Report Information from ProQuest

26 October 2023 01:45

TABLE OF CONTENTS

The COVID-19 pandemic: one year later - an occupational perspective

Anonymous

ABSTRACT (ENGLISH)

The COVID-19 pandemic is discussed. This report points to the importance of occupation as a risk factor but also to the availability and use of appropriate personal protection to mitigate the risk of becoming infected. In addition, well-established socioeconomic factors of health inequalities intermingled with occupations at risk, demonstrated by the fact that most taxi drivers belonged to the same ethnic group and that taxi drivers had higher mortality rates when residing in London. These findings are mirrored in a recent preprint publication from the US state of California, reporting that relative excess mortality was particularly high among food/agriculture, transportation/logistics, facilities, and manufacturing workers.

FULL TEXT

About one year ago, we wrote about how the COVID-19 pandemic was unfolding worldwide and started to impact our personal and professional lives (1). Little did we know that, one year later, more than 2.5 million people would have died, with the highest death tolls in Europe, North America, and Latin America (2). Whereas in many countries, life expectancy has increased steadily over the past decades with a couple of months per year, emerging evidence shows that the COVID-19 pandemic will abruptly end this trend in various countries. As one of the most affected countries, life expectancy at birth in the US was down during the first half of 2020 already 1.0 per year compared to 2019 (3). Projections indicate a potential loss in life expectancy of 1.13 years in 2020 for the total US population, resulting in the lowest life expectancy since 2003. The disproportionate burden of COVID-19 mortality is reflected in a staggering loss of 3.1 years in the Latino population and 2.1 years in the Black population (4). It can be expected that,disparities in life expectancy between social and ethnic groups have increased in many countries, demonstrating that COVID-19 has affected different groups differently.

Although deaths attributed to COVID-19 mainly occur among the elderly, often with underlying health conditions, there is scattered evidence that an individual's type of job may contribute to the risk of becoming infected and, hence, to the mortality pattern in society. One of the first reports has emerged from the UK, where death certificates hold information on occupation. COVID-19-related mortality was highest among men in the lowest skilled occupations, with security guards among the occupation with the highest death rate. Other occupations with increased risks included taxi drivers, chauffeurs, bus drivers, restaurant chefs, and sales and retail assistants. Men and women in social care, including care and home-care workers, had increased mortality, but doctors and nurses in healthcare had death rates similar to the general workforce (5).

This report points to the importance of occupation as a risk factor but also to the availability and use of appropriate personal protection to mitigate the risk of becoming infected. In addition, well-established socioeconomic factors of health inequalities intermingled with occupations at risk, demonstrated by the fact that most taxi drivers belonged to the same ethnic group and that taxi drivers had higher mortality rates when residing in London (5). These findings are mirrored in a recent preprint publication from the US state of California, reporting that relative excess mortality was particularly high among food/agriculture, transportation/logistics, facilities, and manufacturing workers. Again, Latino and Black Californian workers were disproportionally affected (6). Hence, working and living circumstances are strongly intertwined, best illustrated by several well-documented outbreaks of COVID-19 in slaughterhouses pointing at working conditions significantly interrelated to housing and transportation arrangements, and precarious work with migrant workers doing the lowest paid jobs (7). A recent large population-based study in Sweden showed that COVID-19-related mortality was influenced by housing conditions (less m2 per individual in household; someone of working age in the household), neighbourhood characteristics (higher population density) and educational level (lower education) (8). This raises the question how well we can distinguish the relative contribution of these risk factors to COVID-19, with the added complexity that these risk factors often occur together in vulnerable groups.

There is a lively debate as to which occupations face the highest risks of contracting COVID-19, pointing primarily towards jobs in health and social care dealing with (suspected) COVID-19 patients, and jobs that involve a large number of daily contact with the public or close physical proximity to others. However, clear insight is lacking as access to testing capacity and suitable protective equipment, and organizational and environmental control measures strongly differ across occupations. A large study among more than 2 million users of a COVID-19 symptoms app in the US and the UK showed that frontline healthcare workers reported a 12-fold higher rate of positive COVID-19 tests compared to the general community. After adjustment for the likelihood of receiving a COVID-19 test, by using inverse probability weighting, the increased likelihood of receiving a positive COVID-19 test reduced to a 3.4-fold rate, demonstrating the risk of bias due to access to testing capacity (9). Many studies have been published on infection rates within specific occupational groups, but robust studies at population level across a variety of occupations are needed to investigate the incidence of infection from coronavirus across professions. An illustrative example is the study on SARS-CoV-2 antibody seroprevalence across 18 cities in Iran, which showed rates among healthcare workers comparable to that of supermarket cashiers, pharmacy employees, and hotel staff (10). These findings suggest that the risk resulting from a working environment at higher risk of infection (eg, hospitals) may be mitigated due to effective precautions, while more measures and training may be needed in those settings with a low perception of danger and less trained workers.

From an occupational health perspective, we are not only facing the fatal and non-fatal consequences of COVID-19 but also the indirect effects on mental health. Many authors have reported anecdotal evidence about higher levels of symptoms of anxiety, depression, and post-traumatic disorder among healthcare professionals. These cross-sectional studies are mere indications that workers exposed to COVID-19 patients are psychologically stressed. One of the first longitudinal studies was conducted in Japan, following more than 1000 workers during the two months of the first wave. After adjusting for the covariates, psychological distress (and subscales of fatigue, anxiety, and depression) as well as fear and worry of COVID-19 increased among healthcare workers, whereas psychological stress remained remarkably constant among non-healthcare workers (11).

While the pandemic may broadly affect the mental health of the general population (12), there is a concern that it will particularly adversely affect the mental health of those most vulnerable, ie, those who already had existing mental health problems before the pandemic emerged (13). Keeping and reintegrating individuals with mental health problems in the labor market was already a major public and occupational health challenge prior COVID-19 (14), and it might become an even bigger challenge in the near future.

Less is still known about the risk to the health of workers who were required to change their regular work practice. The baseline survey of an occupational cohort in the US illustrates the profound impact of the COVID-19 pandemic where 30% of all workers had to work from home, 24% had reduced working hours or income, and 19% were furloughed or placed on leave of absence (15). Working from home may increase flexibility and control, but this may be offset by a non-work-friendly environment (eg, no room to work alone, lack of high-quality internet connection, and no ergonomic working station). A panel study in Germany suggested that particularly women working from home with children were at higher risk of exhaustion, with job autonomy and partner support partly mitigating this effect (16). A small longitudinal study in England found that 72% of workers who changed to remote work experienced increased sedentary behavior, poorer quality of sleep, and more mood disturbances (17). A repeated cross-sectional study, comparing 2016 with 2020, showed more experience and diversity in internet use, but also considerably more 'techno stress', defined as individual's attempts and struggles to deal with constantly evolving ICTs and changing cognitive and social requirements (18).

The long-lasting effects on workers' health are still unknown. It is a safe bet to accept that work arrangements will not remain the same after the pandemic. We suggest three priorities for the research agenda on COVID-19 and occupational health:

1. Identification of occupations at higher risk for becoming infected and specific work characteristics that contribute to the risks. Such insights will be immensely valuable for preparedness to threats of future pandemics.
2. The impact of COVID-19 on changes in how, where, and when we work, and the consequences for workers' health, especially mental health. The pandemic has strongly accelerated trends of already existing macroeconomic changes (eg, towards online marketplaces), and there is a need for both occupational health professionals and policy makers to adapt to this acceleration. The traditional workplace may be abandoned for many workers, and new ways must be found on how work will create value for the organization as well as the worker.
3. The impact of the pandemic on social inequalities. This is a great concern as vulnerable groups have been disproportionately affected and their working conditions cannot be isolated from poorer social, economic, and living conditions.

We can only reiterate our previous words: COVID-19 will have both short-term and long-lasting impacts on societies, healthcare systems, workplaces and individuals alike. Occupational health experts are challenged to contribute to a world, especially the world of work, that is a better place after this pandemic.

Sidebar

Alex Burdorf and Fabio Porru,
Department of Public Health,
Erasmus Medical Center Rotterdam,
Rotterdam, The Netherlands.
[email:a.burdorf@erasmusmc.nl]
Reiner Rugulies,
National Research Centre for the Working Environment (NFA),
Department of Public Health and Department of Psychology,
University of Copenhagen,
Copenhagen, Denmark.
[email: rer@nfa.dk]

References

References

1. Burdorf A, Porru F, Rugulies R. The Covid-19 (Coronavirus) pandemic: consequences for occupational health. Scand J Work Environ Health 2020;46:229-30. https://doi.org/10.5271/sjweh.3893
2. Johns Hopkins Corona virus resource center. Available at: https://coronavirus.jhu.edu/data/mortality, accessed March 2, 2021.
3. Arias E, Tejada-Vera B, Ahmad F. Provisional Life Expectancy Estimates for January through June, 2020. US Department of Health and Human Services: National Vital Statistics System Report No. 010, Feb 2021. https://doi.org/10.15620/100392
4. Andrasfay T, Goldman N. Reductions in 2020 US life expectancy due to COVID-19 and the disproportionate impact on the Black and Latino populations. PNAS 2021;118:e2014746118. https://doi.org/10.1073/pnas.2014746118
5. United Kingdom Office for National Statistics. Statistical bulletin: Coronavirus (COVID-19) related deaths by occupation, England and Wales: deaths registered up to and including 20 April 2020. Release date: 11 May 2020.
6. Chen YH, Glymour M, Riley A, Balmes J, Duchowny K, Harrison R, et al. Excess mortality associated with the COVID-19 pandemic among Californians 18-65 years of age, by occupational sector and occupation: March through October 2020. medRxiv preprint. https:// doi.org/10.1101/2021.01.21.21250266

7. Kromhout H. Learning from a global pandemic. Occup Environ Med 2020;77:587-8. https://doi.org/10.1136/oemed-2020-106801
8. Brandén M, Aradhya S, Kolk M, Härkönen J, Drefahl S, Malmberg B, et al. Residential context and COVID-19 mortality among adults aged 70 years and older in Stockholm: a population-based, observational study using individual-level data. Lancet Healthy Longev 2020;1:e80-88. https://doi.org/10.1016/S2666-7568(20)30016-7
9. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo CG, Ma W, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. Lancet Public Health 2020;5:e475-83. https://doi.org/10.1016/S2468-2667(20)30164-X
10. Poustchi H, Darvishian M, Mohammadi Z, Shayanrad A, Delavari A, Bahadorimonfared A, et al. SARS-CoV-2 antibody seroprevalence in the general population and high-risk occupational groups across 18 cities in Iran: a population-based cross-sectional study. Lancet Infect Dis 2021;21:473-81. doi.org/10.1016/S1473-3099(20)30858-6
11. Sasaki N, Kuroda R, Tsuno K, Kawakami N. The deterioration of mental health among healthcare workers during the COVID-19 outbreak: A population-based cohort study of workers in Japan. Scand J Work Environ Health 2020;46:639-44. https://doi.org/10.5271/ sjweh.3922
12. Galea S, Merchant RM, Lurie N. The mental health consequences of COVID-19 and physical distancing. The need for prevention and early intervention. JAMA Intern Med. 2020;180(6):817- 8. https://doi.org/10.1001/jamainternmed.2020.1562
13. Varga TV, Bu F, Dissing AS, Elsenburg LK, Herranz Bustamante JJ, Matta J et al. Loneliness, worries, anxiety, and precautionary behaviours in response to the COVID-19 pandemic: A longitudinal analysis of 200,000 Western and Northern Europeans. The Lancet Reg Health Eur. 2021;(2):100020. https://doi.org/10.1016/j.lanepe.2020.100020
14. Schuring M, Robroek SJW, Burdorf A. The benefits of paid employment among persons with common mental health problems: evidence for the selection and causation mechanism. Scand J Work Environ Health 2017;43:540-9. https://doi.org/10.5271/sjweh.3675
15. Kobayashi LC, O'Shea BQ, Kler JS, Nishimura R, Palavicino-Maggio CB, Eastman MR, et al. Cohort profile: the COVID-19 Coping Study, a longitudinal mixed-methods study of middle-aged and older adults' mental health and well-being during the COVID-19 pandemic in the USA. BMJ Open 2021;11:e044965. https://doi.org/10.1136/bmjopen-2020-044965
16. Meyer B, Zill A, Dilba D, Gerlach R, Schumann S. Employee psychological well-being during the COVID-19 pandemic in Germany: A longitudinal study of demands, resources, and exhaustion. Int J Psychol 2021. Feb 21, online. https://doi.org/10.1002/ijop.12743
17. Barone Gibbs B, Kline CE, Huber KA, Paley JL, Perera S. COVID-19 shelter-at-home and work, life-style and well-being in desk workers. Occup Med 2021;71:86-94. https://doi.org/10.1093/occmed/kqab011
18. Nimrod G. Technostress in a hostile world: older internet users before and during the COVID-19 pandemic. Aging Mental Health 2020, online. https://doi.org/10.1080/13607863.2020.1861213

DETAILS

Subject:	Pandemics; Infections; Population; Minority &ethnic groups; Occupational health; Severe acute respiratory syndrome coronavirus 2; Mortality; Social factors; Employment; Medical personnel; COVID-19; Risk analysis; Socioeconomic data; Workers; Life expectancy; Working conditions; Risk factors; Public health; Socioeconomics; Professionals; Mental health; Logistics; Coronaviruses; Taxicabs; Health risks; Socioeconomic factors
Business indexing term:	Subject: Occupational health Employment Workers Working conditions Professionals

Location:	United Kingdom--UK; United States--US
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	245-247
Publication year:	2021
Publication date:	2021
Section:	Editorial
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Editorial
DOI:	https://doi.org/10.5271/sjweh.3956
ProQuest document ID:	2530525029
Document URL:	https://www.proquest.com/scholarly-journals/covid-19-pandemic-one-year-later-occupational/docview/2530525029/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2021-11-02
Database:	Public Health Database

Document 2 of 9

The associations of working hour characteristics with short sickness absence among part- and full-time retail workers

Shiri, Rahman, MD, PhD [1] ; Hakola, Tarja, MSc [1] ; Härmä, Mikko, MD, PhD [1] ; Ropponen, Annina, PhD [1]
[1] Finnish Institute of Occupational Health, Helsinki, Finland

ProQuest document link

ABSTRACT (ENGLISH)

Objective This study aimed to determine the associations of working hour characteristics with short (1-3 days) sickness absence (SA) among retail workers. Methods As part of "RetailHours-project", 4046 employees of 338 Finnish retail stores were included. Registry-based data on working hour characteristics and short SA were utilized. A case-crossover design was used and the odds ratios (OR) were controlled for the clustering effect and working hour characteristics. Results There were strong dose-response relationships between percent of short (<11 hours) shift intervals and short SA among part- and full-time workers, men and women, and younger and older workers. Compared to workers without short shift intervals, the risk of SA was 1.47 times [95% confidence interval (CI) 1.29-1.68] higher among workers who had short shift intervals le;10% of work times, 2.39 times (95% CI 2.03-2.82) higher among workers who had 10-25% of work times, and 4.03 times (CI 2.34-6.93) higher among workers who had short shift intervals >25% of work times. Weekly working hours >40 hours were associated with SA among part-time workers [odds ratio (OR) 2.22, CI 1.65-2.98], women (OR 1.62, CI 1.27-2.07) and among workers <30 years of age (OR 1.68, CI 1.20-2.35) as well as among workers aged ≥30 years (OR 1.43, CI 1.07-1.92). Furthermore, working mainly night shifts was associated with SA among full-time workers (OR 2.41, 95% CI 0.99-5.86) and women (OR 1.72, CI 1.02-2.89). Conclusions A short shift interval is an important risk factor for short SA. Improving intervals between shifts and shortening long weekly working hours could reduce the risk of short SA among retail workers.

