activities tended to be larger than estimates for pain that had been qualified in some way.
- For each period, the prevalence of neck pain which interfered with activities was much lower than the prevalence of any neck pain.
- Finally, prevalence estimates of very specific diagnoses such as cervicogenic headache or spondylotic radiculopathy were very much lower than prevalence estimates of any pain or of pain interfering with activity.

To illustrate findings on neck pain prevalence, we might consider 1-month and 12-month prevalence:

- One-month prevalence estimates of any neck pain ranged from 15.4% to 45.3% among adults and from 4.5% to 8.5% among children/adolescents.
- When pain was qualified as frequent (*e.g.*, weekly) or of specified duration (at least a week), estimates ranged from 12% to 14% among adults and 8% among adolescents.
- One-month prevalence interfering with activities among adults ranged from 7.5% to 14.5%.
- One-month prevalence of cervicogenic headache among adults was estimated as 2.5%.

There were similar patterns for 12-month prevalence:

- The 12-month prevalence of any neck pain among adults ranged from 12.1% to 71.5% and among children ranged from 34.5% to 71.5%.[54,57,60,64,78,84,86,94,98,105] Most estimates of 12-month prevalence were between 30% and 50%.
- The 12-month prevalence of neck pain-limiting activities among adults was estimated as 1.7% (limited ability to work due to neck pain)[57]; 2.4% (limited social activities due to neck pain)[57]; and 11.5% (limited activities due to neck pain).[84]

Factors Associated With the Prevalence of Neck Pain in the General Population

Complete statistical documentation such as measures of effect (odds ratios, risk ratios) and their significance or precision for associations described here can be found in Evidence Tables 3 and 4 (available online through Article Plus).

Demographics/Socioeconomic Factors. The preponderance of evidence on neck pain prevalence by age group among adults shows increasing prevalence with age (to a peak during the middle years and declining prevalence thereafter).[46,51,52,66,68,76,86,88,90,92] Gordon *et al*[65] noted a similar peaking during middle age for men, but not for women, whereas Urwin *et al*[91] noted this trend for women, but not for men. Ciancaglini *et al*,[60] Hasvold *et al*,[72] and Webb *et al*[93] reported increasing prevalence with increasing age. Chiu *et al*[57] reported no significant association between neck pain prevalence and age, although crude prevalence showed highest values for the middle-age group. Findings by Côté *et al*[61] showed the

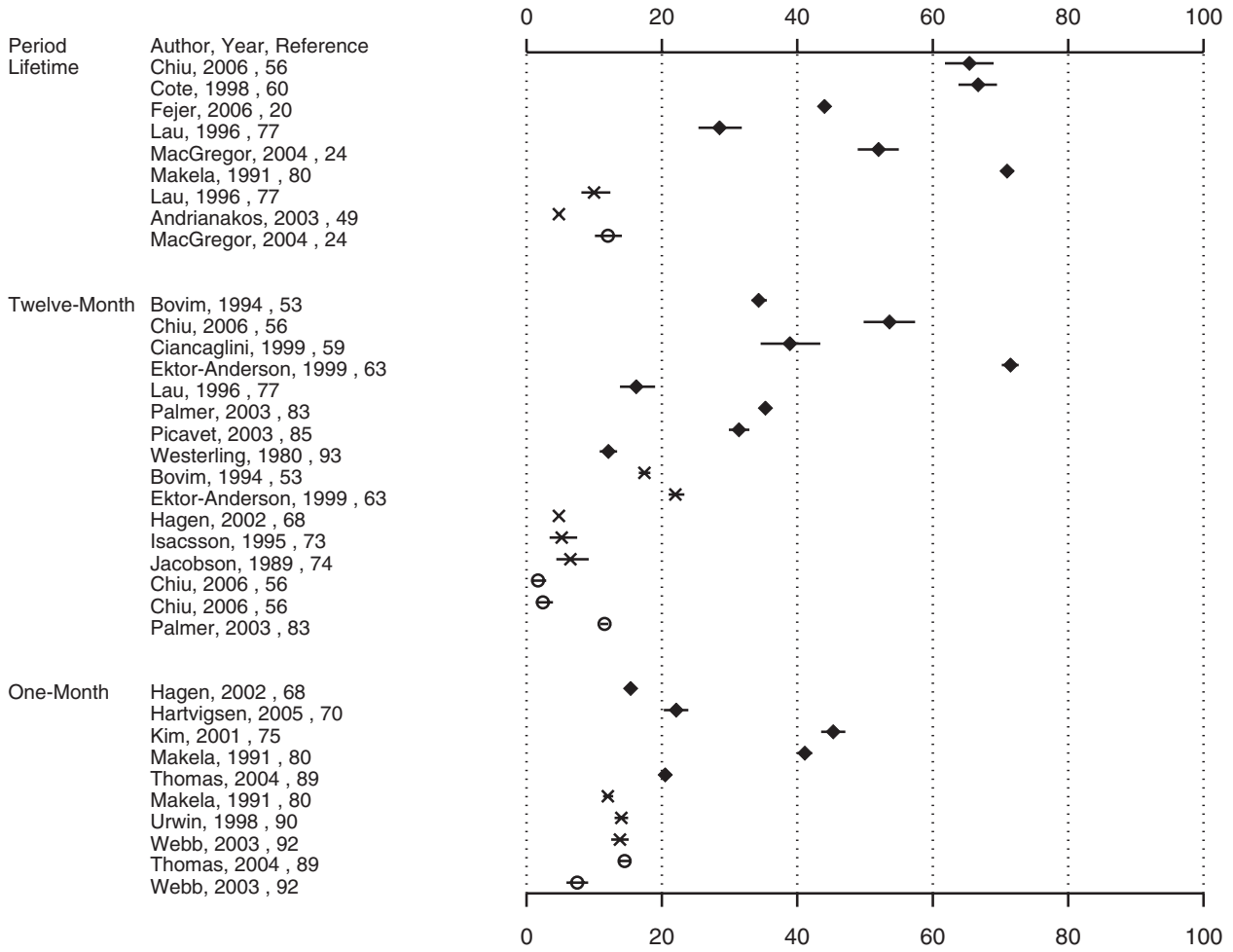

Figure 1. Prevalence estimates (%) and 95% confidence intervals for prevalence of neck pain in the general population from different studies, by period of recall and characteristics of pain (◆ for any pain, × for frequent pain or pain of specified duration, ○ for pain limiting activities).

familiar decline in prevalence in later years for any neck pain; however, when neck pain was stratified by intensity and disability, low intensity, nondisabling neck pain, declined markedly with increasing age, whereas high intensity neck pain and neck pain with disability had more consistent prevalence across age groups.

