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The Burden and Determinants of Neck Pain in Workers

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

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

Study Design. Systematic review and best evidence synthesis.

Objectives. To describe the prevalence and incidence of neck pain and disability in workers; to identify risk factors for neck pain in workers; to propose an etiological diagram; and to make recommendations for future research.

Summary of Background Data. Previous reviews of the etiology of neck pain in workers relied on cross-sectional evidence. Recently published cohorts and randomized trials warrant a re-analysis of this body of research.

Methods. We systematically searched Medline for literature published from 1980–2006. Retrieved articles were reviewed for relevance. Relevant articles were critically appraised. Articles judged to have adequate internal validity were included in our best evidence synthesis.

Results. One hundred and nine papers on the burden and determinants of neck pain in workers were scientifically admissible. The annual prevalence of neck pain varied from 27.1% in Norway to 47.8% in Québec, Canada. Each year, between 11% and 14.1% of workers were limited in their activities because of neck pain. Risk factors associated with neck pain in workers include age, previous musculoskeletal pain, high quantitative job demands, low social support at work, job insecurity, low physical capacity, poor computer workstation design and work posture, sedentary work position, repetitive work and precision work. We found preliminary evidence that gender, occupation, headaches, emotional problems, smoking, poor job satisfaction, awkward work postures, poor physical work environment, and workers' ethnicity may be associated with neck pain. There is evidence that interventions aimed at modifying workstations and worker posture are not effective in reducing the incidence of neck pain in workers.

Conclusion. Neck disorders are a significant source of pain and activity limitations in workers. Most neck pain results from complex relationships between individual and workplace risk factors. No prevention strategies have been shown to reduce the incidence of neck pain in workers.

Key words: neck pain, work, disability, sick leave, systematic review, epidemiology, incidence, risk factors, etiology.

From the *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; Institute for Work & Health, Toronto, Canada; †Institute for Work & 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 Excellence in Improved Disability Outcomes (CREIDO), University Health Network Rehabilitation Solutions, Toronto Western Hospital, Toronto, Canada; ‡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 Public Health Sciences, and the Alberta Centre for Injury Control and Research, School of Public Health, University of Alberta, Canada; ‖Institute for Work & Health, Toronto, Canada; Department of Public Health Sciences, University of Toronto, Canada; **Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden; ††Department of Orthopaedic Surgery, Stanford University School of Medicine, USA; Orthopaedic Spine Center and Spinal Surgery Service, Stanford University Hospital and Clinics, USA; ‡‡Department of Neurology, University of California, Irvine, USA; Department of Epidemiology, School of Public Health, University of California, Los Angeles, CA; §§Departments of Orthopaedics and Environmental Medicine and Program of Ergonomics and Biomechanics, School of Medicine and Graduate School of Arts and Science, NY University, NY; Occupational and Industrial Orthopaedic Center (OIOC), NY University Medical Center, NY; ‖‖Department of Public Health Sciences, John A. Burns School of Medicine, University of Hawaii at Mānoa, Honolulu, HI, USA; ***Department of Medicine, University of British Columbia, Canada; Occupational Health and Safety Agency for Healthcare in BC, Canada; †††Endocrinology, Analgesia and Inflammation, Merck & Co. Rahway, NJ.

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Address correspondence to Pierre Côté, DC, PhD, Toronto Western Hospital, Fell Pavilion 4-124, 399 Bathurst Street, Toronto, ON M5T 2S8; E-mail: pcote@uhnresearch.ca

For centuries the nature of work has influenced the health of populations. The economies of industrialized countries, which once depended on manufacturing and resource extraction jobs, now rely largely on the service sector for growth and prosperity. The shift from manufacturing and resource-based jobs to the service industry has transformed the nature of work injuries and disability. The high rate of acute and fatal injuries observed in most countries at the beginning of the 20th century has been replaced by a sharp increase in the incidence of compensated musculoskeletal disorders such as back and neck pain.[1–4] This wave of musculoskeletal disorders has led workers, employers, unions, clinicians, insurers and policy-makers to ask 3 important questions: Is neck pain

an important source of disability? Do physical and psychosocial exposures at the workplace contribute to the development of neck pain? Can we modify the workplace to reduce the burden of disability associated with neck pain? As we demonstrate with our review, these questions have generated a large body of research aimed at identifying the risk factors of neck pain in workers.

However, answering these questions poses significant challenges. First, it is difficult to precisely determine the onset of neck pain in individuals. It appears that, in today's workplaces, most neck pain develops gradually and follows an episodic course throughout people's lives.[5] Second, diagnosing "work-related" neck pain and determining the exact contribution of work to the onset of neck pain remains an elusive goal.[6] Third, the pathways by which work impacts on health are complex. They depend on a variety of factors such as individual worker characteristics, the workplace environment, organizational and management policies, the type of health care available to workers, and prevailing social structures and economic systems. The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders (Neck Pain Task Force) has addressed these challenges by adopting a life course perspective that integrates the impact of risk and prognostic factors on neck pain.

In the past 20 years, several systematic reviews have synthesized the evidence linking work-related exposures to neck pain.[7–10] Collectively, these reviews found weak evidence that physical and psychosocial risk factors increase the risk of neck pain. Because of the limited number of prospective studies, previous reviews relied heavily on cross-sectional findings to inform their conclusions. Fortunately, there has been an increase in the number of cohort studies in the past 10 years. This new body of knowledge has enabled the Neck Pain Task Force to address the limitations of previous reviews.

Our review adopts a global perspective on the etiology of neck pain in workers. We did not limit our work to occupational exposures. Rather, we synthesized the evidence by integrating worker, workplace and social determinants of neck pain. Our study has 4 objectives. First, we describe the burden of neck pain and disability in workers. Second, we aim to understand the determinants of neck pain in workers by synthesizing the evidence on risk factors. Third, we use the scientific evidence to propose an etiological diagram of neck pain in workers. Finally, we make concrete recommendations for future research.

Methods

Design and Data Collection

We conducted a systematic review of the literature. The literature search and critical review strategy are outlined in detail elsewhere in this report.[11] Briefly, we systematically searched the electronic library database Medline for literature published from 1980 through 2006 on neck pain and its associated disorders (e.g., cervicogenic headache and other referred pain syndromes into the arm and upper back). We also systematically checked reference lists of relevant articles and updated our search with key articles from 2006 and early 2007.

Relevance Screening

We used inclusion and exclusion criteria to screen all titles and abstracts for their relevance to the overall mandate of the Neck Pain Task Force.[11] For this article, studies were considered relevant if they pertained to the prevalence, incidence, risk factors or prevention of neck pain in samples of at least 20 workers. We included studies that investigated pain in the "neck/shoulder" area. Studies were excluded if they were about neck pain that was associated with serious local pathology or systemic disease, such as neck pain from infections; fractures or dislocations; myelopathy; rheumatoid arthritis and other inflammatory joint diseases; or tumors. We also excluded studies that focused on specific shoulder diagnoses (*e.g.*, tendonitis) if the condition was not associated with neck pain.