FULL TEXT

Headnote

Objective This study aimed to determine the associations of working hour characteristics with short (1-3 days) sickness absence (SA) among retail workers.
Methods As part of "RetailHours-project", 4046 employees of 338 Finnish retail stores were included. Registry-based data on working hour characteristics and short SA were utilized. A case-crossover design was used and the odds ratios (OR) were controlled for the clustering effect and working hour characteristics.
Results There were strong dose-response relationships between percent of short (<11 hours) shift intervals and short SA among part- and full-time workers, men and women, and younger and older workers. Compared to workers without short shift intervals, the risk of SA was 1.47 times [95% confidence interval (CI) 1.29-1.68] higher among workers who had short shift intervals le;10% of work times, 2.39 times (95% CI 2.03-2.82) higher among workers who had 10-25% of work times, and 4.03 times (CI 2.34-6.93) higher among workers who had short shift intervals >25% of work times. Weekly working hours >40 hours were associated with SA among part-time workers [odds ratio (OR) 2.22, CI 1.65-2.98], women (OR 1.62, CI 1.27-2.07) and among workers <30 years of age (OR 1.68, CI 1.20-2.35) as well as among workers aged ≥30 years (OR 1.43, CI 1.07-1.92). Furthermore, working mainly night shifts was associated with SA among full-time workers (OR 2.41, 95% CI 0.99-5.86) and women (OR 1.72, CI 1.02-2.89).
Conclusions A short shift interval is an important risk factor for short SA. Improving intervals between shifts and shortening long weekly working hours could reduce the risk of short SA among retail workers.
Key terms night shift; quick return; risk factor; shift work schedule; sick leave.

Sickness absence (SA) is commonly used as an indicator for monitoring work-related health (1). Prospective cohort studies found an association between shift work and SA (2, 3). A systematic review of studies published up to April 2010 found an association between fixed evening shifts and SA among female healthcare workers but showed inconclusive evidence for rotating and night shifts (4). Since then, studies utilizing register-based data among hospital workers showed that long weekly working hours (5), long shifts (>12 hours) (6, 7), night shifts (3, 5), 2- and 3-shift rotations (3), and short (<11 hours) interval between shifts (5, 8) increased the risk of short SA. Shift work that included night work also increased the risk of short SA among female-dominated occupations (2). Furthermore, lack of influence on working hours (9), evening work (10), night shift work (10, 11), 3-shift schedule (12), and shifts that lasted >12 hours (6) increased the risk of long-term SA.

Retail grocery stores and supermarkets provide vital services to the communities. Retail workers are exposed to physical workload factors such as forceful lifting, forceful pushing, pulling or carrying heavy loads, repetitive movements of the hands or wrists, working with arms above the shoulder level, and awkward and static postures (13-15). As a consequence, retail workers are at increased risk of developing musculoskeletal disorders such as neck or shoulder disorders, back disorders, tendinitis, and carpal tunnel syndrome (13-18). Around half of women working at grocery stores reported neck or shoulder complaint in the preceding 7 days and 34% reported elbow or hand complaints (17). Since musculoskeletal disorders, particularly back and shoulder disor ders, are common causes of SA (19), retail workers are at risk of SA. Retail workers are also exposed to psychosocial risk factors such as high job strain (14, 17, 20). An earlier study showed that the association between night shift work and short SA among female-dominated occupations is not due to differences in psychosocial factors between day and night shift workers (2).

To date, little is known about the effects of occupational risk factors on musculoskeletal disorders and their associated disability among grocery store workers (18). Of these workers, only cashiers have mostly been studied (14, 15, 21). Among retail grocery store workers, work schedules more often are unpredictable and unstable, and most workers have little control over their shift work schedules (22). Grocery store workers with unstable and unpredictable work schedules reported poorer sleep quality, had more difficulty in falling asleep, woke more frequently during sleep, and felt tired more often than workers with more stable and predictable work schedules (22). To our knowledge, to date, no study has identified the predictors of SA related to working hour characteristics among retail workers. Similar to healthcare workers, retail workers are predominantly women (5, 22), however, they are somewhat younger and more often work as a part-time job than healthcare workers (5, 22). Furthermore, it is unclear whether age, sex, or type of work contact (part-time or full-time) play a role in the associations between working hour characteristics and short SA. Some previous studies found an increased risk of SA only among older shift workers (10) or among older employees working >40 hours/week (23). Also, a study showed that part-time workers are at higher risk of SA than full-time workers (24).

The aim of the present study was to explore the associations of working hour characteristics with short (1-3 days) SA among retail workers. Moreover, we determined whether the associations differ between partand full-time workers, men and women, and younger and older workers.

Methods

Population

Data were gathered as part of the development of working hours in retail project ("RetailHours-project") that consists of three regions in a chain of companies in the retail sector in Finland. The regions were the capital area of Finland (N >11 000 employees), Middle Finland (N >2700) and Northeast Finland (N >2200). In total, in this chain of companies, there were 900 outlets across Finland and the RetailHours-project included 450 (50%) of them. The RetailHours-project had in total working hour data from 16 728 employees from 6 March 2017 to 31 December 2019. We selected the final sample to include only those who were employed by the three regions (ie, we excluded the agency workers who were employed by other companies and paid on an hourly basis, N=1411) and those who did not have working hours according to the collective agreement of sales sector (N=3864 being employees of other service sectors such as hospitality). Furthermore, the population of the current study was restricted to employees who had at >1 short (1-3 days) SA (ie, the first incidence of short SA since 6 March 2017) and had data on working hour characteristics during eight weeks before the first short SA (N=4046, 911 men and 3083 women). Since the data comprised employer-owned employment information without access to diagnosis-specific SA, no ethical approval was required for the study.

Outcome

We used 1-3 SA days as the outcome of the study. In Finland and the other Nordic countries, a SA of <3 days does not need a medical certificate. For each participant, data on starting and ending SA was collected.

Characteristics of working hours

Data on the working hour characteristics during eight weeks before SA were collected. The payroll-based employer's owned registry data of daily working hours were retrieved from the shift scheduling program Ortec Workforce Scheduling (Elli)-program. Information on the number of weekly working hours, type of shift (early morning, morning, day, evening, and night), length of work shift, and percentage and number of short (<11 hours) shift intervals (interval between two consecutive work shifts) was collected. Also, data included information on age, sex, and part-time and full-time work based on the employment contract. The data did not contain reasons for part-time work (ie, if part-time work was due to health, childcare, studies or else).

For each participant, data included information on starting and ending of each work shift. We defined day shift as a shift of >3 hours between 08:00 and 18:00 hours, morning shift as a shift between 03:00 and 18:00 hours, evening shift as a shift between 18:00 and 23:00 hours, and night shift as a shift between 23:00 and 06:00 hours as modified from Larsen et al (10) and Härmä et al (25-26) for retail work. An early morning shift starts before 06:00 hours and is not classified as a night shift. The classification of the timing of the shift was not mutually exclusive, but we gave highest priority to the night shifts, the second highest to the evening shifts and the lowest priority to the day shifts (26). Early morning and morning shifts did not overlap with other shifts. To distinguish different shifts, we defined a particular shift (eg, night shift) as working >50% of the work time during four weeks in that shift, and those who worked <50% of the time in a particular shift were group in a separate category of any shift <50%. Day shift has the lowest health risk (26), however, due to a small number of day workers in the current study, we compared night, evening, early morning and day shifts with morning shift. We also classified the length of shifts into short (<4 hours), medium (4-9 hours) and long (>9 hours). We defined a short interval between two shifts (quick return) as an interval <11 hours (8, 27). Lastly, long weekly working hours was defined as working >40 hours and very long weekly working hours as working >48 hours per week.

Statistical analysis

A case-crossover design was used to compare the working hour characteristics of the four weeks preceding SA (exposure window) with those of the four weeks before the exposure window (control window). In case-crossover design, each participant serves as his or her own control. A conditional logistic regression model was used, and the odds ratios (OR) were controlled for the clustering effect of 338 retail stores, shift work, number of consecutive night shifts, weekly working hours >40 hours, the length of shifts, and percent of short shift intervals. We conducted stratified analyses to determine whether there were differences in the associations of working-hour characteristics with short SA between part- and full-time workers, men and women, and between younger and older workers. We used median to split age into two groups: (i) workers <30 years and (ii) workers aged >30 years. Stata, version 15 (StataCorp LP, College Station, Texas) was used for the analyses.

Results

The study population worked at 338 retail stores of various sizes, including small grocery stores, supermarkets and hypermarkets. Of the participants, 77.2% were women, and 73.4% worked part-time and 26.6% fulltime according to employment contract (table 1). Participants were aged 15-74 years. Nearly half were <30 years, and only 5% were >60 years. The mean age of the participants was 34.6 [standard deviation (SD) 13.2] years, with men 32.2 (SD 11.5) years and women 35.4 (SD 13.5) years. A majority of the participants (64.4%) worked in the capital area of Finland. On average, 48% of full-time employees and 14% of part-time employees worked >40 hours/week for >2 weeks per month.

Work characteristics of short sickness absence

All workers. Long weekly working hours, short shifts (<4 hours), percent and number of short shift intervals (<11 hours) during four weeks of the exposure window were associated with short SA, while types of shifts, number of consecutive night shifts, and long shifts (>9 hours) were not associated with short SA (table 2). After adjustment for clustering effect and confounders, the risk of short SA was 1.52 times [95% confidence interval (CI) 1.25-1.85] higher among employees who worked >40 hours/week for >3 weeks during four weeks of the exposure window. The risk of SA was 1.30 times (95% CI 1.09-1.56) higher among employees who worked >48 hours/week for >1 week. Working night shift >1 night in a month, and the percentage and number of weeks working night shifts in a month were not associated with short SA.

After adjustment for clustering effect and confounders, short SA was lower among workers who had short shifts [odds ratio (OR) 0.84, 95% CI 0.70-0.99]. The strongest associations were found between percent and number of short shift intervals (<11 hours), and short SA. Compared with workers with no short shift intervals, the risk of SA was 1.47 times (95% CI 1.29-1.68) higher among workers who had short shift intervals <10% of time during four weeks of the exposure window, 2.39 times (95% CI 2.03-2.82) higher among workers who had short shift intervals 10-25% of time, and 4.03 times (95% CI 2.34-6.93) higher among workers who had short shift intervals >25% of time. The risk of short SA also increased with increasing in the number of short shift intervals. The risk was 1.57 times (95% CI 1.40-1.76) higher among workers who had 2-4 short shift intervals in four weeks, 2.51 times (95% CI 1.97-3.19) higher among those who had 5-11 short shift intervals, and 4.34 times (95% CI 1.37-13.69) higher among those who had >12 short shift intervals compared with workers who had 0 or 1 short shift interval in four weeks.

Full-time versus part-time workers. The risk of SA strongly increased with increasing in percent of short shift intervals during four weeks of the exposure window among both full- and part-time workers (table 3). Among fulltime workers, the risk of short SA was 2.41 times (95% CI 0.99-5.86) higher when working mainly night shifts and 1.38 times (95% CI 1.00-1.91) higher when working any shift for <50% compared with morning shifts. The risk of SA was lower among full-time employees who worked either short shifts (OR 0.65, 95% CI 0.420.98) or a combination of short and long shifts (OR 0.61, 95% CI 0.37-0.99) than those who worked 4-9 hours shifts. Among part-time workers, the risk of SA was 2.22 times (95% CI 1.65-2.98) higher among employees who worked >40 hours/week for 3 or 4 weeks and 1.51 times (95% CI 1.19-1.92) higher among employees who worked >48 hours/week for at least one week during four weeks of the exposure window. The number of consecutive night shifts, working night shift at least once a month, and the percentage and number of weeks working night shifts in a month were not associated with short SA among both full-time and part-time workers.

Men versus women. Among both men and women, the risk of short SA strongly increased with increasing in percent of short shift intervals (table 4). Among women, the risk of short SA was 1.72 times (95% CI 1.02-2.89) higher when working mainly night compared with morning shifts. The risk of SA was 1.62 times (95% CI 1.27-2.07) higher among women who worked >40 hours/week for 3 or 4 weeks and 1.25 times (95% CI 1.00-1.56) higher among women who worked >48 hours/week for at least a week during four weeks of the exposure window compared with women who did not work >40 hours/week at any time during the four weeks. Moreover, women who worked only short shifts had lower SA (OR 0.79, 95% CI 0.65-0.97) than women who worked medium length shifts (4-9 hours). Among men, those who worked >48 hours/week for at least a week during four weeks of the exposure window had 1.45 times (95% CI 1.03-2.05) higher risk of short SA than men who did not work >40 hours/week at any time during the four weeks. The types of shift work, and length of work shift were not associated with short SA among men (table 4). The number of consecutive night shifts, working night shift for at least once a month, and the percentage and number of weeks working night shifts in a month were not associated with short SA among both men and women.

Younger (<30 years) versus older workers (>30 years). Among both younger and older workers, the risk of short SA strongly increased with increasing percent of short shift intervals (table 5). In workers <30 years, the risk of SA was 1.68 times (95% CI 1.20-2.35) higher among those who worked >40 hours/week for 3-4 weeks and 1.35 times (95% CI 1.03-1.77) higher among employees who worked >48 hours/week for at least a week during four weeks of the exposure window. In workers aged >30 years, the risk of SA were 1.43 times (95% CI 1.07-1.92) higher among those who worked >40 hours/week for 3-4 weeks, and 1.39 times (95% CI 1.11-1.75) higher when they worked any shift for <50% compared with morning workers. The risk of SA was lower among employees who worked either short shifts (OR 0.75, 95% CI 0.57-0.98) or a combination of short and long shifts (OR 0.60, 95% CI 0.42-0.86). The number of consecutive night shifts, working night shift for at least once a month, and the percentage and number of weeks working night shifts in a month were not associated with short SA among both younger and older workers.