Among children and adolescents, the relationship between age and prevalence reported in 8 studies varied. In 4 studies, the prevalence of neck pain increased with age,[100,104,106,109] whereas 2 studies showed similar prevalence at different ages,[105,112] and 2 studies showed reduced prevalence with age.[108,110]

The preponderance of evidence showed higher prevalence for women than men [46,50,57,60–62,66,68,72,75,76,81,86,88,91,93,94] and for girls over boys [53,98,100,102,103,105,107–110,112] with ratios ranging from 1.2 to 2.0 for 1-month prevalence and 1.1 to 3.4 for 12-month prevalence. There were some exceptions: one study found no gender association,[52] another found higher prevalence among men than women (31% *vs.* 27%)[78] and another found higher prevalence for women under 40 years, but higher prevalence for men at older ages.[65] Most of these are reports of crude (unadjusted) prevalence.

The preponderance of evidence showed no association between neck pain and socioeconomic status (SES) or its correlates (education, income, home ownership, social deprivation)[47,57,62,71,78,91,93,94,98] although three[52,68,81] of 7 studies[47,52,57,62,68,71,81] that considered education reported increased neck pain prevalence with lower education.

Five studies examined the relationship between employment status and neck pain prevalence among adults, with varied findings. In 2 studies, there was no association.[62,81] However, one study[52] reported a higher prevalence of neck pain among retired *versus* employed persons. Another study[68] reported lower prevalence for pensioners and those on sick leave, whereas Chiu *et al*[57] reported lower neck pain prevalence for housewives, unemployed and retired persons compared to employed managers and professionals. The single study considering employment among adolescents[97] found higher neck pain prevalence among working adolescents compared to those not working.

Prior Health/Prior Pain/Comorbidities. Consistent associations were reported between neck pain and a number of other health factors including other musculoskeletal

aches and pains,[103,104,109] previous trauma to the neck,[56,62,63,78,81] headache,[62,69,71,72] disability,[56,80] poorer general or self-rated health,[62,64,71] sleep disturbances[47,76,104] and restricted range of motion.[56] Two studies[109,111] reported no association between neck pain prevalence and age at puberty. One study[53] investigated the relationship between parental musculoskeletal pains in various body regions and neck pain in adolescent offspring; they found an association between neck pain in the mother and/or father and neck pain in the offspring. Associations between parental musculoskeletal pain and adolescent neck pain could reflect genetic mechanisms, shared environments or psychosocial issues.

The preponderance of evidence suggests no relationship between body mass index (BMI) and prevalent neck pain.[47,61,71,81,93,105,109]

Findings for a relationship between radiographic evidence of degeneration and neck pain prevalence varied. One study[85] reported no significant difference in amount of pain and disability between neck-pain patients with and without radiographic evidence of cervical spine degeneration. Another study[92] showed increasing prevalence of neck pain with increasing grade of disc degeneration; however, after controlling for age, this relationship remained statistically significant only for men. Finally, one study[96] showed increasing prevalence of neck pain with increasing grade of degenerative change related to atlanto-odontoid osteoarthritis.

Collision/Workplace Factors. Collision and workplace factors are considered in 2 other articles within the Neck Pain Task Force report.[3,4]

Psychological and Social Factors. The preponderance of evidence for adults, adolescents and children showed an association between prevalent neck pain and poor psychological health, although the specific psychological factors measured varied across studies. Indexes of psychological health included mental distress, any mental disorder, depression, depressed mood, anxiety and general mental health.[64,81,87,92,97–99,101,104,106,108,109] Only one study examining this factor found no such associations.[47]

Compensation/Laws/Societal Factors. We found no study or studies that examined the association between compensation, law or societal factors and neck pain prevalence in the general population.

Genetics. We found no study or studies that examined the association between genetic factors and neck pain prevalence although Borge and Nordhagen[53] explored the relationship between musculoskeletal complaints in parents and their adolescent offspring (reported above).

Health Behaviors. Eight studies investigated smoking and neck pain prevalence. Four reported no association.[47,71,108,109] Two studies specifically focused on exposure to smoking[84,102] and both reported associations between current smoking and neck pain. For adults, the reported effect sizes were of low magnitude (odds ratios for neck pain = 1.1; 95% CI, 1.1–1.2; and OR for neck pain restricting activity 1.5; 95% CI, 1.3–1.6),[84] whereas for adolescents, the odds ratios were 3.1 (95% CI, 2.4–4.0) for boys and 2.5 (95% CI, 2.0–3.1) for girls.[102] Côté *et al*[62] reported associations between smoking and neck pain of OR = 1.66 (95% CI, 0.93–2.98) for high intensity low disability neck pain, and 1.82 (95% CI, 0.76–4.36) for disabling neck pain, whereas Makela *et al*[81] reported a small consistent relationship between current smoking and neck pain (adjusted OR 1.25; 95% CI, 0.99–1.57; and adjusted OR 1.23; 95% CI 0.72–2.11 for people younger than and older than 65 years, respectively).

Six studies considered exercise and participation in sporting activities, but most reported no association with neck pain prevalence.[47,61,62,97,108,109] However, neck pain prevalence was lower among girls who took part in sports that involved dynamic use of the upper extremity, as compared to girls doing other types of physical activity.[105]

Two studies investigated school bags (weight, type, style of carrying); both reported no association with prevalent neck pain.[108,112]

Cultural Factors. We found no study or studies that examined the association between cultural factors and the prevalence of neck pain in the general population.