Quality Assessment

Rotating pairs of Scientific Secretariat members independently reviewed each article to determine its methodologic quality. The criteria used to assess quality are available in Carroll *et al*[11] and online through Article Plus. The purpose of our critical appraisal was to make an informed judgment about the internal validity of studies.[12] A study was deemed scientifically admissible when reviewers judged that selection bias, information bias and confounding had not fatally threatened its internal validity. Only studies judged to be scientifically admissible were included in our analysis.

Analysis

We synthesized the literature according to the principles of best evidence synthesis.[13,14] In best evidence synthesis, scientifically admissible studies are qualitatively synthesized; more weight is given to evidence from studies whose designs make them the least vulnerable to bias.[11,12]

Following this principle, we restricted our analysis to study designs in which the exposure clearly preceded the development of neck pain (case-control studies, cohort studies and randomized controlled trials). Moreover, we stratified the scientifically admissible studies into Phase I, II or III studies.[15–17] This stratification distinguishes between 3 hierarchical phases of research aimed at determining "causal" relationships between a risk factor and a health outcome, and has been used elsewhere in the Neck Pain Task Force report.[5,18–21]

Phase I studies describe crude associations. Crude associations result from bivariate analyses (*e.g.*, gender and neck pain) and are therefore potentially confounded. Phase II studies are exploratory analyses that focus on particular sets of risk factors, or attempt to discover which risk factors predict the development of neck pain without an explicit attempt to control for confounders. In Phase II studies, no specific etiological hypothesis is tested. Phase III investigations are confirmatory studies of explicitly prestated hypotheses that allow for the quantification of the strength, direction and independence of the proposed relationship between a risk factor and the development of neck pain.

As we reviewed the studies, we assumed that the strength of evidence increased from Phase I to Phase III (*i.e.*, evidence from Phase I studies was less valid than evidence from Phase II studies; evidence from Phase II studies was less valid than evidence from Phase III studies). In cases where study results were discordant, we used our scientific judgment (informed by the methodologic quality of each study) to weigh the evidence. For

example, effect sizes reported from Phase II cohort studies where residual confounding is potentially present were given less weight than effect sizes from a Phase III study. Similarly, Phase II results derived from stepwise regression were given less weight than Phase II results obtained from a theoretically driven analysis that included relevant risk factors.

We summarized the evidence on the association between risk factors and the incidence of neck pain by using 1 of 4 qualifiers.

Preponderance of Evidence. According to Webster's dictionary, preponderance is defined as "superiority in weight, power, importance, or strength." We report that the preponderance of evidence suggests that a risk factor is associated with an increase or reduction in the incidence of neck pain when at least 1 Phase III study and at least 1 Phase II study agree in the strength and direction of the association.

Evidence. We do not use the qualifier "preponderance" to describe evidence from a single Phase III study. Rather, we simply used the term "evidence."

Preliminary Evidence. According to Webster's dictionary, the adjective preliminary refers to something that is "coming before and usually forming a necessary prelude to something else." Therefore, we qualify evidence as preliminary when at least 1 Phase II or Phase I study suggests the presence of an association between a risk factor and the incidence of neck pain. The Neck Pain Task Force believes that preliminary evidence *needs* to be confirmed in Phase III studies.

Evidence Varies. We report that the evidence varies when multiple studies of similar scientific quality do not agree on the presence or direction of an association between a risk factor and the incidence of neck pain. We recognize that the apparent lack of agreement may be related to methodologic differences (*e.g.*, selection criteria, confounding adjustment) or to effects that are specific to populations (suggesting effect modification). The Neck Pain Task Force believes that associations for which the evidence is not clearly established *need* to be studied in Phase III studies.

We present the prevalence and incidence of neck pain with 95% confidence intervals (CI). We computed these statistics using Epi Info (http://www.cdc.gov/EpiInfo/) when the original authors failed to provide them but gave sufficient information for their computation. Confidence intervals were calculated using standard formulas.[22] Results from case-control, cohort and randomized trials are reported as odds ratios (OR), relative risks (RR), hazard rate ratios (HRR) or standardized hospitalization ratios (SHR) and 95% CI. For cross-sectional studies, we only report the direction of the association (positive or negative) between the factor and neck pain. Throughout the paper, we use the term disability to describe limitations in activities of daily living.

■ Results

Selection and Critical Appraisal of Articles

Overall, the Task Force retrieved 31,878 citations, of which 1203 met the inclusion criteria for relevance to the Neck Pain Task Force and were reviewed.[11] Six hundred and fifty-one articles were excluded because they were appraised as scientifically inadmissible by the Scientific Secretariat of the Neck Pain Task Force.[11] Of the 552 scientifically admissible articles, 469 related to the incidence, risk factors, prevalence and factors associated with prevalent neck pain: 109 of these articles were specific to neck pain in workers and are the subject of the following best evidence synthesis on the burden and determinants of neck pain in workers. (Scientifically admissible articles related to the burden and determinants of neck pain in the general population and in whiplash-associated disorders are reported elsewhere).[20,21] Of the 109 scientifically admissible articles on neck pain in workers, 88 papers reported from cross-sectional results (Table 1, available online through Article Plus),[23–53,55–65,79,82,91–134] and 27 related to cohort studies (Table 2, available online through Article Plus).[3,40,43,44,46,54,65–82,84–86] (Seven papers reported both cross-sectional and longitudinal findings.) We also accepted 1 randomized controlled trial (Table 3, available online through Article Plus).[87] Our evidence tables are published online through Article Plus.

The Burden of Neck Pain in Workers

Point and 1-Week Prevalence

The prevalence of neck pain varied considerably across occupations and populations. Specifically, the point prevalence ranges from 4.8% in Mexican males employed in shoe-making factories to 50.8% in California drivers who were members of a transit union (Table 1, available online through Article Plus).[41,42]

Reports from Norway and the United Kingdom (U.K.) show that between 10.6% and 19.6% of workers experienced neck pain each week.[36,43] Similarly, in Sweden, the 1-week prevalence of neck pain varied from 7.3% in office workers to 53% in female plant workers exposed to repetitive work employed in the laminate industry.[45,97]

Annual Prevalence of Neck Pain in Workers Sampled From the General Population

Each year, neck disorders are associated with a high burden of pain and disability in the working population. General population surveys of workers suggest that the annual prevalence of neck pain ranged from 27.1% in Norway to 33.7% the U.K. and to 47.8% in Quebec, Canada (Table 1, available online through Article Plus).[36,43,47] In France, 10.2% of workers attending their annual visit with an occupational physician were found to be suffering from chronic neck pain associated with functional limitations.[40]

We found evidence that neck pain is a pervasive source of activity limitation in workers. Specifically, the annual prevalence of neck pain that interfered with daily activities was 11% in the U.K. and 14.1% in Canada.[36,46,47] In Sweden, 49% of workers with neck/upper back pain answered "yes" when asked: "Has it happened over the previous 12 months that you have gone to work despite feeling that you really should have taken sick leave due to your state of health?"[48] This finding suggests that external pressures (financial, job security, deadlines, *etc.*) may influence the de-

cision of workers to remain at work despite being limited in some activities of daily living.