Discussion

The present study showed that among factors related to shift work in the retail sector, a short shift interval is the stronger risk factor for short SA. Moreover, long weekly working hours increased the risk of short SA among part-time workers and working mainly night shifts increased the risk among full-time workers.

We found a strong dose-response relationship between a short interval between shifts (quick return) and short SA. A dose-response relationship was found among both part- and full-time workers, both men and women, and among both younger and older workers. In line with the current study, an earlier study utilizing objectively measured working hour characteristics among Norwegian nurses found a dose-response relationship between quick returns (<11 hours of rest between shifts) and SA (8). Furthermore, another study (5) also utilizing register-based data on working-hour characteristics found a short interval between work shifts increases the risk of short SA among Finnish hospital workers. However, an intervention aiming to increase interval between shifts improved sleep duration, alertness and well-being at work, but had no benefi- cial effect on the number of SA days (28). However, that study (28) recruited only 75 nurses, and the study had low statistical power to determine the effect of increasing interval between evening and morning shifts on the occurrence of SA. Quick return has adverse effects on sleep duration and causes sleepiness and fatigue (29) and can lead to absence from work.

To date, the association between shift work and SA is still uncertain. Some previous studies found that night shifts increase the risk of SA (2, 3, 5, 10, 11), while other studies found that evening shifts (4, 10) or rotating 2- or 3-shift (3, 12, 30) increase the risk of SA. Moreover, a study found no association between night shifts and long-term SA (12). Fixed night shifts (3), shift work including nightwork (night shift, 3-shift work, or rostered work including nights) (2) and working over 75% of time as night shifts (11) were associated with SA. Earlier studies reported inconsistent results on the association between consecutive night shifts and SA (5, 10). Working consecutive night shifts was associated with SA among Danish (10) but not Finnish (10, 23) healthcare workers. In the current study, we also found no association between consecutive night shifts and SA. The association between working >50% of time as night shifts and SA was found only among full-time workers and women. Night shift work can reduce sleep duration and sleep quality (31) and can cause mild depressive symptoms (2), which lead to a higher rate of SA. However, further large prospective studies are needed to confirm a positive link between night shift and SA.

Earlier studies showed that the rate of short SA is more common among hospital workers with extended weekly working hours (5, 23). In line with an earlier study among healthcare workers (23), we found that weekly working hours >40 hours increase the risk of short SA among both younger and older workers. The current study adds to our knowledge that working >40 hours per week increases the risk of short SA among women and part-time workers, whereas working >48 hours per week increases the risk among men. A study among healthcare workers (7) found an increase in the risk of short SA by 0.7-1.0% per week after introduction of the policy of extending shift length from 8 to 12 hours. Reduced sleep duration in employees who work long weekly hours (32) or long shift may play a role in their increased risk of short SA. Extended weekly working hours may also cause more fatigue among part-compared to full-time workers.

The study had some strengths and limitations. The study recruited a relatively large and representative sample of retail workers. Registry-based data on working hour characteristics in the shift work and SA were utilized. Furthermore, a case-crossover design was used, and each participant served as his or her control, which controlled the observed risk differences for the confounding effects of individual factors. However, the participants might have changed their level of exposure to physical and psychosocial factors during the exposure window. As a limitation of the current study, no information on exposure to workload and psychosocial factors was collected. However, the lag was limited to a maximum of four weeks. A 4-week lag between control and exposure windows is more optimal than a shorter or longer lag. A 4-week lag is needed to observe changes to shift patterns and working hour characteristics, while it is a short period to observe any meaningful changes in exposure to physical workload factors among workers with the same tasks. An earlier case-crossover study among healthcare workers (5) found that a 1-week and a 3-month lags between control and exposure windows produce the results similar to a 4-week lag. Lastly, some differences in working hour characteristics between exposure and control windows might have happened because of seasonal variation.

Concluding remarks

The findings of the current study suggest that of working hour characteristics, a short shift interval is the most important risk factor for short SA among retail workers and avoiding it could reduce the risk of short SA. Moreover, shortening long weekly working hours, particularly among women, part-time workers and those <30 years could reduce the risk of short SA.

Funding source

The Finnish Work Environment Fund (Grant # 190124) supported this study.

Conflict of interest

The authors declare no conflicts of interest.

Sidebar

Shiri R, Hakola T, Härmä M, Ropponen A. The associations of working hour characteristics with short sickness absence among part- and full-time retail workers. Scand J Work Environ Health. 2021;47(4):268-276. doi:10.5271/sjweh.3952

References

References

1. Kreis J, Bödeker W. Indicators forwork-related health monitoring in Europe. Essen, Germany: Federal Association of Company Health Insurance Funds, Health Department; 2004. Report No.: 33.

2. Tucker P, Peristera P, Leineweber C, Kecklund G. Can psychosocial working conditions help to explain the impact of shiftwork on health in male- and female-dominated occupations? A prospective cohort study. Chronobiol Int 2020 Sep;1-9. https://doi.org/10.1080/07420528.2020.180 5458.

3. Bernstrøm VH, Houkes I. Shift work and sickness absence at a Norwegian hospital: a longitudinal multilevel study. Occup Environ Med 2020 Aug;77(8):555-63. https://doi. org/10.1136/oemed-2019-106240.

4. Merkus SL, van Drongelen A, Holte KA, Labriola M, Lund T, van Mechelen W et al. The association between shift work and sick leave: a systematic review. Occup Environ Med 2012 Oct;69(10):701-12. https://doi.org/10.1136/ oemed-2011-100488.

5. Ropponen A, Koskinen A, Puttonen S, Härmä M. Exposure to working-hour characteristics and short sickness absence in hospital workers: A case-crossover study using objective data. Int J Nurs Stud 2019 Mar;91:14-21. https://doi. org/10.1016/j.ijnurstu.2018.11.002.

6. Dall'Ora C, Ball J, Redfern O, Recio-Saucedo A, Maruotti A, Meredith P et al. Are long nursing shifts on hospital wards associated with sickness absence? A longitudinal retrospective observational study. J Nurs Manag 2019 Jan;27(1):19-26. https://doi.org/10.1111/jonm.12643.

7. Rodriguez Santana I, Anaya Montes M, Chalkley M, Jacobs R, Kowalski T, Suter J. The impact of extending nurse working hours on staff sickness absence: evidence from a large mental health hospital in England. Int J Nurs Stud 2020 Dec;112:103611. https://doi.org/10.1016/j. ijnurstu.2020.103611.

8. Vedaa Ø, Pallesen S, Waage S, Bjorvatn B, Sivertsen B, Erevik E et al. Short rest between shift intervals increases the risk of sick leave: a prospective registry study. Occup Environ Med 2017 Jul;74(7):496-501. https://doi. org/10.1136/oemed-2016-103920.

9. Sandmark H. Work and family: associations with long-term sick-listing in Swedish women - a case-control study. BMC Public Health 2007 Oct;7:287. https://doi.org/10.1186/14712458-7-287.

10. Larsen AD, Ropponen A, Hansen J, Hansen AM, Kolstad HA, Koskinen A et al. Working time characteristics and longterm sickness absence among Danish and Finnish nurses: A register-based study. Int J Nurs Stud 2020

Dec;112:103639. https://doi.org/10.1016/j.ijnurstu.2020.103639.
11. Dall'Ora C, Ball J, Redfern OC, Griffiths P. Night work for hospital nurses and sickness absence: a retrospective study using electronic rostering systems. Chronobiol Int 2020 Aug;1-8.
12. van Drongelen A, Boot CR, Hlobil H, van der Beek AJ, Smid T. Cumulative exposure to shift work and sickness absence: associations in a five-year historic cohort. BMC Public Health 2017 Jan;17(1):67. https://doi.org/10.1186/ s12889-016-3906-z.
13. Occupational Safety and Health Administration. Ergonomics for the prevention of musculoskeletal disorders: Guidelines for retail grocery stores. U.S. Department of Labor; 2004.
14. Niedhammer I, Landre MF, LeClerc A, Bourgeois F, Franchi P, Chastang JF et al. Shoulder disorders related to work organization and other occupational factors among supermarket cashiers. Int J Occup Environ Health 1998 JulSep;4(3):168-78. https://doi.org/10.1179/oeh.1998.4.3.168.
15. Bonfiglioli R, Mattioli S, Fiorentini C, Graziosi F, Curti S, Violante FS. Relationship between repetitive work and the prevalence of carpal tunnel syndrome in part-time and full-time female supermarket cashiers: a quasi-experimental study. Int Arch Occup Environ Health 2007 Jan;80(3):24853. https://doi.org/10.1007/s00420-006-0129-0.
16. Osorio AM, Ames RG, Jones J, Castorina J, Rempel D, Estrin W et al. Carpal tunnel syndrome among grocery store workers. Am J Ind Med 1994 Feb;25(2):229-45. https://doi. org/10.1002/ajim.4700250209
17. Balogh I, Ohlsson K, Nordander C, Bjork J, Hansson GA. The importance of work organization on workload and musculoskeletal health-Grocery store work as a model. Appl Ergon 2016;53 Pt A:143-51.
18. Graziosi F, Bonfiglioli R, Violante FS. [Occupational risks in grocery stores]. Ital Med Lav Ergon 2014;36(4):219-25.
19. Pekkala J, Rahkonen O, Pietiläinen O, Lahelma E, Blomgren J. Sickness absence due to different musculoskeletal diagnoses by occupational class: a register-based study among 1.2 million Finnish employees. Occup Environ Med 2018 Apr;75(4):296-302. https://doi.org/10.1136/ oemed-2017-104571.
20. Mechergui N, Ben Ali R, Faten B, Ben Khadra H, Ben Yahmed Y, Ladhari N. [Evaluation of psychosocial constraints among grocery stores workers in Tunisia]. Sante Publique 2019 May;31(3):443-50. https://doi.org/10.3917/ spub.193.0443.
21. Forcier L, Lapointe C, Lortie M, Buckle P, Kuorinka I, Lemaire J et al. Supermarket workers: their work and their health, particularly their self-reported musculoskeletal problems and compensable injuries. Work 2008;30(4):493510.
22. Harknett K, Schneider D, Wolfe R. Losing sleep over work scheduling? The relationship between work schedules and sleep quality for service sector workers. SSM Popul Health 2020 Oct;12:100681. https://doi.org/10.1016/j. ssmph.2020.100681.
23. Ropponen A, Koskinen A, Puttonen S, Härmä M. A casecrossover study of age group differences in objective working-hour characteristics and short sickness absence. J Nurs Manag 2020 May;28(4):787-96. https://doi. org/10.1111/jonm.12992.
24. Helgadóttir B, Svedberg P, Mather L, Lindfors P, Bergström G, Blom V. The association between parttime and temporary employment and sickness absence: a prospective Swedish twin study. Eur J Public Health 2019 Feb;29(1):147-53. https://doi.org/10.1093/eurpub/cky145.
25. Härmä M, Ropponen A, Hakola T, Koskinen A, Vanttola P, Puttonen S et al. Developing register-based measures for assessment of working time patterns for epidemiologic studies. Scand J Work Environ Health 2015 May;41(3):26879. https://doi.org/10.5271/sjweh.3492.
26. Härmä M, Sallinen M, Ranta R, Mutanen P, Müller K. The effect of an irregular shift system on sleepiness at work in train drivers and railway traffic controllers. J Sleep Res 2002 Jun;11(2):141-51. https://doi.org/10.1046/j.13652869.2002.00294.x.
27. Härmä M, Hakola T, Karhula K, Puttonen S, Ropponen A, Sallinen M. Työaikojen kuormittavuuden arviointi jaksotyössä [Evaluation of working hour loading in irregular shift work]: Finnish Institute of Occupational Health; 2021. Available from: https://www.ttl.fi/tyontekija/ tyoaika/tyoaikojen-kuormittavuuden-

arviointi/tyoaikojenkuormittavuuden-arviointi-jaksotyossa.
28. Hakola T, Paukkonen M, Pohjonen T. Less quick returns-greater well-being. Ind Health 2010;48(4):390-4. https:// doi.org/10.2486/indhealth.MSSW-02.
29. Vedaa Ø, Harris A, Bjorvatn B, Waage S, Sivertsen B, Tucker P et al. Systematic review of the relationship between quick returns in rotating shift work and healthrelated outcomes. Ergonomics 2016;59(1):1-14. https://doi. org/10.1080/00140139.2015.1052020.
30. Catano VM, Bissonnette AB. Examining paid sickness absence by shift workers. Occup Med (Lond) 2014 Jun;64(4):287-93. https://doi.org/10.1093/occmed/kqu010.
31. Boudreau P, Dumont GA, Boivin DB. Circadian adaptation to night shift work influences sleep, performance, mood and the autonomic modulation of the heart. PLoS One 2013 Jul;8(7):e70813. https://doi.org/10.1371/journal. pone.0070813.
32. Reynolds AC, Bucks RS, Paterson JL, Ferguson SA, Mori TA, McArdle N et al. Working (longer than) 9 to 5: are there cardiometabolic health risks for young Australian workers who report longer than 38-h working weeks? Int Arch Occup Environ Health 2018 May;91(4):403-12. https://doi. org/10.1007/s00420-018-1289-4.
Received for publication: 23 November 2020

DETAILS

Subject:	Schedules; Shift work; Retail stores; Older workers; Working hours; Confidence intervals; Clustering; Employees; Employment; Medical personnel; Dosage; Risk factors; Night shifts; Women; Risk analysis; Risk reduction; Dose-response effects; Part time employment; Grocery stores; Sick leave
Business indexing term:	Subject: Shift work Older workers Working hours Employees Employment Part time employment Grocery stores Sick leave
Location:	Finland
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	268-276
Publication year:	2021
Publication date:	2021
Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety

ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3952
ProQuest document ID:	2530524978
Document URL:	https://www.proquest.com/scholarly-journals/associations-working-hour-characteristics-with/docview/2530524978/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2023-08-22
Database:	Public Health Database

Document 3 of 9

A prospective cohort study of low-back outcomes and alternative measures of cumulative external and internal vibration load on the lumbar spine of professional drivers

Bovenzi, Massimo, MD [1] ; Schust, Marianne, PhD [2] [1] Clinical Unit of Occupational Medicine, Department of Medical Sciences, University of Trieste, Trieste, Italy [2] Unit Experimental Research on Occupational Health, Federal Institute for Occupational Safety and Health, Berlin, Germany

ABSTRACT (ENGLISH)

Objective The aim of this study was to compare the performance of alternative measures of cumulative lifetime vibration dose to predict the occurrence of low-back pain (LBP) outcomes in a cohort of 537 professional drivers investigated at baseline and over a two-year follow up period. Methods The exposure data obtained in the EU VIBRISKS project were used to calculate alternative measures of either acceleration- (external) or force- (internal) based lifetime vibration doses. Vibration was measured in representative samples of machines and vehicles used by the drivers. Internal lumbar forces were calculated by means of anatomy-, posture-, and anthropometry-based finite element models. The relations of LBP outcomes to alternative measures of lifetime vibration doses were assessed by the generalized estimating equations method. Results Metrics of cumulative vibration exposure constructed with either acceleration- or force-based methods were significantly associated with the occurrence of LBP outcomes. A measure of model fitting suggested that force-based doses were better predictors of LBP outcomes than acceleration-based doses. Models with force root-mean-square doses provided a better fit to LBP outcomes than those with force-peak doses. Conclusions Measures of internal lumbar forces were better predictors of LBP outcomes than measures of external vibration acceleration although the exposure metrics constructed with the acceleration-based method have the advantage of greater simplicity compared to the force-based method. The differences between the models with force-based doses suggest that the cumulative health effects on the lumbar spine might depend on the integrated resulting total force over the entire exposure time rather than primarily on the force peaks.