■ Discussion

Main Findings on the Burden of Neck Pain

In this best evidence synthesis on the epidemiology of neck pain we found that neck pain, like other musculoskeletal conditions, is common in the general population. Although neck pain is common, when we start to qualify it (*i.e.*, by duration, by frequency, by intensity, by whether health care was sought) we see the typical "iceberg of burden" that has been reported for other musculoskeletal conditions. That means we observe many cases of some pain, but fewer cases of any significant duration, fewer cases that lead to utilization of the health care system, and fewer still that are disabling.

Neck pain is experienced by people of all ages, including children and adolescents.[27,53,97,98,100,102–110,112] There is consistent evidence that previous neck pain or trauma is predictive of both incident and prevalent neck pain, suggesting that neck pain often follows an episodic course similar to low back pain.

Risk Factors and Factors Associated With Neck Pain

A variety of risk factors and associated factors have been considered, with key findings highlighted here. Here we compare our findings with those in other chapters of this best evidence synthesis.

The evidence on whether age is a risk factor for incident neck pain is equivocal. However, as with other musculoskeletal conditions,[113] most data show that prevalence of neck pain increases with older age, peaking in the middle years and declining in later life. This should be interpreted in light of findings from

general population studies that younger persons with neck pain have a better prognosis,[114] and it may be this factor, rather than differences in incidence rates, which "drives" the relationship between age and prevalent neck pain.

There was consistent evidence that neck pain coexists with other health problems, including other musculoskeletal complaints like low back pain, headache and poorer self-rated health. There was also generally consistent evidence that neck pain is both predicted by and coexists with different types of psychological health conditions. Of note is that our best evidence synthesis of prognostic factors for neck pain in the general population also identifies health problems, musculoskeletal complaints and poor psychological health as prognostic of poor outcome.[114]

We did not identify any evidence demonstrating that disc degeneration is a risk factor for neck pain. Longitudinal studies are required to demonstrate disc degeneration as a risk factor, and there were no such studies judged scientifically admissible. This is an important finding to note, given the existing body of literature based on the assumption that persistent and disabling neck pain is associated with cervical degenerative changes.[115–118] The lack of evidence identified here is consistent with findings reported elsewhere in the Neck Pain Task Force report around the use of diagnostic imaging.[119] Nordin *et al*[119] also concluded there is "no evidence that common degenerative changes on cervical MRI are strongly correlated with neck pain symptoms" and that "common degenerative changes in the cervical spine identified by MRI are at best fair to moderately reproducible."

Modifiable Risk Factors and Prevention of Neck Pain

Most of the identified literature addressed nonmodifiable factors such as gender, a history of neck pain and genetics. Poor psychological health was identified as both a risk factor and an associated factor for neck and low back pain,[9] although to date, there is no evidence that treating psychological conditions will lead to reductions in neck pain or other musculoskeletal complaints.

Smoking was investigated as a risk factor or associated factor in several studies,[17,22,47,62,71,81,84,102,108,109] with many studies reporting no statistically significant relationship with neck pain. However, in 5 studies[22,62,81,84,102] low-magnitude relationships between smoking and neck pain were identified and reported. Exposure to second-hand smoke during childhood was also identified as a risk factor for neck pain later in life.[19] Thus, attempts to reduce smoking in general may have potential benefits for preventing neck pain.

The evidence on exercise and physical activity varied. Many studies showed no association, although most of these relied on a single summary self-report measure of activity participation. One study with a more thorough assessment of activity participation suggested that certain levels of participation provided a protective effect against neck pain.[43] Although this study must be interpreted with caution (because of the possibility of prevalence-incidence bias), their findings generally support evidence cited elsewhere in this Neck Pain Task Force report; that exercise was found to be an effective intervention for neck pain,[120] and that workers who exercised had a better prognosis for recovery from neck pain,[121] although preliminary evidence suggests that general physical activity is not associated with prognosis in the general population.[114]

The State of the Literature

Our search identified 469 articles that were relevant to our investigation of neck pain epidemiology, and 249 were judged scientifically admissible and 101 of these studies related to the burden and determinants of neck pain in the general population. These articles drew on results from 86 different groups of study participants conducted in countries around the world.

The accepted studies varied widely in their design:

- Most of the scientifically admissible studies (52 of 86) were cross-sectional and provided evidence about prevalence and/or factors associated with neck pain.
- There were also 27 cohort studies, although for our purposes, 3 of these were analyzed in a cross-sectional manner.[56,97,103,104] Of the remaining 24 cohorts, 5 produced estimates of incidence rates only, and 19 examined risk factors for neck pain or injury. Of these 19 studies, 13 were Phase I investigations; there were only 2 Phase II and 4 Phase III investigations.
- In addition, there were 3 Phase II and one Phase III case-control studies which examined risk factors for neck pain or neck injury.
- Finally, there were 3 twin studies examining the inheritability of neck pain.

Cross-sectional studies investigating prevalence are useful starting points for understanding the burden of neck pain. But in order to advance this field of study, we need more high-quality cohort studies and case-control studies to identify and investigate both risk and protective factors. Assembling cohorts of people before any episodes of neck pain may prove difficult or inefficient, given the reports of high prevalence seen in children and adolescents.[27,53,97,98,100,102–110,112] However, the evidence points to an episodic, recurrent course for neck pain,[12,17,34,56,62,63,78,81,114] much like other musculoskeletal conditions.[122–131] Therefore, studies integrating investigations into risk and prognosis are likely to be most fruitful.

The studies which comprise our best evidence synthesis on burden and determinants of neck pain in the general population showed geographically distinct patterns of distribution. All but 2 of the 15 sports-related studies were based in North America. The remaining studies were predominantly from northern European countries (Scandinavia, Netherlands and the U.K.). Some more varied geographical distribution appeared in the cross-sectional studies with studies from Australia, Asia and the Middle East, partially due to the Community Ori-

ented Programme for Control of Rheumatic Disease (COPCORD), an initiative first planned by the International League of Associations of Rheumatology (ILAR) and the World Health Organization (WHO) in 1981 to assess the global burden of rheumatic diseases.[132,133] Still, more than half of the cross-sectional studies were from northern Europe.