Annual Prevalence of Neck Pain Within Specific Occupations

We found that the annual prevalence of neck pain varied across occupations. Among health care workers, the annual prevalence of neck pain ranged from 17% in dentists, 26% in pharmacists and 72% in dental hygienists (Table 1 and Figure 1, available online through Article Plus).[23,49,50] Dentists and nurses were particularly affected by neck disorders, with annual prevalence ranging from 17% to 66% in dentists[23,49–54] and from 23.6% to 62.7% in nurses.[24,32,37–39,55–58] Each year, between 5.1% and 6.0% of dentists and 3.9% and 5.1% of nurses experienced work limitations because of neck pain.[23,32,37–39,49,51]

In office workers, the 1-year prevalence of neck pain varied from 17.7% in Norwegian administrative workers to 43.2% in Brazilian call center operators and 63.0% in Swedish secretaries (Table 1, Figure 2, available online through Article Plus).[31,59,60] In the United States, during a 12-month period 5% of office workers employed at a newspaper reported missing work because of neck pain.[61]

Among workers in manual occupations, the annual prevalence of neck pain varied from 16.5% in spinning industry production line workers in Lithuania to 74% in Swedish crane operators (Table 1 and Figure 3, available online through Article Plus).[30,62] The annual prevalence of sickness absence related to neck disorders ranged from 7.8% in Norwegian car mechanics to 8.5% in Dutch welders and metal workers.[63,64]

Annual Incidence of Neck Pain Among Workers Sampled From the General Population

In 1991, the 6-month incidence of neck disorders among workers in France was 44.4% for workers with a history of neck pain and 17.4% for those without such a history (Table 2, available online through Article Plus).[65] Another French study conducted between 1990 to 1995 found that the 5-year incidence of persistent neck pain associated with functional limitations was 9.4%.[40] During the same period in the Netherlands, the annual incidence of frequent or persistent neck pain was 5.7% among employees working for industrial and service companies.[66] Östergren *et al* found a very similar incidence rate in Malmö, Sweden: 6% of men and 8.1% of women developed frequent or persistent neck pain annually.[67]

We accepted 1 U.S. study which looked at the rate of worker compensation for neck pain between 1990 and 1997 in the state of Washington. The study found that the annual incidence of claims for soft tissue disorders of the neck was 40.1 per 10,000 full-time equivalents in workers covered by the state compensation fund compared to 5.1 per 10,000 full-time equivalents in workers employed by self-insured firms (Table 2, available online through Article Plus).[3] In the same study, the incidence rate of lost-time claims of 4 days or more was 19.1 per 10,000 full-time equivalents.[3]

Annual Incidence of Neck Pain Within Specific Occupations

Twelve cohort studies (Table 2, available online through Article Plus) describe the incidence of neck pain in dentists,[54] drivers,[68] forestry workers,[69] technicians,[44] music students,[70] nursing home employees,[71] nurses,[72] office workers/computer users,[73–76] and transit vehicle operators[77]

Office and computer workers had the highest incidence of neck disorders.[68,73,74,76] A U.S. study found that the incidence of neck pain among asymptomatic office workers in the city of Atlanta, GA was 57.5 per 100 worker-years.[73] A Swedish study of workers without neck pain employed in municipal administrative units found an incidence rate of 36 per 100 worker-years (Table 1, available online through Article Plus).[76] In Finland, 34.4% of municipal employees (without neck pain or who had experienced fewer than 8 days of neck pain in the previous year) reported having neck pain for more than 8 days during a 1-year follow-up.[74] Similarly, among computer users employed in 11 Danish firms, 15.4% of men and 25.5% of women (without neck pain or fewer than 8 days of neck pain in the previous year) reported having neck pain for more than 8 days during a 1-year follow-up (Table 2, available online through Article Plus).[68] Interestingly, a Finnish study conducted in the mid-1980s found that manual workers (carpenters and machine operators) had a higher incidence of neck pain than office workers.[78,79]

The annual incidence of neck pain was also high in health care workers. Studies showed that 10% of Swedish dentists, 17% of English nurses and 19% of Dutch nursing home employees reported experiencing at least 1 episode of neck pain annually (Table 2, available online through Article Plus).[54,71,72]

Three studies described the incidence of neck pain in other occupations. In Finland, the annual incidence of radiating neck pain was 5.2% in forestry workers.[69] In Denmark, 1.5% of unionized technicians/computer workers reported moderate neck pain in the previous 7 days.[44] Finally, 25.5% of a cohort of San Francisco transit operators made workers' compensation claims for incident nontraumatic soft tissue neck injuries during a 7.5 year period.[77]

Annual Incidence of Cervical Disc Herniation/Prolapse in Workers

Two studies provided information on the incidence of cervical spine disc herniation in workers. The rate of hospitalization for cervical spine disc herniation among Danish drivers was 0.33 per 1000 driver-years.[68] This Phase I study from Denmark found that professional drivers (truck, taxi, bus and railway) were more likely to be hospitalized for a cervical disc prolapse than men working in other occupations.[68] In U.S. army aviators, the incidence of cervical disc herniation was 0.26 per 1000 aviator-years.[80]

Risk Factors for Neck Pain Among Workers

Our best evidence synthesis includes 19 cohort studies and 1 randomized control trial investigating the risk factors (determinants) for neck pain in workers (Table 2, available online through Article Plus).[40,43,44,46,65–68,70–79,81,82,84–87] Because of the substantial number of scientifically admissible cohort studies, we did not rely on associations reported in cross-sectional studies to make recommendations on specific risk factors. Rather, information from scientifically admissible cross-sectional studies was used to highlight plausible hypotheses for future research (Table 1, available online through Article Plus).