FULL TEXT

Headnote

Objective The aim of this study was to compare the performance of alternative measures of cumulative lifetime vibration dose to predict the occurrence of low-back pain (LBP) outcomes in a cohort of 537 professional drivers investigated at baseline and over a two-year follow up period.

Methods The exposure data obtained in the EU VIBRISKS project were used to calculate alternative measures of either acceleration- (external) or force- (internal) based lifetime vibration doses. Vibration was measured in representative samples of machines and vehicles used by the drivers. Internal lumbar forces were calculated by means of anatomy-, posture-, and anthropometry-based finite element models. The relations of LBP outcomes to alternative measures of lifetime vibration doses were assessed by the generalized estimating equations method.

Results Metrics of cumulative vibration exposure constructed with either acceleration- or force-based methods were significantly associated with the occurrence of LBP outcomes. A measure of model fitting suggested that force-based doses were better predictors of LBP outcomes than acceleration-based doses. Models with force root-mean-square doses provided a better fit to LBP outcomes than those with force-peak doses.

Conclusions Measures of internal lumbar forces were better predictors of LBP outcomes than measures of external vibration acceleration although the exposure metrics constructed with the acceleration-based method have the advantage of greater simplicity compared to the force-based method. The differences between the models with force-based doses suggest that the cumulative health effects on the lumbar spine might depend on the integrated resulting total force over the entire exposure time rather than primarily on the force peaks.

Key terms acceleration magnitude; intraspinal force; low-back pain; vibration dose; whole body vibration.

Long-term exposure to whole-body vibration (WBV) at the workplace has been associated with an excess risk of low-back pain (LBP) outcomes (1). In 2015, the sixth European Working Conditions Survey (EWCS) reported that about 19% of the workforce employed in the 28 EU Member States were exposed to mechanical vibration at least a quarter of the time or more (2), mainly in agriculture and industry (38%) and construction and transport (36%). Among the 43 850 employees interviewed, the most reported health problem was backache (44%) followed by muscular pains in the arms (42%).

In the 2010 EWCS (3), drivers and mobile-plant operators showed a significantly greater prevalence of (low) back pain (55.1%) when compared with the reference category of teaching professionals (35.3%), resulting in a prevalence ratio of 1.36 [95% confidence interval (CI) 1.18- 1.58] after adjustment for individuallevel risk factors. Low-back disorders among professional drivers are considered to be of multifactorial origin since, in addition to individual characteristics, driving tasks involve exposures to several occupational risk factors such as WBV, excessive postural demands, and unfavorable psychosocial load (4).

To implement measures protecting workers from the adverse health effects of WBV, the EU Directive 2002/44/EC on mechanical vibration (5) established daily exposure action values (EAV) and exposure limit values (ELV) for WBV generated by machinery at the workplace. The EAV and ELV are based on the measure ment of vibration acceleration according to ISO standard 2631-1 (6), and the daily exposure to WBV is evaluated in terms of either equivalent acceleration over an 8-hour period according to a second power time-dependency (A(8) in ms-2 r.m.s.) or the vibration dose value according to a fourth power time-dependency (VDV in ms-1.75). A(8) and VDV are metrics of external vibration acceleration load and may be poorly correlated with the internal load acting on the lumbar spine (7). In particular, there is some evidence that the current metrics of WBV exposure might underestimate the severe health effects of vibration that contain shocks (8).

Recently, international standard ISO 2361-5 has developed a procedure to calculate the compressive forces generated by WBV containing multiple shocks (9). The internal lumbar forces are calculated by means of anatomy-based finite element (FE) models of the seated human and adapted to different sitting postures and individual anthropometric data of representative groups of European drivers (10). In our previous cohort study of professional drivers recruited in the Italian arm of the EU VIBRISKS research project, the daily acceleration-based EU metrics A(8) and VDV were poorer predictors of LBP outcomes than the daily forcebased compressive stress on the lumbar spine calculated according to ISO 2631-5 (9, 11). However, it is unlikely that measures of daily vibration exposure are suitable for the assessment of the risk of long-term adverse health effects such as disorders of the lumbar spine.

The aim of the present study is twofold, namely, to: (i) investigate whether measures of cumulative lifetime force-based vibration exposure are associated with the occurrence of low back symptoms in the professional drivers of the VIBRISKS study; and (ii) compare the performance of lifetime force-based doses to predict LBP outcomes with that of lifetime acceleration-based doses calculated according to a second power time dependency method (6) as reported in our previous study of the VIBRISKS cohort (12).

Methods

Study population

The study cohort included 537 male professional drivers of earth-moving machines in marble quarries (N=124), fork-lift trucks, freight-container tractors or mobile cranes in marble laboratories, dockyards, or paper mills (N=169), and garbage trucks or buses in public utilities (N=244). They were investigated at baseline and then participated annually in one (N=220) or two (N=317) follow up surveys. A minimum of one year of professional driving in the current job was the basic requirement for inclusion of drivers in the study population. Written informed consent to the study was obtained from employers and employees at each company. Further details on the recruitment and the response rate of the driver groups have been reported in our previous epidemiological study of the same cohort (12).

Questionnaire and low-back pain outcomes

Personal sociodemographic characteristics, occupational history in current and previous jobs, daily and cumulative duration of driving on specific machines or vehicles, physical demands while driving, and psychosocial work environment were investigated by means of a structured questionnaire developed within the VIBRISKS research project (13). The several sections of the questionnaire have been described in detail in previous papers (12, 14). Briefly, perceived physical demands at work were evaluated by means of a combined approach of direct observation of working conditions (photographs and video) and the subject's self-assessment during the interview. A measure of perceived physical work demands was constructed and categorized into four grades of increasing physical load (mild, moderate, hard, very hard) by rating the frequency of manual activities (eg, lifting loads) and the duration of awkward postures while driving (14). A measure of the perceived psychosocial work environment was derived from questions concerning job decision, job support, and job satisfaction (15) and categorized into four grades of increasing psychosocial load (good, reasonable, a little poor, poor). More details on the response scales used to grade the measures of physical and psychosocial load at work have been reported in a previous paper (12).

Table 1 reports the characteristics of the study population at baseline.

Low-back symptoms occurred in the previous 12 months were defined as follows:

* LBP: pain or discomfort in the low-back area between the 12th ribs and the gluteal folds (indicated in a figure), lasting >7 days but <30 days in the previous 12 months;
* Chronic LBP: daily experience of LBP or several episodes lasting >30 days in the previous 12 months;
* Sciatic pain: radiating pain in one or both legs (below the knee) in the previous 12 months.

Vibration exposure, intraspinal forces, and measures of lifetime vibration dose

Vibration was measured on representative, randomly selected, samples of industrial machines and vehicles used by the professional drivers according to the recom- mendations of the International Standard ISO 2631-1 (6) and the VIBRISKS protocol (13).

Vibration was measured at the driver-seat interface with a semi-rigid mounting disc containing three uniaxial accelerometers. From one-third band frequency spectra (1-80 Hz) recorded from x-, y-, and z-directions, frequency-weighted accelerations (awx, awy awz) were obtained by using the weighting factors suggested in ISO 2631-1 (6). Daily vibration exposure was expressed in terms of 8-hour energy-equivalent frequency-weighted r.m.s. acceleration [4(8)] according to the EU Directive on mechanical vibration (5).

The intra-spinal forces were predicted using anatomy-based FE models. Representative tri-axial acceleration time histories from various machine types and working tasks were selected as an input to FE models. The measuring time varied from 300-1100 seconds. Ultimately, 19-time histories from as many machines/ vehicles were available as inputs into the FE models. Some subjects operated a combination of two or three vehicles per working day, other subjects operated one machine exclusively. All of the time histories contained shocks in at least one direction according to several criteria for detecting shock (7). Impacts due to sitting down or losing the contact to the seat were eliminated. The median value of unweighted accelerations (aunwz r.m.s.) the subjects were exposed to was 0.64 (range 0.29 - 1.04) ms-2 r.m.s.. The internal forces were predicted on the basis of transfer functions between unweighted vibration accelerations and vertebral forces. The transfer functions are derived from the results of validated anatomy-based FE models and depend on the posture, body mass (BM), body mass index (BMI) of the exposed subjects, as well as the magnitude of the measured acceleration (9). On the basis of 4 observed sitting postures of the drivers (photographs and video), 10 BM/BMI categories, and 2 ranges of acceleration magnitude (aunwz <0.65 ms-2, 0.65 ms-2 <aunwz <1.35 ms-2), 80 modifications of the FE model were created. These 80 model modifications delivered 17280 acceleration to spine-force transfer functions in total as a basis for calculating the force time histories (80 modifications of the model, 4 acceleration inputs (buttock, back, hands, feet), 3 acceleration directions, 6 spine levels, 3 spinal force directions). A description of the 4 observed sitting postures and the 10 BM/BMI categories, and the sophisticated procedure of data processing for the estimation of static and dynamic spinal forces based on FE models have been reported elsewhere (7).

In this study, several measures of cumulative lifetime vibration doses were calculated by combining an exposure quantity with a duration of vibration (table 2). The exposure quantities for acceleration-based doses are given by either the frequency-weighted r.m.s. acceleration of the machine vibration in the vertical direction (awz) or the derived 4(8)z metric calculated according to the principle of "equal energy". The choice of the z-axis (vertical) weighted acceleration for the calculation of acceleration-based doses was for purposes of comparison with the ISO 2361-5 method for the evaluation of exposure to multiple mechanical shocks, which is validated for exposures to peak acceleration signals up to 9.81 ms-2 in the z-direction (9). It should be noted that in this study the exposure quantities for acceleration-based doses (awz, 4(8)z) were derived from the time histories of vibration acceleration used for the calculation of forcebased doses; as a result, they may differ from the values of acceleration measures reported in previous studies of the VIBRISKS cohort (12).

The exposure quantities for force-based doses are given by the r.m.s. value of force (Ftotahrms) and the daily dose of peak-to-peak values of force (F^po) calculated from the internal spinal forces. The forces in the three directions (anterior-posterior Fap, lateral left-right (symmetric) Flat, compressive-decompressive Fcd) were aggregated in Ftota¡,rms and Fd,,o,alpeak by calculating the Euclidean vector (index 'total').

The daily compressive dose Sed recommended by ISO 2361-5 (9) was also calculated (table 2). The metric Sed (MPa) is a measure of whole-body multiple-shock exposure based on the estimation of vibration-induced dynamic compressive stress on the lumbar spine. Sed is calculated from the sum of the peak compressive vertical forces depending on sitting posture, body mass and body mass index and acting on the area of a vertebra endplate over the daily exposure time. Peak is defined here as a maximum value of the additional compressive force between two consecutive mean value crossings in the force time histories. The size of the endplates at the six lumbar spine levels from T12/L1 to L5/S1 is derived from Seidel et al. (16). The 6th power method to calculate Sed is based on the Palmgren-Miner model with reference to fatigue fractures caused by repeated compressive loading of the human

spine (9). Fd¡Mal¡peat (N) is computed similar to Sed with the 6th power but using the Euclidean vector of peak-to-peak values instead of the compressive peaks and without relation to the endplate areas.
To determine exposure duration for each driver, questionnaire data, information obtained by interviewing employees and employers, and company records were used to estimate daily and weekly exposure to WBV expressed in driving hours, as well as the total duration of exposure to WBV in full-time driving years. In addition, samples of driving activities were monitored by a digital chronometer to estimate the actual duration of vibration exposure during a typical workday and over a one-week period (17). More details on the methods to estimate the duration of daily and lifetime vibration exposures are reported elsewhere (12).
The dynamic internal forces and the daily compressive dose Sed (spinal stress values) were calculated for each of the six lumbar spine levels from T12/L1 to L5/ S1. The values are different at each spine level. They depend on factors like eg, sitting posture, BM/BMI, and range of external acceleration magnitude as mentioned above. In this study, data analysis was carried out on the basis of the highest among the six spinal stress values.
Table 3 reports median values (quartiles) of the measures of the acceleration-based and force-based lifetime vibration doses at baseline in the professional drivers.
Data analysis
Continuous variables were summarized with the median as a measure of central tendency and quartiles as measures of dispersion. Categorical data were tabulated into contingency tables. Point and period prevalence and cumulative incidence were calculated according to conventional epidemiological methods.
The associations between LBP (binary) outcomes and individual- and work-related explanatory variables were assessed by means of the generalized estimating equations (GEE) method to account for the within-subject dependency of the observations over time. Odds ratios (ORs) and robust 95% CI were estimated from the GEE logistic regression coefficients and their standard errors. To investigate the temporal sequence of the relationship between the occurrence of LBP outcomes and predictor variables, GEE-logistic regression analysis was performed with a time-lag model, in which the binary outcome variable for subject i at time-point t (Yit) was related to independent variable(s) k for subject i measured at time-point t _ 1 (Xk _ 1), ie, at one time-point earlier.
Measures of either acceleration-based or force-based lifetime vibration doses entered the logistic model as time-dependent continuous or categorical variables, while other individual- or work-related covariates were included as time-dependent categorical variables, except for age which was treated as a time independent continuous variable (age-at-entry). Interactions between independent variables were assessed by adding appropriate product terms to the GEE logistic models. All models included a linear term for time effect. The Quasi-likelihood Information Criterion (QIC), a modification of the Akaike's Information Criterion (AIC), was used to compare the fit of GEE longitudinal models including alternative measures of cumulative lifetime vibration doses (18). The models with the smallest QIC values were chosen as the best-fitting models for the relation between LBP outcomes and vibration doses. By analogy with the strength of evidence rules suggested for the AIC method (19), the following guidelines for selecting the best-fitting model were adopted: AQIC <2 suggests no difference in the fit between models; 4< AQIC <7 tends to give support for the model with the smaller QIC; AQIC >10 means that the model with the smaller QIC provides a substantially better fit to the data.
Results
Occurrence of low-back pain outcomes
At the cross-sectional survey, the prevalences of LBP, chronic LBP, and sciatic pain were 12.7, 7.5, and 23.1%, respectively. Over the follow-up time, there were 79 new cases of LBP, 46 new cases of chronic LBP and 90 new cases of sciatic pain, giving rise to cumulative incidences of 16.8, 9.3 and 21.8%, respectively. Since there were 83 individuals who recovered from lowback symptoms during the follow up, the overall period prevalence of any LBP outcomes in the professional drivers was about 67%.
Relation of low-back pain outcomes to acceleration- and force-based vibration doses
The associations between LBP outcomes and the alternative measures of cumulative lifetime vibration dose treated as either continuous or categorical (quartiles) variables are reported in tables 4 and 5, respectively. Overall, after

adjustment for potential confounders acceleration-based doses ([awz2t\, [A(8)z2t\), force r.m.s.-based doses ([F totaljms2t\, [Ftotaljmst\), and force peak-based doses ([Fd¡totai,Pfak t1/6\, [Sed^k t1/6\) were significantly associated with the occurrence of LBP outcomes over time, although to a different extent. Nevertheless, the information criterion QIC for model fitting suggested that force-based doses were better predictors of LBP outcomes than acceleration-based doses, mainly when the measures of lifetime vibration doses were included as continuous variables in the GEE logistic models: compared with the acceleration model [awz2t\, calculated according to a second power time dependency, the force models showed smaller QIC values with AQIC of 7-12 units for LBP, 5-13 units for chronic LBP, and 9-17 units for sciatic pain. There were differences between force-based doses in the fit to LBP outcomes: test for trend and AQIC values revealed that force r.m.s.-based doses performed better for the prediction of LBP outcomes than force peak-based doses (eg, sciatic pain: AQIC of 5-8 units for models with continuous data, AQIC of 5-16 units for models with categorical data).