The importance of "case definition" in public health and clinical inquiry have been duly noted in the literature,[134–140] particularly for symptom-based conditions; this has also been true of other methodologic issues when it comes to measuring prevalence.[113] In out exploration of neck pain epidemiology and risk, we saw that summarizing the evidence and making comparisons across populations and settings was especially challenging due to extensive between-study variations in the case definitions of "neck pain/neck injury." This has led the Neck Pain Task Force to propose a framework for case definitions.[10] We found that case definitions and sampling frames used by researchers varied in many different ways:

- Some studies only included specific conditions such as prolapsed disc[22,42] or disc protrusion or herniation resulting in radicular syndrome.[23] Others included any self-reported pain in the neck region.
- Some studies included only those people with neck pain who were presenting for health care; others surveyed general populations and generally yielded higher estimates of neck pain incidence or prevalence.
- The actual location of symptoms also varied. Some investigators only considered pain felt in a very clearly delimited part of the body[24,78]; others included "neck/shoulder" pain within their case definition. Generally, the more extensive the area(s) of the body, the higher the prevalence of neck pain.[139]
- There were also differences in the period under consideration for measures of prevalence (from point prevalence to lifetime) and also in the frequency, duration, and severity of symptoms captured by different case definitions, as previously described in a framework presented by Beaton *et al*[135] Some case definitions also specified pain with disability or interference with activities of daily living.

Generally, the fewer conditions placed on duration, period, frequency and intensity, the higher the incidence or prevalence of neck pain. We also noted that some studies were specifically focused on neck pain, and so only neck pain statistics were gathered, whereas other studies included information on a wide variety of musculoskeletal complaints in different parts of the body.

Typically, estimates of neck pain prevalence were lower in the broader investigations. The unified framework for case definitions proposed elsewhere in the Neck Pain Task Force report,[10] if used consistently by researchers, would provide a flexible and comprehensive set of approaches to case definition and facilitate future literature synthesis.

Limitations of Our Review

Our findings on the epidemiology and risk factors for neck pain in the general population are, of course, limited by the available literature. There were far fewer studies of incidence and risk in neck pain compared to studies looking at prevalence and associated factors. We found limited evidence on risk factors and even more limited evidence on "modifiable" risk factors. No admissible evidence was found for some categories of factors, such as societal level factors and cultural factors. For practical reasons, we restricted our literature search to articles appearing in Medline; we only searched for publications in English, French and Swedish; and we limited publication to a specific time frame (between 1980 and 2005). Thus, it is possible that we might have missed relevant literature not indexed by these databases or which fell outside these restrictions.[2]

■ Key Points

- Neck pain is common in the adult general population, with typical 12-month prevalence estimates from 30% to 50%. Among children and adolescents, 12-month prevalence estimates range from 21% to 42%.
- Neck pain which limits activities is less common, with 12-month prevalence estimates ranging from 2% to 11%.
- There is no evidence to support the assumption that degenerative disc changes are a risk factor for neck pain without radiculopathy.
- Poor psychological health is a risk factor for neck pain and is often associated with it.
- Helmet use during activities such as bicycling, skiing, and hockey may reduce some types of injuries without increasing the risk of neck injury.

tables

Tables available online through Article Plus.

Acknowledgments

We are indebted to Ms. Oksana Colson and Ms. Leah Phillips, MA, for their administrative assistance and to Mr. Stephen Greenhalgh, MA, MLIS, Ms. C. Sam Cheng, MLIS, and Ms. Lori Giles-Smith, MLIS, research librarians, for their assistance in the work of the Neck Pain Task Force. The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders was supported by grants from the following: National Chiropractic Mutual Insurance Company (USA); Canadian Chiropractic Protective Association (Canada); State Farm Insurance Company (USA); Insurance Bureau of Canada; *Länsförsäkringar* (Sweden); *The Swedish Whiplash Commission*; Jalan Pacific Inc. (Brazil); Amgen (USA). All funds received were unrestricted grants. Funders had no control in planning, research activities, analysis or results. The report was not released to grant-

ors prior to publication and no approval was required from funders regarding the final report. Dr. Côté is supported by the Canadian Institutes of Health Research through a New Investigator Award and by the Institute for Work & Health through the Workplace Safety and Insurance Board of Ontario. Dr. van der Velde is supported by the Canadian Institutes of Health Research through a Fellowship Award. Dr. Carroll is supported by a Health Scholar Award from the Alberta Heritage Foundation for Medical Research. Dr. Cassidy is supported by an endowed research chair from the University Health Network.