Demographic and Socioeconomic Characteristics

Age. The preponderance of evidence indicates that the incidence of neck pain increases with age. One Phase III study[76] and 5 Phase II studies[40,46,71–74,78,79] reported that older worker were more likely than younger workers to develop neck pain. In most studies, the effect of age peaked in the fourth and fifth decades of life and remained stable thereafter. Three Phase II studies[43,44,75] found no association and 2 Phase I studies found an inverse relationship between age and neck pain.[67,75]

Gender. We found preliminary evidence that women experience more neck pain than men. Six Phase II studies reported an increased risk for working women.[40,44,67,68,73,74] Two Phase II studies reported no associations between gender and the risk of neck pain in workers.[43,46,71]

Marital and Family Status. The evidence varies in 3 studies linking marital status to neck pain incidence. In Norway, a Phase II study found that being married or cohabiting was associated with an increased risk for neck pain (*vs.* being single).[43] In Sweden, a Phase II study reported that widowed men aged 45 to 65 years were more likely to develop persistent neck pain compared to married men.[67] In the same study, women who were divorced had a higher incidence of frequent neck pain compared to married women. One Phase II study of Dutch nursing home workers did not find an association between family status and the incidence of neck pain.[46,71] We found no evidence that having young children (<6 years old) increased the risk of neck pain.[73]

Education. The evidence varies in 2 studies linking education to the risk of neck pain. A Phase II Swedish cohort study by Östergren *et al* reported that workers with fewer than 9 years of education had an increased risk of persistent neck pain compared to those with more than 12 years of education.[67] However, Gerr *et al* (Phase II study) reported that having a college degree did not affect the incidence of neck pain in a cohort of American office workers.[73]

Income. We found preliminary evidence that income was not associated the risk of neck pain. In their phase II study, Gerr *at al* found no difference in the incidence of neck pain across income levels (those earning $25,000–$49,999 *vs.* ≥$50,000) in a cohort of office workers in Atlanta, GA.[73]

Occupation. We found preliminary evidence that occupation and occupational class is associated with the risk of neck pain. The studies reported in the section on the "*annual incidence of neck pain within specific occupations*" show that the incidence varies across occupations. Moreover, a Swedish Phase II study by Östergren *et al* found that male manual workers had an increased risk of developing persistent neck pain compared to male executives or professionals.[67] However, a French Phase II study by Cassou *et al* reported no difference in the risk of chronic neck pain among executives, clerks and blue-collar workers.[40]

Duration of Employment. The evidence linking duration of employment to the incidence of neck pain varies in 2 studies. A Danish Phase II study by Jensen *at el* found an inverse relationship between duration of employment and the incidence of neck pain.[75] However, crude odds ratios from a Finnish study of carpenters, office workers and machine operators suggests that those with a longer tenure at the same occupation (>15 years) had a higher risk of experiencing neck pain.[79]

Ethnicity and Cultural Factors

Ethnicity. We found preliminary evidence that the incidence of neck pain may vary between ethnic groups. In their Phase II cohort study of office workers in Atlanta, GA, Gerr *et al* found that nonwhite workers had a lower incidence of neck pain than whites.[73]

Country of Origin. There is preliminary evidence that country of origin is associated the development of persistent neck pain. Based on their Phase II study of Malmö residents, Östergren *et al* reported that workers who did not originate from Sweden were more likely to develop persistent neck pain.[67]

General Health, Prior Pain and Comorbidities

Physical Capacity. We found evidence that low-to-moderate physical capacity of the neck and shoulder musculature is associated with an increased risk of neck pain. A Phase III analysis of Dutch workers by Van der Grinten *et al* found that the incidence of regular or prolonged neck pain increased by 21% and 31% in workers who displayed low-to-moderate performance in tests designed to determine isokinetic neck/shoulder lifting strength.[81] Similarly, the risk of neck pain increased by 15% to 22% among workers with low-to-moderate static endurance of the neck muscles.[81]

History of Musculoskeletal Symptoms. The preponderance of evidence indicates that a history of musculoskeletal pain or tension in the neck, lower back or upper extremities increases the risk of neck pain in workers. One Phase III study,[76] 6 Phase II studies[40,44,67,72,73,75] and 2 Phase I analyses reported consistent findings that support this

association.[43,65] However, a Phase II study of Danish technicians found no association between a history of medical disorder (musculoskeletal or neurologic impairment) and the incidence of neck pain.[44]

Cervical Spondylosis. We found no scientifically admissible study reporting on the association between degenerative changes in the cervical spine and the incidence of neck pain.

Obesity, Body Mass Index and Anthropometric Measures. The evidence varies in 4 studies linking obesity and anthropometric measures to the risk of neck pain. Two Phase II studies found that obesity ($\geq$30 kg/m^2) was associated with an increased risk of neck pain in English nurses and in nursing home employees in the Netherlands.[71,72] However, 2 Phase II studies involving American office workers and Danish technicians do not support this relationship.[44,73] Finally, 1 Phase II study of American office workers found that those in or below the 20th percentile in height (*i.e.*, $<$1.58 m for women and $<$1.73 m for males) had a lower incidence of neck pain.[73]

Headache. There is preliminary evidence that a history of headaches is associated with an increased risk of neck pain. A Phase II cohort study of working residents in Ullensaker, Norway by Eriksen *et al* found that those who had suffered from headaches in the previous year were more likely to develop neck pain in the subsequent year.[43]

Self-Assessed Health Status. The evidence varies in 2 studies linking self-assessed health status to the risk of neck pain. Two Phase II studies reported divergent results.[46,71,74] In Finland, Korhonen *et al* found no association between self-rated health status and neck pain in municipal workers.[74] However, Luime *et al* found that Dutch nursing home employees who reported poor/fair general health were more likely to develop neck pain than those who reported good health.[46,71]

Individual Psychological Factors

Depressive/Emotional Symptoms. We found preliminary evidence that workers who experienced depressive or emotional symptoms have a higher risk of developing neck pain. A Phase II study of French workers suggests that those reporting depressive symptoms at baseline were more likely to develop chronic neck pain.[40] Similarly, a Phase II study from Ullensaker, Norway found that individuals reporting emotional symptoms were more likely to report having experienced an episode of neck pain at follow-up.[43] Finally, a Phase II study of Danish technicians found a weak association between negative affectivity and the development of neck pain.[44] However, no association was found between the frequency of depressive symptoms and the development of neck pain in a Phase II study of Finnish municipal workers.[74]

Mental Stress and Strain. The evidence varies in studies linking mental stress and mental strain to the incidence of neck pain. In their study of Finnish municipal workers, Korhonen *et al* reported no association between mental stress or mental strain (stress and strain were not defined in the article) and the incidence of neck pain.[74] This result contrasts with the finding that stress at work may be associated with a higher incidence of neck pain (see below).[43]

Personality Type. There is preliminary evidence that workers who report signs of "Type A" personality may be at an increased risk of developing neck pain. In their study of Danish technicians, Brandt *et al* found that workers who reported competitive, jealous, ambitious and impatient behaviors were more likely to report neck pain at follow-up than those who did report engaging in such behaviors.[44]

Need for Recovery After a Day's Work. We found preliminary evidence that "need for recovery after a day's work" is not associated with to the incidence of neck pain. In their Phase II study of Dutch nursing home employees, Luime *et al* reported that the incidence of neck pain did not differ between those who scored high on a self-reported "need for recovery" scale (*vs.* those who scored low).[71]

Health Behaviors

Physical Activity. The evidence on the association between physical or sports activity during leisure time and the risk of neck pain varies in 8 studies. One phase III study reported a small decrease (OR = 0.82; 95% CI 0.67–0.99) in the incidence of neck pain in workers who participated in sporting activities for at least 10 months per year.[82] However, this study included both workers with and without neck pain at baseline which may have led to prevalence-incidence bias. One Phase II study noted a small reduction in the risk for developing chronic neck pain among male workers who engaged in sporting activity (compared to those who did not).[40] In contrast, 6 Phase II studies found that workers who exercised regularly or participated in sporting activities had a similar incidence of neck pain when compared to those who did not engage in recreational physical activities.[43,44,46,71,74,78,79]