In previous investigations of the VIBRISKS cohort (11, 12), physical workload, in addition to vibration exposure, was significantly associated with low-back outcomes, while psychosocial work environment, ageat-entry and other individual-related variables (smoking and drinking habits, marital status, annual car driving, education and physical activity) showed no significant relations to LBP outcomes. These findings, however, are beyond the scope of the present study

There were no significant interactions between measures of either acceleration-based or force-based lifetime doses and physical load when appropriate product terms were included in the statistical models.

Discussion

LBP outcomes in driving occupations

The findings of this prospective cohort study are in accordance with those of other epidemiological studies and surveys of working populations. A recent systematic literature review and meta-analysis have reported a pooled risk estimate of 2.17 (95% CI 1.61-2.91) for LBP in WBV-exposed worker groups compared to unexposed reference groups, although significant heterogeneity was found between studies (20). Moreover, LBP showed a pooled risk estimate of 1.51 (95% CI 1.30-1.75) by contrasting high- and low-exposure groups of workers, suggesting a possible exposure-response relationship. Similar findings were reported in earlier reviews and metaanalyses (4, 21). In the fifth EWCS 2010 (3), duration of occupational exposures to vibration classified as "often" and "always" of the working time were associated with LBP prevalences of 58.2 and 61.2%, respectively. These figures are consistent with the period prevalence of LBP outcomes (67%) observed in the professional drivers of this study. An excess risk for sciatic pain has been reported in few studies of WBV-exposed workers. In a meta-analysis of nine cross-sectional studies, a pooled risk estimate of 1.92 (95% CI 1.38-2.67) for sciatic pain has been reported in WBV-exposed groups when compared with unexposed reference groups (manual workers, office workers) (20). In this study, a cumulative incidence of 21.8% for sciatic pain was observed in our cohort of professional drivers. This figure is very similar to a three-year cumulative incidence of 22% reported in a longitudinal study of Finnish machine operators who were free from sciatica at baseline (22).

LBP outcomes and alternative measures of cumulative lifetime vibration dose

The exposure action and limit values for WBV provided by the EU Directive are based on metrics of frequency-weighted acceleration of vibration to which a worker is exposed during a working day, normalized to an 8-hour reference period (5). The protective effectiveness of the EU levels of daily WBV exposure against the risk to the lower lumbar spine and the connected nervous system is not fully known but it is a matter of concern that epidemiological studies have reported low-back troubles among workers exposed to WBV levels lower than the EU exposure action values (8, 12). The metrics A(8) and VDV are measures of daily WBV exposure and may be not sufficient to predict the probability of low back disorders which are chronic conditions and can take several years to develop. Furthermore, the current EU WBV metrics for the assessment of vibration related LBP outcomes are measures of external vibration exposure which can reflect only partially the internal dynamic stress on the lumbar spine caused by WBV.

In the present study, the occurrence of LBP outcomes over time was related to a broad variety of external and internal vibration doses by using different exposure quantities (r.m.s. acceleration, r.m.s. force, peak force) integrated over the total lifetime duration of vibration exposure. Vibration exposure expressed in terms of VDV measured by means of the root-mean-quad (r.m.q.) weighting method was not considered in this paper since a previous study of the same cohort of professional drivers revealed that the effects of transient vibration, shocks, or repetitive shocks were better predicted by measures of dynamic compressive stress (eg, Sed) rather than by the VDV metric (11).

Measures of lifetime vibration dose which combine r.m.s. acceleration magnitude with total driving time resulted in improved associations with the occurrence of low-back symptoms compared to those previously observed for the same measures of acceleration magnitude integrated over the daily duration of vibration exposure (11). This is a remarkable finding suggesting that measures of exposure to vibration acceleration accumulated over the work life are more predictive of the development of long-term adverse health effects to the lower back of professional drivers than measures of daily vibration exposure.

Nevertheless, a statistic for model fitting revealed that measures of internal dynamic spinal forces (either r.m.s. force or peak force) combined with total duration of exposure were better predictors of LBP outcomes than acceleration-based lifetime doses. Thus, the findings of this study suggest that metrics of vibration exposure based on cumulative internal spinal load (force) are related to LBP outcomes to a greater extent than those from cumulative external load (acceleration).

In this study, models with force-r.m.s. doses provided a better fit to LBP outcomes than those with forcepeak doses. This finding was evident mainly for sciatic pain which is a symptom more severe and with poorer prognosis than low back complaints of non-specific origin. Hence, the differences between the models with force-based doses suggest that the cumulative health effect on the lumbar spine might depend on the integrated resulting total force over the entire time rather than primarily on the force peaks. These findings are consistent with those reported in other epidemiological studies concluding that metrics of cumulative mechanical load are more predictive of the occurrence of LBP outcomes than peak loads (23, 24). This view is also in line with the experimental evidence that vibration and shock are sufficient mechanical risk factors for the initiation and the progression of injuries to the spine tissues supporting a fatigue model for LBP aetiology as the result of accumulation of tissue microdamage and failure to the anatomical structures of the lumbar spine (25, 26).

It may be argued that the method for the measurement of internal spinal forces is too complex to be applicable at a workplace. The force-based method requires several variables to be specified in the input file of the software (measurement/assessment of postures, body mass and height, acceleration time series measured in three directions at the seat surface of the machine(s), daily and lifetime exposure durations) and then processed by means of acceleration to spine-force transfer functions to calculate the spinal forces and the derived metrics for the evaluation of mechanical shocks. In opposite the accelerationbased method requires only the frequency-weighted r.m.s. acceleration (single axis or tri-axial) measured at the machine seat surface and the total duration of exposure to calculate a lifetime acceleration-based dose. Nevertheless, in this study both the acceleration-based doses and the force-based doses were significantly associated with the occurrence of LBP outcomes, although a measure of model fitting showed that the internal force method performed better for the prediction of the adverse health effects on the lumbar spine. These findings suggest that despite the substantial differences in the complexity of the two methods for the evaluation of WBV exposure, they may be considered complementary to each other under certain conditions of exposure. The weighted r.m.s. acceleration-based method, also called the "basic evaluation method" in ISO 2631-1 (6), is suitable for the measurement of periodic, random and transient WBV with crest factor (ie, the ratio of the maximum instantaneous peak value of the frequency-weighted acceleration signal to its r.m.s. value) <9. On the other hand, international standard ISO 2631-5 recommends to estimate the internal spinal forces for the evaluation of the biomechanical response of the lumbar spine to vibration containing multiple, repeated, shocks (9). Since the risk assessment methods and related models described in ISO 2631-5 are not yet epidemiologically validated, the findings of this cohort study tend to support the force-based method for assessing the risk of health impairment to the lumbar spine due to long-term exposure to WBV containing multiple mechanical shocks.

Limitations of the study

There are limitations and uncertainties in this study that deserve attention (11, 12). Some limitations are linked to the exposure data. Since vibration measurements were made on currently available machines or vehicles, uncertainty in the estimation of lifetime vibration doses may arise. Nevertheless, the weighted r.m.s. acceleration magnitude of vibration measured in the vehicles of the present study are comparable with those reported in recent and past investigations (4, 27-29). In this study, the acceleration-based doses were constructed using only the vibration acceleration weighted in the z-direction (vertical). As aforementioned, this was done for purposes of comparison with the metrics for vibration shocks recommended by ISO 2631-5 (9). It should be noted, however, that the z-axis (vertical) weighted acceleration (awz) was the dominant directional component of vibration measured in all of the machines and vehicles (7, 12). Considering the multiplying factor 1.4 for the horizontal axes according to EU Directive on mechanical vibration (5), only one vehicle during a special activity (wheel loader, stone transportation in a quarry) revealed a dominant directional component in the x-axis (7).

Estimation of daily and weekly driving times with exposure to WBV by means of questionnaire methods may be subject to recall bias. In this study additional information was retrieved from company records and direct interviews to employees and employers. The daily exposure patterns were assumed to be constant over the working life. Some subjects operated one machine exclusively; other subjects operated a combination of two or three vehicles. If two or three vehicles were driven per day, an equal proportion of time per day was assumed (one-half and one-third, respectively), and the time histories of the spinal forces in response to each vehicle were combined to calculate the overall internal spinal load.

The questionnaire used in this study was originally developed within the European project VINET (14). The questionnaire underwent a process of improving revisions on the basis of the findings of pilot studies and epidemiological surveys conducted across some European countries (14). Although the role of the questionnaire as an instrument to collect exposure data is still controversial (30), questionnaire methods may offer a means for studying cumulative exposure over time, a variable which cannot be estimated by direct observations or measurements (31).

In this study the spinal response to WBV has been investigated by means of FE-modelling based on the real anatomy of the lumbar spine region. The FE-models have been validated by means of experimental laboratory research on human biodynamics and field research on anthropometry and posture of representative groups of European drivers (10, 32-34). Present limitations of the FE-models concern its linearity, simplified modelling of soft tissue at the input areas, missing consideration of twisting, and limited verification for horizontal and rotational inputs (7). The current FE-models to calculate spinal forces during exposure to WBV do not provide a quantitative risk assessment for internal stresses caused by shear forces, bending and torsion, since reliable strength data (ultimate static strength, strength under dynamic repetitive load) for such stresses are not available.

Concluding remarks

In this prospective cohort study, metrics of cumulative vibration exposure based on either external (acceleration-based) or internal (force-based) spinal load were significantly associated with the occurrence of LBP outcomes in professional drivers exposed to WBV containing multiple mechanical shocks. Measures of internal lumbar forces were better predictors of LBP outcomes than measures of external vibration acceleration although the exposure metrics constructed with the acceleration-based method have the advantage of greater simplicity compared to the force-based method. Models with force-r.m.s. doses provided a better fit to LBP outcomes than those with force-peak doses. These findings suggest that the cumulative health effect on the lumbar spine might depend on the integrated resulting total force over the entire time rather than primarily on the force peaks.

Acknowledgements

This research was supported by the European Commission under the Quality of Life and Management of Living Resources programme - Project No. QLK4-2002- 02650 (VIBRISKS), and by the Federal Institute for Occupational Safety and Health, Germany - Research Project F 2257.

Conflict of interest

The authors declare no conflicts of interest.

Sidebar

Bovenzi M, Schust M. A prospective cohort study of low-back outcomes and alternative measures of cumulative external and internal vibration load on the lumbar spine of professional drivers. Scand J Work Environ Health. 2021;47(4):277-286. doi:10.5271/sjweh.3947

References

References

1. Comité Européen de Normalisation (CEN). Mechanical vibration - guide to the health effects of vibration on the human body. Brussels: CEN; 1996. CR Report 12349.
2. Eurofound. Sixth European Working Conditions Survey - overview report. Luxembourg: Publications Office of the European Union; 2016.
3. Farioli A, Mattioli S, Quaglieri A, Curti S, Violante FS, Coggon D. Musculoskeletal pain in Europe: the role of personal, occupational, and social risk factors. Scand J Work Environ Health 2014 Jan;40(1):36-46. https://doi. org/10.5271/sjweh.3381.
4. Bovenzi M, Hulshof CT. An updated review of epidemiologic studies on the relationship between exposure to wholebody vibration and low back pain (1986-1997). Int Arch Occup Environ Health 1999 Sep;72(6):351-65. https://doi. org/10.1007/s004200050387.
5. Directive 2002/44/EC of the European Parliament and the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) (16th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC). Off J Eur Communities. L 117/13, 6.7.2002.
6. International Standardization Organization (ISO). Mechanical vibration and shock - guide for the evaluation of human exposure to whole-body vibration - Part 1: General requirements. Geneva: ISO; 1997. ISO 2631-1.
7. Schust M, Menzel G, Hofmann J, Forta NG, Pinto I, Hinz B et al. Measures of internal lumbar load in professional drivers - the use of a whole-body finite-element model for the evaluation of adverse health effects of multi-axis vibration. Ergonomics 2015;58(7):1191-206. https://doi.or g/10.1080/00140139.2014.960009.
8. Seidel H. On the relationship between whole-body vibration exposure and spinal health risk. Ind Health 2005 Jul;43(3):361-77. https://doi.org/10.2486/indhealth.43.361.
9. International Standardization Organization (ISO). Mechanical vibration and shock - evaluation of human exposure to vibration - Part 5: Methods for evaluation of vibration containing multiple shocks. Geneva: ISO; 2018, 2nd edition. ISO 2631-5.
10. Hinz B, Seidel H, Hofmann J, Menzel G. The significance of using anthropometric parameters and postures of European drivers as a database for finite-element models when calculating spinal forces during whole-body vibration exposure. Int J Ind Ergon 2008;38(9-10):816-43. https:// doi.org/10.1016/j.ergon.2007.10.022.
11. Bovenzi M, Schust M, Menzel G, Prodi A, Mauro M. Relationships of low back outcomes to internal spinal load: a prospective cohort study of professional drivers. Int Arch Occup Environ Health 2015 May;88(4):487-99. https://doi. org/10.1007/s00420-014-0976-z.
12. Bovenzi M. Metrics of whole-body vibration and exposureresponse relationship for low back pain in professional drivers: a prospective cohort study. Int Arch Occup Environ Health 2009 Jul;82(7):893-917. https://doi.org/10.1007/ s00420-008-0376-3.
13. Risks of Occupational Vibration Exposures (VIBRISKS). FP5 Project No. QLK4-2002-02650. European Commission Quality of Life and Management of Living Resources Programme. Southampton, UK: Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton [updated 28 February 2007; cited 1 June 2020]. Available from: http://www.vibrisks.soton.ac.uk.
14. Pope M, Magnusson M, Lundström R, Hulshof CT, Verbeek J, Bovenzi M. Guidelines for whole-body vibration health surveillance. J Sound Vibrat 2002;253(1):131-67. https:// doi.org/10.1006/jsvi.2001.4253.
15. Karasek RA. Job demands, job decision latitude, and mental strain: implications for job redesign. Adm Sci Q