References

1. Haldeman S, Carroll LJ, Cassidy JD. Introduction/Mandate: the empowerment of people with neck pain. The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008; 33(Suppl):S8–S13.
2. Carroll LJ, Cassidy JD, Peloso PM, et al. Methods for the best evidence synthesis on neck pain and its associated disorders. The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33(Suppl):S33–S38.
3. Côté P, van der Velde G, Cassidy JD, et al. The burden and determinants of neck pain in workers. Results of the Bone and Joint 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33(Suppl):S60–S74.
4. Holm LW, Carroll LJ, Cassidy JD, et al. The burden and determinants of neck pain in whiplash-associated disorders after traffic collisions: Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33(Suppl):S52–S59.
5. Altman DG, Lymann GH. Methodological challenges in the evaluation of prognostic factors in breast cancer. *Breast Cancer Res Treat* 1998;52:289–303.
6. Côté P, Cassidy JD, Carroll L, et al. A systematic review of the prognosis of acute whiplash and a new conceptual framework to synthesize the literature. *Spine* 2001;26:E445–58.
7. Carroll LJ, Cassidy JD, Peloso PM, et al. Prognosis for mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med* 2004;43:84–105.
8. Cassidy JD, Carroll LJ, Peloso PM, et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med* 2004; 43:28–60.
9. Carroll LJ, Cassidy JD, Côté P. Depression as a risk factor for onset of an episode of troublesome neck and low back pain. *Pain* 2004;107:134–9.
10. Guzman J, Hurwitz EL, Carroll LJ, et al. A conceptual model for the course and care of neck pain. Results of The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008; 33(Suppl):S14–S23.
11. SAS Online Doc 9.1.3 [computer program]. Version 9.1.3. 2004.
12. Berglund A, Alfredsson L, Cassidy JD, et al. The association between exposure to a rear-end collision and future neck or shoulder pain: a cohort study. *J Clin Epidemiol* 2000;53:1089–94.
13. Bjornstig U, Hildingsson C, Toolanen G. Soft-tissue injury of the neck in a hospital based material. *Scand J Soc Med* 1990;18:263–7.
14. Bot SD, van der Waal JM, Terwee CB, et al. Incidence and prevalence of complaints of the neck and upper extremity in general practice. *Ann Rheum Dis* 2005;64:118–23.
15. Bring G, Bjornstig U, Westman G. Gender patterns in minor head and neck injuries: an analysis of casualty register data. *Accid Anal Prev* 1996;28: 359–69.
16. Côté P, Cassidy JD, Carroll LJ, et al. The annual incidence and course of neck pain in the general population: a population-based cohort study. *Pain* 2004;112:267–73.
17. Croft PR, Lewis M, Papageorgiou AC, et al. Risk factors for neck pain: a longitudinal study in the general population. *Pain* 2001;93:317–25.
18. Croft P, Lewis M, Hannaford P. Is all chronic pain the same? A 25-year follow-up study. *Pain* 2003;105:309–17.
19. Eriksen W. Do people who were passive smokers during childhood have increased risk of long-term work disability? A 15-month prospective study of nurses' aides. *Eur J Public Health* 2004;14:296–300.
20. Fejer R, Hartvigsen J, Kyvik KO. Heritability of neck pain: a population-based study of 33,794 Danish twins. *Rheumatology* 2006;45:589–94.
21. Hartvigsen J, Pedersen HC, Frederiksen H, et al. Small effect of genetic factors on neck pain in old age: a study of 2,108 Danish twins 70 years of age and older. *Spine* 2005;30:206–8.
22. Kelsey JL, Githens PB, Walter SD, et al. An epidemiological study of acute prolapsed cervical intervertebral disc. *J Bone Joint Surg Am* 1984;66:907–14.
23. Kondo K, Molgaard CA, Kurland LT, et al. Protruded intervertebral cervical disk: incidence and affected cervical level in Rochester, MN, 1950 through 1974. *Minn Med* 1981;64:751–3.
24. MacGregor AJ, Andrew T, Sambrook PN, et al. Structural, psychological, and genetic influences on low back and neck pain: a study of adult female twins. *Arthritis Rheum* 2004;51:160–7.
25. Rekola KE, Keinanen-Kiukaanniemi S, Takala J. Use of primary health services in sparsely populated country districts by patients with musculoskeletal symptoms: consultations with a physician. *J Epidemiol Community Health* 1993;47:153–7.
26. Siivola SM, Levoska S, Latvala K, et al. Predictive factors for neck and shoulder pain: a longitudinal study in young adults. *Spine* 2004;29:1662–9.
27. Stahl M, Mikkelsson M, Kautiainen H, et al. Neck pain in adolescence. A 4-year follow-up of pain-free preadolescents. *Pain* 2004;110:427–31.
28. Versteegen GJ, Kingma J, Meijler WJ, et al. Neck sprain not arising from car accidents: a retrospective study covering 25 years. *Eur Spine J* 1998;7: 201–5.
29. Rivara FP, Thompson DC, Thompson RS. Epidemiology of bicycle injuries and risk factors for serious injury. *Inj Prev* 1997;3:110–4.
30. Benson BW, Mohtadi NG, Rose MS, et al. Head and neck injuries among ice hockey players wearing full face shields vs half face shields. *JAMA* 1999;282:2328–32.
31. Stuart MJ, Smith AM, Malo-Ortiguera SA, et al. A comparison of facial protection and the incidence of head, neck, and facial injuries in Junior A hockey players. A function of individual playing time. *Am J Sports Med* 2002;30:39–44.
32. LaPrade RF, Burnett QM, Zarzour R, et al. The effect of the mandatory use of face masks on facial lacerations and head and neck injuries in ice hockey. A prospective study. *Am J Sports Med* 1995;23:773–5.
33. Watson RC, Singer CD, Sproule JR. Checking from behind in ice hockey: a study of injury and penalty data in the Ontario University Athletic Association Hockey League. *Clin J Sport Med* 1996;6:108–11.
34. Hagel BE, Fick GH, Meeuwisse WH. Injury risk in men's Canada West University football. *Am J Epidemiol* 2003;157:825–33.
35. Meeuwisse WH, Hagel BE, Mohtadi NG, et al. The distribution of injuries in men's Canada West university football. A 5-year analysis. *Am J Sports Med* 2000;28:516–23.
36. Hinton RY, Lincoln AE, Almquist JL, et al. Epidemiology of Lacrosse Injuries in High School-Aged Girls and Boys-A Three Year Prospective Study. *Am J Sports Med* 2005;33:1305–14.
37. Cummings RS Jr, Shurland AT, Prodoehl JA, et al. Injuries in the sport of luge. Epidemiology and analysis. *Am J Sports Med* 1997;25:508–13.
38. Minoyama O, Tsuchida H. Injuries in professional motor car racing drivers at a racing circuit between 1996 and 2000. *Br J Sports Med* 2004;38:613–6.
39. Hagel B, Pless IB, Goulet C, et al. The effect of helmet use on injury severity and crash circumstances in skiers and snowboarders. *Accid Anal Prev* 2005;37: 103–8.
40. Pieter W, Zemper ED. Head and neck injuries in young taekwondo athletes. *J Sports Med Phys Fitness* 1999;39:147–53.
41. Lorish TR, Rizzo TD Jr, Ilstrup DM, et al. Injuries in adolescent and preadolescent boys at two large wrestling tournaments. *Am J Sports Med* 1992;20:199–202.
42. Mundt DJ, Kelsey JL, Golden AL, et al. An epidemiologic study of sports and weight lifting as possible risk factors for herniated lumbar and cervical discs. The Northeast Collaborative Group on Low Back Pain. *Am J Sports Med* 1993;21:854–60.
43. van den Heuvel SG, Heinrich J, Jans MP, et al. The effect of physical activity in leisure time on neck and upper limb symptoms. *Prev Med* 2005;41:260–70.
44. Deleted in proof.
45. Al-Awadhi A, Olusi S, Moussa M, et al. Musculoskeletal pain, disability and health-seeking behavior in adult Kuwaitis using a validated Arabic version of the WHO-ILAR COPCORD core questionnaire. *Clin Exp Rheumatol* 2004;22:177–83.
46. Andersson HI, Ejlertsson G, Leden I, et al. Chronic pain in a geographically defined general population: studies of differences in age, gender, social class, and pain localization. *Clin J Pain* 1993;9:174–82.
47. Andersson H, Ejlertsson G, Leden I. Widespread musculoskeletal chronic pain associated with smoking. An epidemiological study in a general rural population. *Scand J Rehabil Med* 1998;30:185–91.
48. Andersson HI. The epidemiology of chronic pain in a Swedish rural area. *Qual Life Res* 1994;3:S19–26.
49. Andersson HI, Ejlertsson G, Leden I, et al. Musculoskeletal chronic pain in