Smoking. We found preliminary evidence that smoking increases the risk of neck pain. Four Phase II studies found that smokers or ex-smokers were at greater risk for developing neck pain compared to those who never smoked.[40,74,78,79] However, 1 Phase II study did not support this association.[43]

Other Factors. We found no evidence that sleep quality, time spent on domestic activities or time spent on hobbies by workers was associated with the development of neck pain.[43,74] One Phase II study reported that the number of kilometers driven per year by workers was not related to the incidence of neck pain.[78,79]

Self-reported Psychosocial/Organization Exposures at the Workplace

Job Strain. The preponderance of evidence indicates that high levels of psychological job strain increase the risk of neck pain. Most studies evaluated job strain as it has been defined by Karasek *et al*.[83] Four Phase III studies[66,76,77,84] found that workers with high job strain scores had a higher incidence of neck pain. This finding is supported by 4 Phase II studies; these studies found that workers exposed to high job strain/demands or low job control were more likely to develop neck pain than those exposed to lower strain/demands and more job control.[44,46,71,74,75,85] Three Phase II studies reported that job demands[43,72] or job control[40,72] were not associated with neck pain.

Social Support. The preponderance of evidence indicates that workers who report low coworker support are more likely to develop neck pain. This finding comes from 2 Phase III studies of Dutch workers and San Francisco transit operators[74,77]; and 2 Phase II studies of Danish technicians[44] and computer users.[75] Two Phase II studies found no association between social support and neck pain in cohorts of English nurses[72] and Dutch nursing home workers,[46,71]suggesting that the effect of social support on neck pain may vary across occupations.

Satisfaction With Work/Workplace. We found preliminary evidence that job satisfaction is not associated with the incidence of neck pain. The best study investigating this association, a Phase II study of Finnish municipal workers, found no relationship between job satisfaction and experiencing local or radiating neck pain for more than 8 days during a 1-year follow-up.[74] Four studies found that workers who expressed job dissatisfaction had higher rates of neck pain compared to those who were more satisfied at work. However, it is important to note that these findings are based on crude analyses suggesting weak associations.[43,44,72,79]

Job Security. We found evidence that job security is associated with the risk of neck pain. In their Phase III study of Dutch workers, Ariens *et al* found that workers who reported job insecurity had a small increased risk of neck pain.[66]

Other Psychosocial/Organization Exposures at the Workplace. Several factors have been evaluated in single Phase II studies. These studies do not support an association between neck pain and: taking breaks while working at a computer[74]; doing shift-work[40]; the possibility for development,[75] the quality of computer technical support at work[75]; or the number of psychosocial factors (shift work, staff shortage, mental load and psychological load) at work.[55] However, there is preliminary evidence that stress at work[43] and frequently experiencing technical problems with a computer[75] may be associated with an increased risk of neck pain.

Physical Risk Factors at Work

Prolonged Work in a Sedentary Position. The preponderance of evidence suggests that working in a sedentary position for prolonged periods increases the risk of neck pain. In their Phase III study of Dutch workers, Ariens *et al* found that workers who sat for more than 95% of the time had more than twice the risk of developing neck pain compared to workers who spent less time sitting down on the job.[85] Similarly, 2 Danish studies from Jensen *et al*[75] and Brandt *et al*[44] found that workers who spent a significant proportion of their work week at a computer were at greater risk of developing neck pain. These results are supported by crude associations in Norwegian municipal workers and Dutch nursing home workers.[43,71] However, 2 Phase II studies did not find an association between prolonged sitting, standing or computer work and neck pain.[43,74]

Repetitive and Precision Work. The preponderance of evidence indicates that repetitive or precision work is associated with a small increase in the risk of neck pain. In their Phase III study of Swedish computer users, Wahlström *et al* reported that workers who performed repetitive or precision work on a daily or almost daily basis were between 30% and 40% more likely to report at least 3 days of neck pain per month.[76] The authors reported that the effect of repetitive and precision work was magnified (effect modification) by the presence of high levels of muscular tension and job strain.[76] These findings are supported by Phase II studies of French workers,[40] Swedish music students,[70] and by crude results from cohorts of Danish female computer users,[75] and Dutch nursing home employees.[71] Only 1 study (Phase II) reported no association between repetitive work and neck pain.[43]

Neck Posture. We found evidence that working with the cervical spine in flexion for prolonged periods of time may increase the risk neck pain. In their Phase III cohort study of Dutch workers Ariens *et al* reported that working with the neck in forward flexion ($\geq$20°) more than 70% of the time seemed to increase workers' risk of developing neck pain.[85] However, the same study did not find an association between neck pain and working with the neck in forward flexion ($\geq$45°) more than 10% of the time; nor did it find any link between neck pain and working with the neck rotated ($\geq$45°).

Working With Hands Above the Shoulders. The evidence varied in 2 studies linking work done with the hands above shoulder level to the risk of neck pain. Both Phase II studies reported weak crude associations.[43,46,71] Eriksen *et al* found that the incidence of neck pain was lower in Norwegian municipal employees who worked with their hands above their shoulders compared to those who did not.[43] However, Luime *et al* (Phase II study) found that Dutch nursing home workers who worked with their hands elevated had a higher incidence of neck pain.[46,71]

Awkward Postures. We found preliminary evidence that working in awkward positions increases the risk of neck pain. In the Netherlands, nursing home workers who worked in awkward positions (frequent bending or turning of the torso or working in uncomfortable positions) experienced a higher incidence of neck pain than those who did not report awkward postures.[46,71] Similarly, crude effects from a Finnish cohort of carpenters, office workers and machine operators suggest that regular bending or twisting of the trunk at work may increase the risk of neck pain.[79]

Heavy Physical Work. The evidence varies in 4 studies linking heavy physical work to the incidence of neck pain. English nurses employed in acute care hospitals who performed repetitive heavy physical tasks had a higher incidence of neck pain compared to those who infrequently performed these tasks (Phase II).[72] The tasks found to be associated with neck pain included: frequent ($\geq$5 times/shift); moving; mobilization or repositioning of patients; washing patients; and transferring patients in and out of a bath.[72] Crude odds ratios from a Phase II study of Dutch nursing home employees support this finding.[71] Workers frequently involved in lifting $\geq$25 kg or those who regularly used force with their arms or hands had a higher incidence of neck pain.[71] However, a Phase II study of Norwegian municipal workers found no association between heavy lifting and neck pain.[43] Moreover, a Phase I study of Danish drivers (truck, taxi, railway, bus) who performed heavy lifting at work had a lower crude risk of being hospitalized because of a cervical disc prolapse than those who performed little heavy lifting.[68] This finding raises the hypothesis that in certain occupations, heavy physical work may not increase the risk of cervical disc prolapse requiring hospitalization.