1979;24(2):285-307. https://doi.org/10.2307/2392498.
16. Seidel H, Pöpplau BM, Morlock MM, Püschel K, Huber G. The size of lumbar vertebral endplate areas - prediction by anthropometric characteristics and significance for fatigue failure due to whole-body vibration. Int J Ind Ergon 2008;38(9-10):844-55. https://doi.org/10.1016/j. ergon.2007.10.001.
17. Pinto I, Stacchini N. Uncertainty in the evaluation of occupational exposure to whole body vibration. J Sound Vibrat 2006;298(3):556-62. https://doi.org/10.1016/j. jsv.2006.06.018.
18. Cui J. QIC program and model selection in GEE analyses. Stata J 2007;7(2):209-20. https://doi. org/10.1177/1536867X0700700205
19. Burnham KP, Anderson DR. Multimodel inference: understanding AIC and BIC in model selection. Sociol Methods Res 2004;33(2):261-304. https://doi. org/10.1177/0049124104268644.
20. Burström L, Nilsson T, Wahlström J. Whole-body vibration and the risk of low back pain and sciatica: a systematic review and meta-analysis. Int Arch Occup Environ Health 2015 May;88(4):403-18. https://doi.org/10.1007/s00420014-0971-4.
21. BurdorfA, Sorock G. Positive and negative evidence of risk factors for back disorders. Scand J Work Environ Health 1997 Aug;23(4):243-56. https://doi.org/10.5271/sjweh.217.
22. Riihimäki H, Viikari-Juntura E, Moneta G, Kuha J, Videman T, Tola S. Incidence of sciatic pain among men in machine operating, dynamic physical work, and sedentary work. A three-year follow-up. Spine 1994 Jan;19(2):138-42. https:// doi.org/10.1097/00007632-199401001-00003.
23. Coenen P, Kingma I, Boot CR, Bongers PM, van Dieēn JH. Cumulative mechanical low-back load at work is a determinant of low-back pain. Occup Environ Med 2014 May;71(5):332-7. https://doi.org/10.1136/ oemed-2013-101862.
24. Norman R, Wells R, Neumann P, Frank J, Shannon H, Kerr M. A comparison of peak vs cumulative physical work exposure risk factors for the reporting of low back pain in the automotive industry. Clin Biomech (Bristol, Avon) 1998 Dec;13(8):561-73. https://doi.org/10.1016/S02680033(98)00020-5.
25. Wade KR, Schollum ML, Robertson PA, Thambyah A, Broom ND. ISSLS Prize Winner: Vibration Really Does Disrupt the Disc: A Microanatomical Investigation. Spine 2016 Aug;41(15):1185-98. https://doi.org/10.1097/ BRS.0000000000001594.
26. Yates JP, McGill SM. The effect of vibration and posture on the progression of intervertebral disc herniation. Spine 2011 Mar;36(5):386-92. https://doi.org/10.1097/ BRS.0b013e3181d2cece.
27. Dupuis H, Zerlett G. The effects of whole-body vibration. Berlin: Springer-Verlag, 1986.
28. Griffin MJ. Handbook of human vibration. London: Academic Press, 1990.
29. Griffin MJ, Howarth HVC, Pitts PM, Fischer S, Kaulbars U, Donati P, et al. Guide to good practice on whole-body vibration. European Commission Directorate General Employment, Social Affairs and Equal Opportunities (contract VC/2004/0341); 2006.
30. Burdorf A, van der Beek AJ. In musculoskeletal epidemiology are we asking the unanswerable in questionnaires on physical load? Scand J Work Environ Health 1999 Apr;25(2):81-3. https://doi.org/10.5271/ sjweh.409.
31. Kilbom A. Assessment of physical exposure in relation to work-related musculoskeletal disorders-what information can be obtained from systematic observations? Scand J Work Environ Health 1994;20(Spec No):30-45.
32. Pankoke S, Buck B, Wölfel HP. Dynamic FE model of sitting man adjustable to body height, body mass, and posture used for calculating internal forces in the lumbar intervertebral disks. J Sound Vibrat 1998;215(4): 827-39. https://doi.org/10.1006/jsvi.1998.1699.
33. Seidel H, Blüthner R, Hinz B. Application of finite-element models to predict forces acting on the lumbar spine during whole-body vibration. Clin Biomech (Bristol, Avon) 2001;16 Suppl 1:S57-63. https://doi.org/10.1016/S02680033(00)00106-6.
34. Seidel H, Hinz B, Hofmann J, Menzel G. Intraspinal forces and health risk caused by whole-body vibration - Prediction for European drivers and different field conditions. Int J Ind Ergon 2008;28(9-10):856-67. https://doi.org/10.1016/j. ergon.2007.10.007.

Received for publication: 18 August 2020

DETAILS

Subject:	Load; Back pain; Finite element method; Posture; Work environment; Anthropometry; Vibration; Vibration measurement; Exposure; Spine (lumbar); Working conditions; Low back pain; Questionnaires; Mathematical models; Recruitment; Spine; Cohort analysis
Business indexing term:	Subject: Work environment Working conditions Recruitment
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	277-286
Publication year:	2021
Publication date:	2021
Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3947
ProQuest document ID:	2530524930
Document URL:	https://www.proquest.com/scholarly-journals/prospective-cohort-study-low-back-outcomes/docview/2530524930/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021

Last updated:	2023-05-11
Database:	Public Health Database

Is job strain associated with a higher risk of type 2 diabetes mellitus? A systematic review and meta-analysis of prospective cohort studies

Li, Wenzhen, MD [1] ; Yi, Guilin, MS [2] ; Chen, Zhenlong, MS [2] ; Dai, Xiayun, MD [2] ; Wu, Jie, MS [2] ; Peng, Ying, MS; BS, Wenyu Ruan; Lu, Zuxun, MD; Wang, Dongming, MD [1] Department of Social Medicine and Health Management, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, People's Republic of China [2] Wuhan Prevention and Treatment Center for Occupational Diseases, Wuhan, Hubei, People's Republic of China

ABSTRACT (ENGLISH)

Objectives Epidemiological studies have explored the relationship between work-related stress and the risk of type 2 diabetes mellitus (T2DM), but it remains unclear on whether work-related stress could increase the risk of T2DM. We aimed to evaluate the association between job strain and the risk of T2DM. Methods We searched PubMed and Web of Science up to April 2019. Summary risk estimates were calculated by random-effect models. And the analysis was also conducted stratifying by gender, study location, smoking, drinking, body mass index, physical activity, family history of T2DM, education and T2DM ascertainment. Studies with binary job strain and quadrants based on the job strain model were analyzed separately. Results A total of nine studies with 210 939 participants free of T2DM were included in this analysis. High job strain (high job demands and low control) was associated with the overall risk of T2DM compared with no job strain (all other combinations) [relative risk (RR) 1.16, 95% confidence interval (CI) 1.03-1.31], and the association was more evident in women (RR 1.48, 95% CI 1.02-2.14). A statistically significant association was also observed when using high strain as a category (job strain quadrants) rather than binary variable (RR 1.62, 95% CI 1.04-2.55) in women but not men. Conclusions Our study suggests that job strain is an important risk factor for T2DM, especially among women. Appropriate preventive interventions in populations with high job strain would contribute to a reduction in T2DM risk.

FULL TEXT

Headnote

Li W, Yi G, Chen Z, Dai X, Wu J, Peng Y, Ruan W, Lu Z, Wang D. Is job strain associated with a higher risk of type 2 diabetes mellitus? A systematic review and meta-analysis of prospective cohort studies. Scand J Work Environ Health. 2021;47(4):249-257. doi:10.5271/sjweh.3938

Objectives Epidemiological studies have explored the relationship between work-related stress and the risk of type 2 diabetes mellitus (T2DM), but it remains unclear on whether work-related stress could increase the risk of T2DM. We aimed to evaluate the association between job strain and the risk of T2DM.

Methods We searched PubMed and Web of Science up to April 2019. Summary risk estimates were calculated by random-effect models. And the analysis was also conducted stratifying by gender, study location, smoking, drinking,

body mass index, physical activity, family history of T2DM, education and T2DM ascertainment. Studies with binary job strain and quadrants based on the job strain model were analyzed separately.
Results A total of nine studies with 210 939 participants free of T2DM were included in this analysis. High job strain (high job demands and low control) was associated with the overall risk of T2DM compared with no job strain (all other combinations) [relative risk (RR) 1.16, 95% confidence interval (CI) 1.03-1.31], and the association was more evident in women (RR 1.48, 95% CI 1.02-2.14). A statistically significant association was also observed when using high strain as a category (job strain quadrants) rather than binary variable (RR 1.62, 95% CI 1.04-2.55) in women but not men.
Conclusions Our study suggests that job strain is an important risk factor for T2DM, especially among women. Appropriate preventive interventions in populations with high job strain would contribute to a reduction in T2DM risk.
Key terms job control; job demand; psychosocial; work stress.
Recently, studies have shown that work-related stress, a known occupational hazard, might increase the risk of cardiovascular disease (CVD), cancer and death (1-4). Psychosocial factors at work played a pivotal role in the pathogenesis and progression of CVD and cancer, involving activation of sympathetic nervous system and dysregulation of the hypothalamic-pituitary-adrenal axis, which could accelerate the development of the metabolic syndrome, increase the production of cortisol, trigger and maintain chronic inflammation, and lead to dysrhythmia (5-8).
Type 2 diabetes mellitus (T2DM), one of the most prevalent chronic diseases, is considered to be one of the major public health challenges in both developed and developing countries (9). Work-related psychosocial stress has been hypothesized to increase the individual risk of T2DM; however, the results of the studies examining the association between work-related stress and T2DM risk are inconsistent. In 2012, a meta-analysis conducted by Cosgrove et al (10) showed that high psychosocial stress was not directly associated with increased risk of T2DM, the significant heterogeneity in the design of the original studies and the work-related stress models may introduce bias into the meta-analysis. Another meta-analysis published in 2016 (11) suggested that no significant association was found between work-related stress and risk of T2DM based on seven prospective cohort studies. Notably, the psychosocial work characteristics and the reference of job strain between included studies were different, for example, Smith et al's study (12) presented the hazard ratios (HR) associated with separate dimensions of psychosocial work environment and T2DM, while Nyberg et al's study (13) presented the HR for job strain (high demands and low control) compared with no job strain (all other combinations) based on job strain model (14). Moreover, the literature search was limited to September 2014, and some new, high quality studies have been reported in subsequent several years.
We therefore carried out an updated systematic review and meta-analysis of prospective cohort studies to comprehensively explore the relationship between job strain and T2DM risk. Job strain was measured with sets of questions from the validated Job Content Questionnaire and Demand-Control Questionnaire in these prospective cohort studies (15), and the scores were assessed according to Karasek and colleague's job strain model (16).

Methods

Search strategy

This systematic review was conducted in accordance with the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (17). Eligible studies were identified from review articles, computer-aided literature searches in the PubMed and Web of Science, using combinations of the search terms: ('work stress' or 'job strain' or 'job stress' or 'occupational stress' or 'work-related psychosocial stress') and ('diabetes mellitus' or 'type 2 diabetes mellitus' or 'diabetes'), up to 3 April 2019. The search was restricted to human studies. No restrictions were imposed on the language of publications. Abstracts, non-original papers (reviews, editorials, or letters), grey literature, and unpublished results or information were not included. We also reviewed the reference lists of all included studies and relevant reviews.

Inclusion criteria

A study was included in the meta-analysis if it: (i) was a cohort design, (ii) evaluated the association between job strain and the T2DM risk, (iii) reported estimates of relative risk (RR) or HR with 95% confidence intervals (CI), and (iv) defined the job strain according to the Job Content Questionnaire (JCQ) or derivatives of the JCQ, and scores of the validated JCQ based on the job strain model. Only the most recent and informative studies were included, when multiple reports were published on the same population.

Data collection

Two investigators extracted detailed information in the predefined criteria to ensure consistency in data collection independently. Any disagreements were discussed to obtain consistency by another investigator. We extracted the following data from the studies included in the final analyses: name of first author, year of publication, country, characteristics of study population at baseline, duration of follow-up, number of cases, number of participants, risk estimates and corresponding 95% CI, and covariates adjusted in the statistical analysis. Any article stratified by gender or age was treated as two separate reports.

Quality assessment

Two reviewers independently performed the quality assessment using the Newcastle-Ottawa Scale (18), which is a 9-point scale allocating points based on the selection process of cohorts (0-4 points), the comparability of cohorts (0-2 points) and the identification of the exposure and the outcomes of study participants (0-3 points). We considered a study with a score of >6 as a high-quality study.

Statistical analysis

We pooled multivariable adjusted risk estimates when such estimates were reported. If adjusted analysis was unavailable, we used the unadjusted estimate. In addition, the HR were regarded directly as RR in our analysis. Binary job strain was defined as job strain (high demands and low control) versus no strain (all other categories combined), and/or job strain categories, or quadrants based on the job strain model, including high strain job (high demands and low control), active job (high demands and high control), passive job (low demands and low control), and low strain job (low demands and high control). Job strain was modeled both as a binary exposure (strain versus no strain) and as a categorical exposure (high strain, active job, and passive job versus low strain). We used the study-specific RR for job strain versus no strain, or high strain, active job, and passive job versus low strain.