general practice. Studies of health care utilisation in comparison with pain prevalence. *Scand J Prim Health Care* 1999;17:87–92.
50. Andrianakos A, Trontzas P, Christoyannis F, et al. Prevalence of rheumatic diseases in Greece: a cross-sectional population based epidemiological study. The ESORDIG Study. *J Rheumatol* 2003;30:1589–601.
51. Badley EM, Tennant A. Changing profile of joint disorders with age: findings from a postal survey of the population of Calderdale, West Yorkshire, United Kingdom. *Ann Rheum Dis* 1992;51:366–71.
52. Bassols A, Bosch F, Campillo M, et al. An epidemiological comparison of pain complaints in the general population of Catalonia (Spain). *Pain* 1999;83:9–16.
53. Borge AI, Nordhagen R. Recurrent pain symptoms in children and parents. *Acta Paediatr* 2000;89:1479–83.
54. Bovim G, Schrader H, Sand T. Neck pain in the general population. *Spine* 1994;19:1307–9.
55. Chaiamnuay P, Darmawan J, Muirden KD, et al. Epidemiology of rheumatic disease in rural Thailand: a WHO-ILAR COPCORD study. Community Oriented Programme for the Control of Rheumatic Disease. *J Rheumatol* 1998;25:1382–7.
56. Chiu TT, Lam TH, Hedley AJ. Correlation among physical impairments, pain, disability, and patient satisfaction in patients with chronic neck pain. *Arch Phys Med Rehabil* 2005;86:534–40.
57. Chiu TT, Leung AS. Neck pain in Hong Kong: a telephone survey on prevalence, consequences, and risk groups. *Spine* 2006;31:E540–4.
58. Chopra A, Saluja M, Patil J, et al. Pain and disability, perceptions and beliefs of a rural Indian population: A WHO-ILAR COPCORD study. WHO-International League of Associations for Rheumatology. Community Oriented Program for Control of Rheumatic Diseases. *J Rheumatol* 2002;29:614–21.
59. Chopra A, Patil J, Billempelly V, et al. Prevalence of rheumatic diseases in a rural population in western India: a WHO-ILAR COPCORD Study. *J Assoc Physicians India* 2001;49:240–6.
60. Ciancaglini R, Testa M, Radaelli G. Association of neck pain with symptoms of temporomandibular dysfunction in the general adult population. *Scand J Rehabil Med* 1999;31:17–22.
61. Côté P, Cassidy JD, Carroll L. The Saskatchewan Health and Back Pain Survey. The prevalence of neck pain and related disability in Saskatchewan adults. *Spine* 1998;23:1689–98.
62. Côté P, Cassidy JD, Carroll LJ. The factors associated with neck pain and its related disability in the Saskatchewan population. *Spine* 2000;25:1109–17.
63. Côté P, Cassidy JD, Carroll LJ. Is a lifetime history of neck injury in a traffic collision associated with prevalent neck pain, headache and depressive symptomatology? *Accid Anal Prev* 2000;32:151–9.
64. Ektor-Andersen J, Isacsson SO, Lindgren A, et al. The experience of pain from the shoulder-neck area related to the total body pain, self-experienced health and mental distress. The Malmo Shoulder-Neck Study group. *Pain* 1999;82:289–95.
65. Gordon SJ, Trott P, Grimmer KA. Waking cervical pain and stiffness, headache, scapular or arm pain: gender and age effects. *Aust J Physiother* 2002;48:9–15.
66. Guez M, Hildingsson C, Nilsson M, et al. The prevalence of neck pain: a population-based study from northern Sweden. *Acta Orthop Scand* 2002;73:455–9.
67. Guez M, Hildingsson C, Stegmayr B, et al. Chronic neck pain of traumatic and non-traumatic origin: a population-based study. *Acta Orthop Scand* 2003;74:576–9.
68. Hagen KB, Kvien TK, Bjorndal A. Musculoskeletal pain and quality of life in patients with noninflammatory joint pain compared to rheumatoid arthritis: a population survey. *J Rheumatol* 1997;24:1703–9.
69. Hagen K, Einarsen C, Zwart JA, et al. The co-occurrence of headache and musculoskeletal symptoms amongst 51 050 adults in Norway. *Eur J Neurol* 2002;9:527–33.
70. Zwart JA, Dyb G, Hagen K, et al. Analgesic overuse among subjects with headache, neck, and low-back pain. *Neurology* 2004;62:1540–4.
71. Hartvigsen J, Christensen K, Frederiksen H. Back and neck pain exhibit many common features in old age: a population-based study of 4,486 Danish twins 70–102 years of age. *Spine* 2004;29:576–80.
72. Hasvold T, Johnsen R. Headache and neck or shoulder pain—frequent and disabling complaints in the general population. *Scand J Prim Health Care* 1993;11:219–24.
73. Hasvold T, Johnsen R, Forde OH. Non-migrainous headache, neck or shoulder pain, and migraine—differences in association with background factors in a city population. *Scand J Prim Health Care* 1996;14:92–9.
74. Isacsson A, Hanson BS, Ranstam J, et al. Social network, social support and the prevalence of neck and low back pain after retirement. A population study of men born in 1914 in Malmo, Sweden. *Scand J Soc Med* 1995;23:17–22.