Physical Environment. We found preliminary evidence that the general physical environment of a workplace is associated with the risk of neck pain. In a Phase II cohort of Finnish office workers employed in municipal administrative offices, Korhonen *et al* found that those who rated their physical environment (lighting, temperature, air quality, room size and acoustics) as poor had a higher risk of neck pain.[74] Similarly, crude effects from a cohort in a Finnish study of carpenters, office workers and machine operators suggests that being "troubled by draft" on the job seemed to increase the risk of neck pain.[79]

Keyboard Position. We found evidence that inadequate keyboard position may increase the risk of neck pain in computer users. In their Phase III study of office workers in Atlanta, GA, Marcus *et al* found that a distance from the desktop edge to the "J" key greater than 12.5 cm was associated with a small reduction in the incidence of neck/shoulder pain.[86] In the same study, office workers who used a keyboard which required an inner elbow angle greater than 121° were 5 times less likely to develop neck/shoulder pain compared to those using keyboards which created smaller elbow angles.[86] These results are supported by a Phase II study of Finish municipal employees where employees who had their keyboard positioned less than 15 cm from the edge of the desktop had an increased risk of neck pain.[74]

Mouse Position. We found evidence that inadequate mouse position may increase the risk of neck pain in computer users. Marcus *et al* report from their Phase III study of office workers in Atlanta, GA, that using mouse devices which caused their shoulders to be flexed more than 25° were at increased risk of neck/shoulder pain, with a peak effect occurring between 35° and 44° of flexion.[86] This finding was not supported by a Phase II study which found that mouse position was not associated with the incidence of neck pain.[74]

Screen Height. The evidence varies in 3 studies assessing the association between screen height and the risk of neck pain. A Danish Phase II study found that women who positioned the top of their screen above the eye level seemed to have an increased risk of developing neck pain (crude association).[75] Results from a Phase II Finnish study found a higher incidence of neck pain (crude association) when the distance between the top of the screen and the horizontal level of the worker's eyes was less than 10 cm.[74] The lack of confounder adjustment in these 2 studies significantly weakens the validity of their results. However, one Phase II study of Danish technicians concluded that screen position was not associated with an increased risk for neck pain.[44]

Chair Armrests. We found evidence that the use of chairs with armrests was linked to lower risk for neck pain. The Phase III cohort study of office workers by Marcus *et al* found that workers who sat in chairs equipped with armrests had a lower risk of developing neck/shoulder disorders compared to those who sat in armless chairs.[86] However, Brandt *et al* reported that arm supports were not associated with neck pain in a Phase II cohort study of Danish technicians.[44]

Telephone Shoulder Rests. We found evidence that using a telephone shoulder rest increases the risk of neck pain. A Phase III study of American office workers who used telephone shoulder rest devices had at least double the risk of developing neck/shoulder disorders compared to workers who did not use such devices.[86] This study suggests that telephone shoulder rests may have had an iatrogenic effect.

Upper Extremity Posture. There is evidence from one Phase III study that elbow and shoulder posture while working at the computer is associated with the risk of neck/shoulder pain. A Phase III study by Marcus *et al* found that office workers who used a keyboard which required an inner elbow angle greater than 121° were five times less likely to develop neck/shoulder pain compared to those using keyboards which created smaller elbow angles.[86] However, the same study found the

workers using mouse devices which caused their shoulders to be flexed more than 25° were at increased risk of neck/shoulder pain, with a peak effect occurring between 35° and 44° of flexion.[86] Finally, the same authors reported a small increased risk associated with a difference in height between the keyboard and the elbow that was greater than zero cm.[86]

Head Posture. There is evidence that head posture while working at the computer is associated with the risk of neck/shoulder pain. A Phase III cohort study of office workers by Marcus *et al* found that those who worked with a monitor which caused their heads to tilt at an angle greater than 3° were 50% more likely to develop neck/shoulder pain compared to those who did not.[86]

Glare. We found preliminary evidence (crude relative risk) that women who are disturbed by glare several times per week may have a higher risk of neck pain.[75]

Workstation and Postural Modification. We found evidence that interventions aimed at modifying workstations and workers' posture do not reduce the risk of neck pain among computer users. A randomized controlled trial of newly hired office workers by Gerr at al. found that implementing 2 types of interventions aimed at improving workers' head, shoulder and elbow postures, improving the position of their keyboards, and using a "high quality" chair with armrests did not reduce the incidence of neck/shoulder pain among workers in the intervention groups (compared to colleagues who received no such interventions).[87]

Vibration. We found no scientifically admissible study reporting on the association between vibration and neck disorders.

Other Risk Factors. A Phase II cohort study of male French workers found that those exposed to "awkward work" (awkward postures, carrying heavy loads, vibration or work exertion required to operate tools or machines) had a slightly greater increased risk for developing persistent neck pain.[40]

■ Discussion

Our systematic review demonstrates that neck pain is a significant health problem in workers. Each year, it can be expected that at least five percent of the working population will develop frequent or persistent neck disorders and that depending on their occupations, up to 10% will probably experience at least one episode of activity limitations because of neck pain.

The evidence suggests that most neck pain in workers is nontraumatic and that its etiology is multifaceted. While the evidence suggests that several occupational factors are important contributors to the development of neck pain, it is also evident that no single risk factor is sufficient to cause neck pain. For example, although high quantitative job demands is a strong risk factor for neck pain, not everybody with high quantitative job demands will develop neck pain (Table 2, available online through Article Plus).[44,74–77,84,85] Rather, combinations of risk factors are necessary to cause neck pain and the specific combinations necessary to cause an episode likely vary between workers.

Our analysis suggests that neck pain results from complex relationships between individual, work-related and cultural variables. We found evidence that age, previous musculoskeletal pain, quantitative job demands, social support at work, job insecurity, low physical capacity, poor computer workstation design and work posture, sedentary work position, repetitive work and precision work are associated with the development of an episode of neck pain. We also found preliminary evidence suggesting that gender, a history of headache, emotional problems, smoking, awkward work postures, physical work environment, and ethnicity may contribute to the development of neck pain.

Bringing It Together: The Need for an Etiological Diagram

The current literature provides valuable information about the risk factors for neck pain. Today, we can identify with a reasonable level of certainty the factors that predispose a worker to develop neck pain. However, we know little about the process involved in the development of neck pain and disability. The studies reviewed by the Neck Pain Task Force have all assumed (through their design and analysis) that risk factors only have direct effects on neck pain and disability (Figure 4A). Moreover, these studies have assumed that the risk factors are not themselves outcomes of antecedent risk factors. These assumptions are flawed because neck pain is likely caused by multiple serial exposures rather than by the direct effect of a single exposure. For example, our systematic review found that high levels of psychological job strain increase the risk of neck pain. However, the relationship between psychological job strain and neck pain is more complex than suggested by the available literature. Psychological job strain is likely the result of many antecedent exposures such as type of occupation; and its effect on neck pain is likely mediated by how workers cope with the ensuing stress. To the extent that coping can be thought of as a "generalized/usual" way of dealing with life events, coping occurs before any particular physiologic or psychological stress exposure at work, and therefore before the specific coping behaviors that follow that stressor. The "generalized/usual" way of coping with life events may or may not be similar to the coping behaviors used in response to a particular work-related stress exposure. In this sense, coping could be considered both a trait and a state, and as a trait, could act as an effect modifier of the individual's reactions to the stressor (psychosocial or physical workplace exposures).