We calculated summary estimates of the RR/HR using random-effects models, which considered both within- and between-study variation. Heterogeneity of effect size across studies was tested by I2 statistics, the following cut-off points were used: <30% (little or no heterogeneity), 30-75% (moderate heterogeneity), and >75% (high heterogeneity) (19). Sources of heterogeneity were investigated by meta-regression analyses and subgroup analyses. Analyses were separated based on sex, study location and whether the results were adjusted by smoking, drinking, body mass index (BMI), physical, family history of T2DM, education and T2DM ascertainment. Visual inspection of funnel plots, Begg's and Egger's tests were used to evaluate the publication bias (20, 21). The meta-analysis was performed using STATA version 12.0 (Stata Corp, College Station, TX, USA). All P values are two tailed, and we set P<0.05 as the threshold for significance.

Results

Identification of relevant studies

Detailed process of the study selection is described in figure 1. Briefly, from the initial searched literatures, we identified and screened articles (PubMed: N=1567, Web of Science: N=2793). Of which, the majority were excluded because they were reviews, animal studies, not relevant to our analysis or association of interest was not evaluated, or requested data were not reported. By examining the full texts of eight articles, we added one study from reference lists. Finally, nine studies were included in our meta-analysis.

Description of studies included in the final analysis

We identified nine studies on job strain and T2DM risk and the details of included studies are presented in table 1. The selected studies were published between 1999-2017. The study samples ranged from 584-124 808, with a total of 210 939, and the number of cases of T2DM ranged from 34-3703, with a total of 5105. The duration of follow-up for incident T2DM ranged from 5.8-12.7 years. One cohort was conducted in Japan (22), three in Sweden (23-25), one in UK (26), one in Europe (13), two in US (27, 28) and one in Germany (29). In total, one study reported result for women only (27), one study reported result for men only (22), and one study reported result for both men and women combined only (29). Four studies (13, 22, 25, 26) presented RR for job strain versus no strain, five studies (23, 24, 27-29) reported RR for high strain, active job, and passive job versus low strain, respectively. The average score for included studies was 7.8 (range 7-9), supplementary material (www.sjweh.fi/ show_abstract.php?abstract_id=3938), table S1.

Association of high job strain with T2DM risk

Four prospective studies (13, 22, 25, 26) with six reports were included in the high job strain meta-analysis. Results indicated that high job strain (high job demands and low control) was associated with the overall risk of T2DM, compared with no job strain (all other combinations) (RR 1.16, 95% CI 1.03-1.31, I2=34.4%, P=0.179) (figure 2). Especially, high job strain was significantly associated with the risk of T2DM among women (RR 1.48, 95% CI 1.02-2.14, I2=61.3%, P=0.051) with moderate heterogeneity and both gender group (RR 1.15, 95% CI 1.06-2.14, I2=0.00%, P=0.437) without heterogeneity in the subgroup analysis, but not for men. In addition, the association was observed in Europe but not Asia (table 2).

Association between job strain model quadrants and T2DM risk

Five prospective studies (23, 24, 27-29) were included in the job strain model quadrants meta-analysis. No significant association was found between the quadrants of the job strain model (versus low strain) and T2DM risk, and similar results were found in the three categories of high strain, active job, and passive job when compared with low strain (figure 3). However, the subgroup analysis indicated that the T2DM risk increased 62% among women in high strain category with moderate heterogeneity (RR 1.62, 95% CI 1.04-2.55, I2=48.2%, P=0.122), but not for men (table 3).

Subgroup and sensitivity analyses

Subgroup analysis was conducted to test the stability of the results. Results changed when controlling for smoking, drinking, BMI, alcohol consumption, physical activity family history of T2DM, education and T2DM ascertainment in both the subgroup analyses of the association between high job strain and T2DM risk (table 2) and with respect to the association between job strain model quadrants and T2DM risk (table 3). In addition, sensitivity analysis excluding a single study in turn did not alter the combined RR (supplementary figures S1a and S1b).

Publication bias

Visual inspection of funnel plots failed to identify substantial asymmetry [supplementary figures S2(A) and S2(B)]. There was no evidence of publication bias among the studies was found by Begg's rank correla- tion test and Egger's linear regression test for high job strain (Begg's test P=0.602; Egger's P=0.612) and job strain model quadrants (Begg's test P=0.189; Egger's P=0.418).

Discussion

Our meta-analysis suggested high job strain (high job demands and low control) increased overall risk of T2DM when compared with no job strain (all other combinations). And the result was significant among women but not men. Studies have showed that women tend to work more in high stress occupations such as healthcare jobs and education (30). Another explanation could be that women had lower degree of freedom at work, a higher stress load due to non-paid work compared to men, and experienced the gender inequality during work life (31). Women may therefore be at higher risk of experiencing adverse health-related outcomes such as T2DM due to the higher proportion experiencing the job to be high-strain. Besides, combined high strain, active job, and passive job were not associated with T2DM risk when job strain was divided into four categories according to job strain model; however, the T2DM risk increased by 62% among women in the high strain category.

Our study was inconsistent with two previous metaanalyses (10, 11), both of which indicated that job strain is not directly associated with increased risk of T2DM. However, Hua Sui et al's study (11) showed that the highest group of job strain was associated with T2DM risk among women (RR 1.22, 95% CI 1.01-1.46), when compared with the lowest category. Our results found the risk to be greater (RR 1.62, 95% CI 1.04-2.55). Furthermore, the subgroup analyses showed that results changed when controlling for smoking, drinking, BMI, alcohol consumption, physical activity, family history of T2DM, education and T2DM ascertainment, which suggested that lifestyle factors may play a key role in the relationship between job strain and T2DM risk. Stressed individuals are more likely to smoke, increase alcohol consumption, and be obese than stress-free individuals (32-34), and these worsening health-related lifestyle factors were related to T2DM (35-37).

The potential biological mechanisms that underlie the association of job strain with T2DM risk are complex. Neuroendocrine disorders may be the most key mechanism, including activation of sympathetic nervous system and dysregulation of the hypothalamic-pituitary-adrenal axis, which has been described in details in previous studies (38-40). Besides, except for contributing to worsening health-related lifestyle factors, job stress could also affect depressive symptoms (41) that was well-documented risk factor for T2DM (42), which may also be an important indirect mechanism.

The present meta-analysis has several strengths. We included only prospective cohort studies with a mean quality score of 7.8, which could ensure the high quality of our study. Besides, the exposure was defined clearly in our meta-analysis, and all included papers defined job strain according to JCQ or derivatives of the JCQ and scores of the validated JCQ based on the job strain model. Binary job strain and quadrants based on the job strain model were analyzed separately, which could make the results more reliable and accurate.

There were several limitations in our meta-analysis. Firstly, we focused on job strain, which is the most widely studied form of work-related stress. However, other work-related stress, such as effort-reward imbalance (43), job insecurity (44) as well as various sources of stress outside work (45) were not considered in our study. Thus, our findings are likely to underestimate the overall impact of work-related stress on T2DM risk. Secondly, ascertainment of T2DM varied between these studies, and case ascertainment in some studies was based on self-reports. Thus, there could have been misclassification of T2DM. Last but not least, critics have commented that the crude median split definition of job strain leads to underestimation of the true magnitude of the association (46, 47), as most participants in an epidemiological study are likely to center round the middle.

Concluding remarks

In summary, our analysis indicates that job strain may increase T2DM risk, especially among women. Prospective cohort studies with larger sample sizes and longer follow-up times are warranted to probe the potential mechanisms and establish causality.

Conflicts of interest

The authors declare no conflicts of interest.

Funding

The study was supported by National Natural Science Foundation of China (81903291, 81703203), the Fundamental Research Funds for the Central Universities (2019kfyXJJS032), Hubei Province health and family planning scientific research project (WJ2017M203), and Wuhan municipal health Commission (WG16B08). The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Sidebar

Correspondence to: Dongming Wang, Department of Occupational &Environmental Health, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei 430030, China. [E-mail: 648283002@qq.com]

References

References

1. Kivimaki M, Nyberg ST, Batty GD, Fransson EI, Heikkila K, Alfredsson L, et al. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. Lancet. 2012;380(9852):1491-7. https://doi. org/10.1016/S0140-6736(12)60994-5.

2. Huang Y, Xu S, Hua J, Zhu D, Liu C, Hu Y, et al. Association between job strain and risk of incident stroke: A meta-analysis. Neurology. 2015;85(19):1648-54. https://doi.org/10.1212/ WNL.0000000000002098.

3. Yang T, Qiao Y, Xiang S, Li W, Gan Y. Work stress and the risk of cancer: A meta-analysis of observational studies. Int J Cancer. 2019;144(10):2390-400. https://doi.org/10.1002/ ijc.31955.

4. Kivimaki M, Pentti J, Ferrie JE, Batty GD, Nyberg ST, Jokela M, et al. Work stress and risk of death in men and women with and without cardiometabolic disease: a multicohort study. Lancet Diabetes Endocrinol. 2018;6(9):705-13. https://doi. org/10.1016/S2213-8587(18)30140-2.
5. Kivimaki M, Steptoe A. Effects of stress on the development and progression of cardiovascular disease. Nat Rev Cardiol. 2018;15(4):215-29. https://doi.org/10.1038/ nrcardio.2017.189.
6. Muratsubaki T, Hattori T, Li J, Fukudo S, Munakata M. Relationship between Job Stress and Hypo-high-density Lipoproteinemia of Chinese Workers in Shanghai: The Rosai Karoshi Study. Chin Med J (Engl). 2016;129(20):2409-15. https://doi.org/10.4103/0366-6999.191750.
7. Hansel A, Hong S, Camara RJ, von Kanel R. Inflammation as a psychophysiological biomarker in chronic psychosocial stress. Neurosci Biobehav Rev. 2010;35(1):115-21. https:// doi.org/10.1016/j.neubiorev.2009.12.012.
8. Brotman DJ, Golden SH, Wittstein IS. The cardiovascular toll of stress. Lancet. 2007;370(9592):1089-100. https://doi. org/10.1016/S0140-6736(07)61305-1.
9. Zimmet P, Alberti KG, Shaw J. Global and societal implications of the diabetes epidemic. Nature. 2001;414(6865):782-7. https://doi.org/10.1038/414782a.
10. Cosgrove MP, Sargeant LA, Caleyachetty R, Griffin SJ. Workrelated stress and Type 2 diabetes: systematic review and metaanalysis. Occup Med (Lond). 2012;62(3):167-73. https://doi. org/10.1093/occmed/kqs002.
11. Sui H, Sun N, Zhan L, Lu X, Chen T, Mao X. Association between work-related stress and risk for type 2 diabetes: A systematic review and meta-analysis of prospective cohort studies. PloS one. 2016;11(8):e0159978. https://doi. org/10.1371/journal.pone.0159978.
12. Smith PM, Glazier RH, Lu H, Mustard CA. The psychosocial work environment and incident diabetes in Ontario, Canada. Occup Med (Lond). 2012;62(6):413-9. https://doi. org/10.1093/occmed/kqs128.
13. Nyberg ST, Fransson EI, Heikkila K, Ahola K, Alfredsson L, Bjorner JB, et al. Job strain as a risk factor for type 2 diabetes: a pooled analysis of 124,808 men and women. Diabetes Care. 2014;37(8):2268-75. https://doi.org/10.2337/dc13-2936.
14. Karasek R, Theorell T. Healthy Work: Stress, Productivity, and the Reconstruction of Working Life. Basic Books; New York: 1990.
15. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998;3(4):32255. https://doi.org/10.1037/1076-8998.3.4.322.
16. Karasek R, Baker D, Marxer F, Ahlbom A, Theorell T. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. Am J Public Health. 1981;71(7):694-705. https://doi.org/10.2105/ AJPH.71.7.694.
17. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. Jama. 2000;283(15):2008-12. https://doi.org/10.1001/ jama.283.15.2008.
18. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol. 2010;25(9):603-5. https:// doi.org/10.1007/s10654-010-9491-z.
19. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003;327(7414):55760. https://doi.org/10.1136/bmj.327.7414.557.
20. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997;315(7109):629-34. https://doi.org/10.1136/ bmj.315.7109.629.
21. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. Biometrics. 1994;50(4):1088-101. https://doi.org/10.2307/2533446.
22. Kawakami N, Araki S, Takatsuka N, Shimizu H, Ishibashi H. Overtime, psychosocial working conditions, and occurrence of non-insulin dependent diabetes mellitus in Japanese men. J Epidemiol Community Health. 1999;53(6):359-63. https:// doi.org/10.1136/jech.53.6.359.
23. Norberg M, Stenlund H, Lindahl B, Andersson C, Eriksson JW, Weinehall L. Work stress and low emotional