75. Jacobsson L, Lindgarde F, Manthorpe R. The commonest rheumatic complaints of over six weeks' duration in a twelve–month period in a defined Swedish population. Prevalences and relationships. *Scand J Rheumatol* 1989;18:353–60.
76. Kim K, Uchiyama M, Liu X, et al. Somatic and psychological complaints and their correlates with insomnia in the Japanese general population. *Psychosom Med* 2001;63:441–6.
77. Lahz S, Bryant RA. Incidence of chronic pain following traumatic brain injury. *Arch Phys Med Rehabil* 1996;77:889–91.
78. Lau EM, Sham A, Wong KC. The prevalence of and risk factors for neck pain in Hong Kong Chinese. *J Public Health Med* 1996;18:396–9.
79. Lee H, Nicholson LL, Adams RD, et al. Proprioception and rotation range sensitization associated with subclinical neck pain. *Spine* 2005;30:E60–7.
80. Luo X, Edwards CL, Richardson W, et al. Relationships of clinical, psychologic, and individual factors with the functional status of neck pain patients. *Value Health* 2004;7:61–9.
81. Makela M, Heliovaara M, Sievers K, et al. Prevalence, determinants, and consequences of chronic neck pain in Finland. *Am J Epidemiol* 1991;134:1356–67.
82. Minaur N, Sawyers S, Parker J, et al. Rheumatic disease in an Australian Aboriginal community in North Queensland, Australia. A WHO-ILAR COPCORD survey. *J Rheumatol* 2004;31:965–72.
83. Nilsson N. The prevalence of cervicogenic headache in a random population sample of 20–59 year olds. *Spine* 1995;20:1884–8.
84. Palmer KT, Syddall H, Cooper C, et al. Smoking and musculoskeletal disorders: findings from a British national survey. *Ann Rheum Dis* 2003;62:33–6.
85. Peterson C, Bolton J, Wood AR, et al. A cross-sectional study correlating degeneration of the cervical spine with disability and pain in United kingdom patients. *Spine* 2003;28:129–33.
86. Picavet HS, Schouten JS. Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC(3)-study. *Pain* 2003;102:167–78.
87. Rajala U, Keinanen-Kiukaanniemi S, Uusimaki A, et al. Musculoskeletal pains and depression in a middle-aged Finnish population. *Pain* 1995;61:451–7.
88. Salemi G, Savettieri G, Meneghini F, et al. Prevalence of cervical spondylotic radiculopathy: a door-to-door survey in a Sicilian municipality. *Acta Neurol Scand* 1996;93:184–8.
89. Schytt E, Lindmark G, Waldenstrom U. Physical symptoms after childbirth: prevalence and associations with self-rated health. *Int J ObstetGynaecol* 2005;112:210–7.
90. Thomas E, Peat G, Harris L, et al. The prevalence of pain and pain interference in a general population of older adults: cross-sectional findings from the North Staffordshire Osteoarthritis Project (NorStOP). *Pain* 2004;110:361–8.
91. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. [see comments]. *Ann Rheum Dis* 1998;57:649–55.
92. van der Donk J, Schouten JS, Passchier J, et al. The associations of neck pain with radiological abnormalities of the cervical spine and personality traits in a general population. *J Rheumatol* 1991;18:1884–9.
93. Webb R, Brammah T, Lunt M, et al. Prevalence and predictors of intense, chronic, and disabling neck and back pain in the UK general population. *Spine* 2003;28:1195–202.
94. Westerling D, Jonsson BG. Pain from the neck-shoulder region and sick leave. *Scand J Soc Med* 1980;8:131–6.
95. Wigley R, Manahan L, Muirden KD, et al. Rheumatic disease in a Philippine village. II: a WHO-ILAR-APLAR COPCORD study, phases II and III. *Rheumatol Int* 1991;11:157–61.
96. Zapletal J, Hekster RE, Straver JS, et al. Relationship between atlantoodontoid osteoarthritis and idiopathic suboccipital neck pain. *Neuroradiology* 1996;38:62–5.
97. Ehrmann-Feldman D, Shrier I, Rossignol M, et al. Risk factors for the development of neck and upper limb pain in adolescents. *Spine* 2002;27:523–8.
98. Haavet OR, Straand J, Saugstad OD, et al. Illness and exposure to negative life experiences in adolescence: two sides of the same coin? A study of 15-year-olds in Oslo, Norway. *Acta Paediatr* 2004;93:405–11.
99. Lien L, Claussen B, Hauff E, et al. Bodily pain and associated mental distress among immigrant adolescents: a population-based cross-sectional study. *Eur Child Adolesc Psychiatry* 2005;7:375.
100. Hakala P, Rimpelä A, Salminen J. J. et al. Back, neck, and shoulder pain in Finnish adolescents: national cross sectional surveys. *BMJ* 2002;325:743–6.
101. Harma A, Kaltiala-Heino R, Rimpela M, et al. Are adolescents with frequent pain symptoms more depressed? *Scand J Prim Health Care* 2002;2:96.
102. Holmen TL, Barrett-Connor E, Holmen J, et al. Health problems in teenage