To understand the etiology of neck pain, we need to map the possible causal pathways followed by workers as they transition from an asymptomatic state to a state of pain and

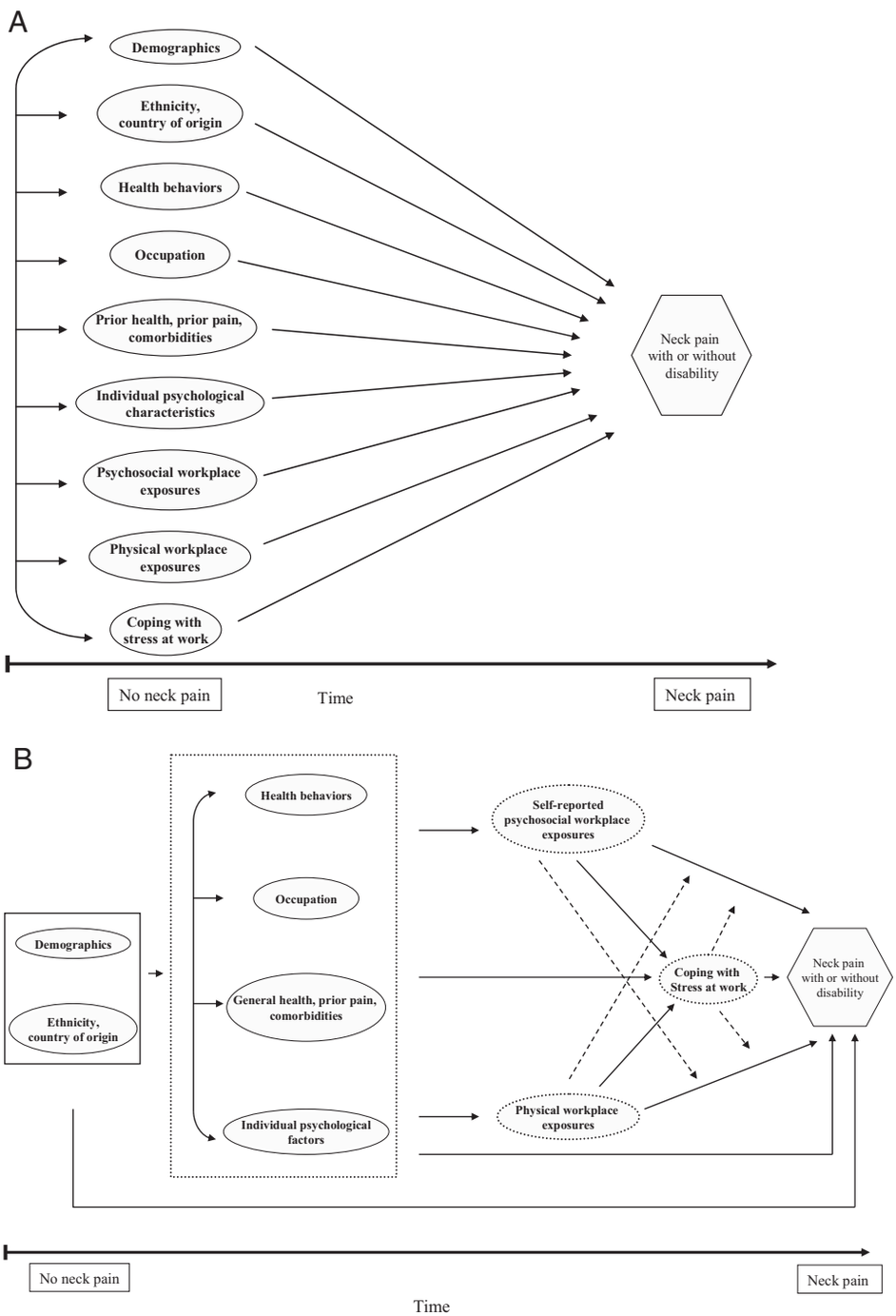

Figure 4. (**A**) Traditional approach to conceptualize associations between risk factors and the incidence of neck pain. **Ovals** represent risk factor 'domains'. Note that specific risk factors are not listed in the ovals (refer to the text for a complete list and descriptions of risk factors). The **hexagon** represents the main outcome. **Solid arrows** represent an association between a risk factor domain and an outcome. The **curved arrows** illustrate that risk factor domains are correlated. (**B**) Etiological diagram integrating mediation and effect modification. **Ovals** represent risk factor 'domains'. Note that specific risk factors are not listed in the ovals (refer to the text for a complete list and descriptions of risk factors). **Boxes** group risk factors that are associated with the outcome at the same point in time. The **hexagon** represents the main outcome. **Dashed boxes** and **dashed ovals** represent mediators between antecedent risk factors and the outcome. **Solid arrows** represent the association between a risk factor domain and an outcome. **Curved arrows** illustrate that risk factor domains are correlated. **Dashed arrows** illustrate that effect modification exists between risk factors and an outcome.

disability.[88,89] Building on our best-evidence synthesis, we propose an etiological diagram that can guide future etiological research. In turn, this research will inform the design of prevention strategies by identifying target risk factors that are amenable to intervention. Our diagram brings together the risk factors identified in our best-evidence synthesis. Based on epidemiological theory, our understanding of the literature and our collective experience, we have organized these risk factors in a series of sequential and plausible relationships (Figure 4B).

The proposed diagram classifies risk factors (or variables) into 2 types: those that are inherent to the worker and those that are related to the workplace. The risk factors inherent to the worker are represented on the far left of the diagram and have been grouped into 6 categories: 1) demographic; 2) ethnicity and country of origin, 3) health behaviors; 4) occupation: 5) general health, prior pain and comorbidities; and 6) individual psychological factors. The risk factors related to the workplace are represented on the right of the diagram and have been grouped into 3 categories: 1) psychosocial workplace exposures; 2) physical workplace exposures; and 3) how the worker copes with stress at work. The diagram suggests that risk factors inherent to the worker can have a

direct effect on the development of neck pain with or without functional limitations (represented by the uninterrupted arrow starting at the far left and pointing to neck pain). Risk factors inherent to the worker can also have indirect effects on neck pain that are mediated through the risk factors related to the workplace (represented by arrows between risk factors inherent to the worker and those related to the workplace). Coexisting risk factors inherent to the worker may be correlated (represented by curved arrows between risk factors).

Our diagram provides a graphical representation of hypothetical causal pathways followed by workers when developing neck pain and disability. Because neck pain follows a recurrent course, it is possible that risk factors present at time "*t*" were themselves outcomes of a previous episode of neck pain that occurred at time "*t − 1*". For example, it is possible that a worker changed occupation in the past because of neck pain. Thus the current occupation may be, in part, an outcome of a previous episode of neck pain and disability.

At any given point in time, a worker's physical health, mental health and occupation are influenced by her/his demographic, ethnic and cultural characteristics. These characteristics may have direct effects on neck pain and disability. However, they may also exert their effects indirectly through health behaviors, occupation, workplace physical and psychological exposures and how a worker copes with stress at work. Similarly, depending on their occupation and general health, workers will encounter specific workplace psychosocial and physical exposures. Furthermore, risk factors related to the workplace can modify the direct effects of other workplace-related risk factors (*i.e.*, "effect modification") on the incidence of neck pain (dashed arrows). Finally, the effects of risk factors related to the workplace on neck pain are likely mediated by how workers cope with the ensuing workplace stress.

The proposed diagram may appear simplistic; but it is not meant to describe all the possible causal pathways. We hope that this etiological diagram will be debated and modified as new scientific evidence is gathered. We call on researchers to formally test, modify and refute this diagram. Analytical approaches such as path analysis, structural equation modeling and causal diagrams are useful tools that will assist in supporting or refuting our proposed causal pathways for the development of neck pain in workers.[89]

Limitations of Our Review

Our systematic review has 2 main limitations. First, although all papers used in our analysis were judged to be scientifically admissible, the methodology of individual studies varied considerably. In particular, the control of confounders was very heterogeneous. We addressed this potential source of bias by classifying studies into Phase I, II and III and by giving greater scientific weight to studies that explicitly controlled for confounders (*i.e.*, Phase III studies).

Second, we concluded that the evidence about certain risk factors varied between studies. This variation may have been due to the fact that we attempted to combine studies that did not necessarily contradict each other. In fact, it is possible that the divergence in the strength and direction of a relationship between a risk factor and neck pain that we observed is a valid result of population-specific effects.

Implications for the Prevention of Neck Pain

Our systematic review highlights that the development of neck pain in workers is multifactorial. Therefore, it is unlikely that prevention strategies targeting a specific domain of risk factors will reduce the incidence of neck pain in the workplace. For example, despite sound evidence that computers users and office workers with poorly adapted workstations had an increased risk of neck pain,[44,73–75,84,86] implementing a well-designed intervention to modify workstations and postures failed to reduce the incidence of neck pain in this population.[87]

The Neck Pain Task Force recommends 2 promising directions for reducing the incidence of neck pain at work. First, at the individual level, we need to educate workers that neck pain runs an episodic course and that one potential way to prevent new episodes may be to improve the physical capacity of the neck and shoulder musculature.[81] Second, at the workplace level, prevention strategies need to address how physical exposures (*e.g.*, prolonged sitting or repetitive movements) and psychosocial exposures (quantitative job demands) interact to produce neck pain.[58,66,73,77,84–86] The Neck Pain Task Force urges all involved stakeholders to test the effectiveness and possible adverse effects of any new interventions before changing workplace policies.

Research Recommendations

The Role of Cross-Sectional Studies. We recommend that future investigations on the etiology of neck pain in workers use observational (*e.g.*, case-control, cohort studies) and experimental designs (randomized controlled trial) rather than cross-sectional surveys. Recent cross-sectional studies have added little new evidence about the risk factors of neck pain in workers. Sparse research resources should be invested in explaining – rather than describing – relationships between various exposures and neck pain.

Identifying Modifiable Risk Factors in Neck Pain. The next generation of studies needs to focus on identifying modifiable risk factors. This is the first step in developing viable prevention strategies. Specifically, we need to better understand how psychosocial and physical exposures at work interact with each other in causing neck pain. Finally, the effect of public health policy on the legitimacy, reporting and compensation of neck pain in workers needs to be investigated.

Neck Pain, Presenteeism, Productivity and Costs to Society. One area in urgent need of scientific investigation is the study of presenteeism (*i.e.*, workers who are present at

work but function at a lower level), lost productivity and the ensuing societal costs related to neck pain in workers. The next generation of studies in this field should attempt to measure these constructs to better understand the real burden of neck pain in workers.

Incidence and Risk Factors for Cervical Radiculopathy. We need studies focused on the incidence and risk factors for cervical radiculopathy in workers. Our best evidence synthesis only identified one Phase I study of hospitalization for cervical disc prolapse in Danish drivers.[68] The contribution of work risk factors to the development of cervical radiculopathy remains unknown.

Theory-Driven Design and Analyses. The design and analysis of future studies must mirror the complex etiology of neck pain in workers. We need to develop and test theoretical frameworks to understand the possible causal pathways followed by workers when transitioning from an asymptomatic state to a state of neck pain and disability. Advanced analytical methods such as path analysis and structural equation modeling should be promoted within this field of research.

■ Conclusion

In the introduction to this paper, we highlighted 3 questions that are relevant to all stakeholders invested in occupational health. We believe that our systematic review of the evidence regarding neck pain in workers has yielded answers to these questions:

Is Neck Pain an Important Source of Disability?

Yes. The Neck Pain Task Force found evidence that a significant proportion of workers are disabled each year because of neck disorders. We also found evidence that most workers remain at their jobs despite reporting neck pain.

Do Physical and Psychosocial Exposures at the Workplace Contribute to This Epidemic?

Yes. The Neck Pain Task Force found evidence that workplace physical exposures (*i.e.*, sedentary work position, repetitive work, precision work, awkward work postures, physical work environment, computer workstation setup) and psychosocial exposures (*i.e.*, quantitative job demands and social support at work) are risk factors for neck pain in workers. However, their effects are small and nonspecific; a single one of these exposures is unlikely to cause neck pain on its own. Neck pain has a multifactorial etiology and its development is dependent on the presence of more than one risk factor. The role of working with hands above the shoulders, heavy physical work and computer screen height as risk factors remains unclear. Finally, we found no scientifically admissible studies examining the role of vibration as a risk factor for neck pain.

Can We Modify the Workplace to Reduce the Burden of Disability Associated With Neck Pain?

We found evidence from 1 randomized trial that modifying workstations and posture alone did not reduce the risk of neck pain among computer users. The Neck Pain Task Force did not find evidence that supports the implementation of any other workplace interventions. This finding is in agreement with the conclusions from another recently published review.[90]

■ Key Points

- Neck pain is endemic in workers throughout the industrialized world.
- Each year, neck pain is responsible for a significant burden of disability in workers.
- Individual and workplace physical and psychosocial factors contribute to the development of neck pain in workers.
- We found no scientific evidence that the implementation of prevention programs aimed at modifying workstations and worker posture reduces the incidence of neck pain.

tables

Tables available online through Article Plus.

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