daily smokers versus nonsmokers, Norway, 1995–1997: the Nord-Trondelag Health Study. *Am J Epidemiol* 2000;151:148–55.
103. Mikkelsson M, Salminen JJ, Kautiainen H. Non-specific musculoskeletal pain in preadolescents. Prevalence and 1-year persistence. *Pain* 1997;73:29–35.
104. Mikkelsson M, Sourander A, Piha J, et al. Psychiatric symptoms in preadolescents with musculoskeletal pain and fibromyalgia. *Pediatrics* 1997;100: 220–7.
105. Niemi S, Levoska S, Kemila J, et al. Neck and shoulder symptoms and leisure time activities in high school students. *J Orthop Sports Phys Ther* 1996;24:25–9.
106. Niemi SM, Levoska S, Rekola KE, et al. Neck and shoulder symptoms of high school students and associated psychosocial factors. *J Adolesc Health* 1997;20:238–42.
107. Smedbraten BK, Natvig B, Rutle O, et al. Self-reported bodily pain in schoolchildren. *Scand J Rheumatol* 1998;27:273–6.
108. van Gent C, Dols J, de Rover C, et al. The weight of schoolbags and the occurrence of neck, shoulder, and back pain in young adolescents. *Spine* 2003;9:916–21.
109. Vikat A, Rimpela M, Salminen JJ, et al. Neck or shoulder pain and low back pain in Finnish adolescents. *Scand J Public Health* 2000;28:164–73.
110. Wedderkopp N, Leboeuf-Yde C, Andersen LB, et al. Back pain reporting pattern in a Danish population-based sample of children and adolescents. *Spine* 2001;26:1879–83.
111. Wedderkopp N, Andersen LB, Froberg K, et al. Back pain reporting in young girls appears to be puberty-related. *BMC Musculoskelet Disord* 2005;6.
112. Whittfield J, Legg SJ, Hedderley DI. Schoolbag weight and musculoskeletal symptoms in New Zealand secondary schools. *Appl Ergon* 2005;36: 193–8.
113. Loney PL, Stratford PW. The prevalence of low back pain in adults: a methodological review of the literature. *Phys Ther* 1999;79:384–96.
114. Carroll LJ, Hogg-Johnson S, van der Velde G, et al. Course and prognostic factors for neck pain in the general population. Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33(Suppl):S75–S82.
115. Simmons EH, Bhalla SK. Anterior cervical discectomy and fusion. A clinical and biomechanical study with eight-year follow-up. *J Bone Joint Surg Br* 1969;51:225–37.
116. Whitecloud T, Seago R. Cervical Discogenic Syndrome: Results of Operative Intervention in Patients with Positive Discography. *Spine* 1987;12: 313–6.
117. Palit M, Schofferman J, Goldthwaite N, et al. Anterior discectomy and fusion for the management of neck pain. *Spine* 1999;24:2224–8.
118. Garvey T, Transfeldt EEM, Malcolm JRM, et al. Outcome of anterior cervical discectomy and fusion as perceived by patients treated for dominant axial-mechanical cervical spine pain. *Spine* 2002;27:1887–94.
119. Nordin M, Carragee EJ, Hogg-Johnson S, et al. Assessment of neck pain and its associated disorders. Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008; 33(Suppl):S101–S122.
120. Hurwitz EL, Carragee EJ, van der Velde G, et al. Treatment of neck pain: Non-invasive interventions. Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008; 33(Suppl):S123–S152.
121. Carroll LJ, Hogg-Johnson S, Côté P, et al. Course and prognostic factors for neck pain in workers. Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008; 33(Suppl):S93–S100.
122. Abenhaim L, Suissa S, Rossignol M. Risk of recurrence of occupational back pain over three year follow up. *Br J Ind Med* 1988;45:829–33.
123. Carey TS, Garrett JM, Jackman A, et al. Recurrence and care seeking after acute back pain: results of a long-term follow-up study. North Carolina Back Pain Project. *Med Care* 1999;37:157–64.
124. Dunn MK, Croft PR. Epidemiology and natural history of low back pain. *Eura Medicophys* 2004;40:9–13.
125. Elders LA, Burdorf A. Prevalence, incidence, and recurrence of low back pain in scaffolders during a 3-year follow-up study. *Spine* 2004;29:E101–6.
126. Enthoven P, Skargren E, Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. *Spine* 2004;29: 2458–65.
127. Ghaffari MM, Alipour AM, Farshad AAP, et al. Incidence and recurrence of disabling low back pain and neck-shoulder pain. [Miscellaneous Article]. *Spine* 2006;31:2500–6.
128. Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: what is the long-term course? A review of studies of general patient populations. [Review] [46 refs]. *Eur Spine J* 2003;12:149–65.
129. Oleske DM, Lavender SA, Andersson GB, et al. Risk factors for recurrent episodes of work-related low back disorders in an industrial population. *Spine* 2006;31:789–98.
130. Wasiak R, Pransky G, Verma S, et al. Recurrence of low back pain: definition-sensitivity analysis using administrative data. *Spine* 2003;28:2283–91.
131. Wasiak R, Verma S, Pransky G, et al. Risk factors for recurrent episodes of care and work disability: case of low back pain. *J Occup Environ Med* 2004;46:68–76.
132. Chopra A. The WHO–ILAR COPCORD Bhigwan (India) model: foundation for a future COPCORD design and data repository. *Clin Rheumatol* 2006;25:443–7.
133. Muirden KD. The developing relationship between the World Health Organization and the International League Against Rheumatism. *J Rheumatol* 1991;18:793–5.
134. Bates D, Buchwald D, Lee J, et al. A comparison of case definitions of chronic fatigue syndrome. *Clin Infect Dis* 1991;18(Supp 1):S11–5.
135. Beaton DE, Cole DC, Manno M, et al. Describing the burden of upper-extremity musculoskeletal disorders in newspaper workers: what difference do case definitions make? *J Occup Rehabil* 2000;10:39–53.
136. Harrington JM, Carter JT, Birrell L, et al. Surveillance case definitions for work related upper limb pain syndromes. *Occup Environ Med* 1998;55: 264–71.
137. Hyams KC. Developing case definitions for symptom-based conditions: the problem of specificity. *Epidemiol Rev* 1998;20:148–56.
138. Katz JN, Larson MG, Fossel AH, et al. Validation of a surveillance case definition of carpal tunnel syndrome. *Am J Public Health* 1991;81:189–93.
139. Pope DP, Croft PR, Pritchard CM, et al. Prevalence of shoulder pain in the community: the influence of case definition. *Ann Rheum Dis* 1997; 56:308–12.
140. Seligman PJ, Matte TD. Case definitions in public health. *Am J Public Health* 1991;81:161.