support is associated with increased risk of future type 2 diabetes in women. Diabetes Res Clin Pract. 2007;76(3):368-77. https:// doi.org/10.1016/j.diabres.2006.09.002.
24. Eriksson AK, van den Donk M, Hilding A, Ostenson CG. Work stress, sense of coherence, and risk of type 2 diabetes in a prospective study of middle-aged Swedish men and women. Diabetes Care. 2013;36(9):2683-9. https://doi.org/10.2337/ dc12-1738.
25. Pan KY, Xu W, Mangialasche F, Fratiglioni L, Wang HX. Work-related psychosocial stress and the risk of type 2 diabetes in later life. J Intern Med. 2017;281(6):601-10. https://doi. org/10.1111/joim.12615.
26. Heraclides A, Chandola T, Witte DR, Brunner EJ. Psychosocial stress at work doubles the risk of type 2 diabetes in middleaged women: evidence from the Whitehall II study. Diabetes Care. 2009;32(12):2230-5. https://doi.org/10.2337/dc090132.
27. Kroenke CH, Spiegelman D, Manson J, Schernhammer ES, Colditz GA, Kawachi I. Work characteristics and incidence of type 2 diabetes in women. Am J Epidemiol. 2007;165(2):17583. https://doi.org/10.1093/aje/kwj355.
28. Mutambudzi M, Javed Z. Job Strain as a Risk Factor for Incident Diabetes Mellitus in Middle and Older Age U.S. Workers. J Gerontol B Psychol Sci Soc Sci. 2016;71(6):108996. https://doi.org/10.1093/geronb/gbw091.
29. Huth C, Thorand B, Baumert J, Kruse J, Emeny RT, Schneider A, et al. Job strain as a risk factor for the onset of type 2 diabetes mellitus: findings from the MONICA/KORA Augsburg cohort study. Psychosom Med. 2014;76(7):562-8. https://doi.org/10.1097/PSY.0000000000000084.
30. Bonsaksen T, Thørrisen MM, Skogen JC, Aas RW. Who reported having a high-strain job, low-strain job, active job and passive job? The WIRUS Screening study. PloS one. 2019;14(12):e0227336. https://doi.org/10.1371/journal. pone.0227336.
31. Kristensen TS, Borg V, Hannerz H. Socioeconomic status and psychosocial work environment: results from a Danish national study. Scand J Public Health Suppl. 2002;59:41-8. https://doi.org/10.1177/14034948020300030701.
32. Heikkila K, Nyberg ST, Fransson EI, Alfredsson L, De Bacquer D, Bjorner JB, et al. Job strain and tobacco smoking: an individual-participant data meta-analysis of 166,130 adults in 15 European studies. PloS one. 2012;7(7):e35463. https:// doi.org/10.1371/journal.pone.0035463.
33. Fujishiro K, Lividoti Hibert E, Schernhammer E, RichEdwards JW. Shift work, job strain and changes in the body mass index among women: a prospective study. Occup Environ Med. 2017;74(6):410-6. https://doi.org/10.1136/ oemed-2016-103747.
34. Heikkila K, Nyberg ST, Fransson EI, Alfredsson L, De Bacquer D, Bjorner JB, et al. Job strain and alcohol intake: a collaborative meta-analysis of individual-participant data from 140,000 men and women. PloS one. 2012;7(7):e40101. https:// doi.org/10.1371/journal.pone.0040101.
35. Al-Goblan AS, Al-Alfi MA, Khan MZ. Mechanism linking diabetes mellitus and obesity. Diabetes Metab Syndr Obes. 2014;7:587-91. https://doi.org/10.2147/DMSO.S67400.
36. Oba S, Suzuki E, Yamamoto M, Horikawa Y, Nagata C, Takeda J. Active and passive exposure to tobacco smoke in relation to insulin sensitivity and pancreatic beta-cell function in Japanese subjects. Diabetes Metab. 2015;41(2):160-7. https://doi. org/10.1016/j.diabet.2014.09.002.
37. Koloverou E, Tambalis K, Panagiotakos DB, Georgousopoulou E, Chrysohoou C, Skoumas I, et al. Moderate physical activity reduces 10-year diabetes incidence: the mediating role of oxidative stress biomarkers. Int J Public Health. 2018;63(2):297-305. https://doi.org/10.1007/s00038-0171052-8.
38. Magnusson Hanson LL, Virtanen M, Rod NH, Steptoe A, Head J, Batty GD, et al. Does inflammation provide a link between psychosocial work characteristics and diabetes? Analysis of the role of interleukin-6 and C-reactive protein in the Whitehall II cohort study. Brain Behav Immun. 2019;78:153-60. https:// doi.org/10.1016/j.bbi.2019.01.017.
39. Joseph JJ, Golden SH. Cortisol dysregulation: the bidirectional link between stress, depression, and type 2 diabetes mellitus. Ann N Y Acad Sci. 2017;1391(1):20-34. https://doi. org/10.1111/nyas.13217.
40. McEwen BS. Protective and damaging effects of stress mediators. N Engl J Med. 1998;338(3):171-9. https://doi. org/10.1056/NEJM199801153380307.

41. Park SG, Min KB, Chang SJ, Kim HC, Min JY. Job stress and depressive symptoms among Korean employees: the effects of culture on work. Int Arch Occup Environ Health. 2009;82(3):397-405. https://doi.org/10.1007/s00420-0080347-8.
42. Moulton CD, Pickup JC, Ismail K. The link between depression and diabetes: the search for shared mechanisms. Lancet Diabetes Endocrinol. 2015;3(6):461-71. https://doi. org/10.1016/S2213-8587(15)00134-5.
43. Notelaers G, Tornroos M, Salin D. Effort-Reward Imbalance: A Risk Factor for Exposure to Workplace Bullying. Front Psychol. 2019;10:386. https://doi.org/10.3389/ fpsyg.2019.00386.
44. Ferrie JE, Virtanen M, Jokela M, Madsen IEH, Heikkila K, Alfredsson L, et al. Job insecurity and risk of diabetes: a metaanalysis of individual participant data. CMAJ. 2016;188(1718):E447-e55. https://doi.org/10.1503/cmaj.150942.
45. Steptoe A, Kivimaki M. Stress and cardiovascular disease: an update on current knowledge. Annu Rev Public Health. 2013;34:337-54. https://doi.org/10.1146/annurevpublhealth-031912-114452.
46. Theorell T. Commentary triggered by the Individual Participant Data Meta-Analysis Consortium study of job strain and myocardial infarction risk. Scand J Work Environ Health. 2014;40(1):89-95. https://doi.org/10.5271/sjweh.3406.
47. Kivimäki M, Kawachi I. Need for more individual-level metaanalyses in social epidemiology: example of job strain and coronary heart disease. American J Epidemiol. 2013;177(1):12. https://doi.org/10.1093/aje/kws407.
Received for publication: 15 July 2020

DETAILS

Subject:	Occupational stress; Diabetes mellitus (non-insulin dependent); Diabetes; Womens health; Physical activity; Family medical history; Epidemiology; Body mass index; Estimates; Strain analysis; Questionnaires; Statistical analysis; Risk analysis; Quadrants; Men; Confidence intervals; Diabetes mellitus; Body mass; Body size; Genetics; Risk factors; Data collection; Occupational health; Systematic review; Meta-analysis; Health risks; Cohort analysis
Business indexing term:	Subject: Occupational stress
Location:	United States--US
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	249-257
Publication year:	2021
Publication date:	2021
Section:	Review
Publisher:	Scandinavian Journal of Work, Environment &Health

Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Evidence Based Healthcare, Journal Article
DOI:	https://doi.org/10.5271/sjweh.3938
ProQuest document ID:	2530524157
Document URL:	https://www.proquest.com/scholarly-journals/is-job-strain-associated-with-higher-risk-type-2/docview/2530524157/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2023-03-06
Database:	Public Health Database

Combined ergonomic exposures and development of musculoskeletal pain in the general working population: A prospective cohort study

Andersen, Lars L, PhD [1] ; Vinstrup, Jonas, PhD [1] ; Sundstrup, Emil, PhD [1] ; Skovlund, Sebastian V, MSc [1] ; Villadsen, Ebbe, BSc [1] ; Thorsen, Sannie V, PhD [1] National Research Centre for the Working Environment, Copenhagen, Denmark

ABSTRACT (ENGLISH)

Objective This study aimed to investigate the importance of combined ergonomic exposures at work for the development of musculoskeletal pain. Methods Through four rounds (2012-2018) of the Work Environment and Health in Denmark Study, 18 905 employees of the general working population replied to a baseline and 2-year follow-up questionnaire. First, a k-means cluster analysis of seven ergonomic factors (back bending, arm above shoulders, lifting etc., from 'never' to 'almost all the time') identified nine naturally occurring clusters. Second, using a weighted survey regression model controlling for age, gender, survey year, education, lifestyle, influence at work, and pain intensity at baseline, we estimated development of pain intensity (0-10) in the neck-shoulder and low-back in these clusters. The largest cluster served as reference to the other clusters and was characterized by low ergonomic exposures. Results Clusters characterized by multiple combined ergonomic exposures for a relatively high percentage of the working time showed the largest increase in neck-shoulder as well as low-back pain intensity from baseline to follow-up. However, clusters characterized by high exposure to a few specific ergonomic factors also increased pain significantly, eg, standing/walking combined with lifting/carrying or twisted/bent back for the majority of the working time increased low-back pain, whereas repetitive arm movements for the majority of the working time with or without standing/walking increased neck-shoulder pain. Conclusion Combined occupational ergonomic exposures play an important role in the development of musculoskeletal pain. Workplace preventive approaches should consider this in risk assessments and organization of the work.

FULL TEXT

Headnote

Objective This study aimed to investigate the importance of combined ergonomic exposures at work for the development of musculoskeletal pain.

Methods Through four rounds (2012-2018) of the Work Environment and Health in Denmark Study, 18 905 employees of the general working population replied to a baseline and 2-year follow-up questionnaire. First, a k-means cluster analysis of seven ergonomic factors (back bending, arm above shoulders, lifting etc., from 'never' to 'almost all the time') identified nine naturally occurring clusters. Second, using a weighted survey regression model controlling for age, gender, survey year, education, lifestyle, influence at work, and pain intensity at baseline, we estimated development of pain intensity (0-10) in the neck-shoulder and low-back in these clusters. The largest cluster served as reference to the other clusters and was characterized by low ergonomic exposures.

Results Clusters characterized by multiple combined ergonomic exposures for a relatively high percentage of the working time showed the largest increase in neck-shoulder as well as low-back pain intensity from baseline to follow-up. However, clusters characterized by high exposure to a few specific ergonomic factors also increased pain significantly, eg, standing/walking combined with lifting/carrying or twisted/bent back for the majority of the working time increased low-back pain, whereas repetitive arm movements for the majority of the working time with or without standing/walking increased neck-shoulder pain.

Conclusion Combined occupational ergonomic exposures play an important role in the development of musculoskeletal pain. Workplace preventive approaches should consider this in risk assessments and organization of the work.

Key terms back pain; musculoskeletal disorder; neck pain; occupational exposure; physical workload; shoulder pain.

The 2017 Global Burden of Disease Study underscores that musculoskeletal disorders remain a global public health burden (1), with low-back pain as the leading cause of years lived with disability (2). Neck pain also remains a serious public health burden, especially in Scandinavian countries (3). In the working population, musculoskeletal pain can have serious consequences for the ability to do the work (4) and increases the risk for long-term sickness (5). While the origin of musculoskeletal pain is multifactorial in terms of interacting biological, psychological and social factors (6), the work environment also plays an important role (7, 8).

Drawing on data from 35 European countries, a recent systematic review from the World Health Organization (WHO) and International Labour Organization (ILO) shows that occupational exposure to ergonomic risk factors remains highly prevalent (9). Thus, a continued effort to identify the most relevant risk factors and practical workplace solutions is crucial. Longitudinal studies have identified several ergonomic risk factors for developing poor health expressed as long-term sickness absence (10-12) and musculoskeletal pain (7, 8, 13-15). Workplace risk assessments often include ergonomic exposure of the low-back, eg, manual lifting, twisting and bending of the back. In terms of musculoskeletal pain, short-term as well as longitudinal studies have documented an exposure-response association between occupational lifting and development of lowback pain (16, 17). A longitudinal study of the general working population in Norway found that prolonged standing, awkward lifting as well as squatting/kneeling were important ergonomic predictors of developing lowback pain (7). Nevertheless, the evidence for a causal association between working posture and low-back pain is not completely clear in systematic reviews, although the majority of studies favors an association (13, 18, 19). Likewise, working with elevated arms is commonly included in workplace risk assessments. A longitudinal study of the general working population found that high physical work demands, neck flexion and awkward lifting were important predictors of neck-shoulder pain (8). Moreover, systematic reviews including mainly longitudinal studies found that working with elbows or hands above shoulder height were associated with development of neck-shoulder pain and disorders (15, 20).

A shared feature of the literature referenced above is the focus on single ergonomic exposures, without considering the many combinations of ergonomic exposures that may occur in real life at the workplaces. From a methodological standpoint, this is understandable as the number of possible combinations increases markedly with the number of exposure variables. For example, six types of exposure each with three response categories result in 729 possible combinations, which would lead to small subgroups, increased risk of random findings, and be next to impossible to interpret in any practical context. An alternative approach - which we use in the present study - is to group individuals using cluster analysis, where the intent is to maximize the variation in ergonomic exposure between groups and minimize the variation within groups. A cluster analysis approach can therefore identify naturally occurring groups of individuals with rather similar types of exposure and may therefore better reflect reality at the workplaces. Thus, clusters are not pre-defined, but determined based on the actual data. This statistical approach is common in the field of machine learning and marketing, eg, to target specific messages to specific groups of consumers, but has been less used in occupational research.

The present study aimed to investigate the importance of combined ergonomic exposures at work for the development of musculoskeletal pain in the low-back and neck-shoulder in the general working population. First, we identified naturally occurring clusters of ergonomic exposures at work. Next, we analyzed the prospective development of pain in these clusters during 2-year follow-up.

Methods

Study design and population

This prospective cohort study used all four questionnaire rounds (2012, 2014, 2016, 2018) of the Work Environment and Health in Denmark Study (WEHD) (21, 22). In short, probability samples of workers aged 18-64 years, having an income of >DKK3000 (approximately €400) per month during that the last 3 months, and being employed for >35 hours per month, were drawn from Danish registers and invited to participate. Through the four rounds, 228 173 invitations were sent of which 127 882 (56%) responses were received. As labor market status could change from the time of drawing the probability sample to the time of replying to the questionnaire, we included only individuals who confirmed on the questionnaire that they were currently employed wage earners (N=110 357). As the WEHD was primarily intended for surveillance of the work environment in Denmark, only a smaller random sample formed part of the cohort that was invited to participate in more than one questionnaire round. Furthermore, only first and second occasion responses for each individual were used, eg, if an individual participated in 2012, 2014 and 2016, only the first two responses were included, ie, the first (2012) as baseline and the second (2014) as follow-up. Thus, 18 905 individuals participated in the cohort and fulfilled the criteria of being wage earners at the time of the questionnaire and replying to the specific questions about ergonomic exposure and pain at baseline and pain at 2-year follow-up. Reporting follows the STROBE guidelines for cohort studies (23).

Occupational ergonomic factors (exposure)

The questions concerning ergonomic exposure (10, 24) at baseline were: 'How much of your working time do you... (i) sit (ii) walk or stand? (iii) work with twisted or bent back without support from the hands and arms? (iv) have the arms lifted to or above shoulder height, (v) do the same arm movements several times a minute? (eg, package work, mounting, machine feeding, carving), (vi) squat or kneel when you work? (vii) push or pull? and (viii) lift or carry?

The ergonomic exposure variables were checked for multicollinearity (r >0.70). The question about sitting at work was strongly and negatively correlated with walking/standing at work (r = -0.89), which makes sense as doing both at the same time is not possible due to the compositional nature of these tasks. The question about sitting was therefore excluded from the cluster analysis. Response options for each question were 'almost all the time', 'approximately 3/4 of the time', 'approximately 1/2 of the time', 'approximately 1/4 of the time', 'seldom / very little', and 'never'. To obtain a normalized score, these response categories were recoded to 100, 75, 50, 25, 12½, and 0, respectively, which correspond to percentages of the working time.

Change in pain intensity (outcome)

Pain intensity in the neck-shoulder and low-back, respectively, was assessed on a horizontal scale of 0-10 as the worst pain experienced during the last three months, where 0 is no pain at all and 10 is worst imaginable pain (25). Participants replied to this at baseline and 2-year follow-up, from which the change-score in pain intensity was calculated. While the distribution of pain intensity at each respective time point had a tail towards higher values (ie, not normally distributed), the changescore followed an almost perfect normal distribution.

Baseline control variables

Age (continuous variable) and gender for each individual were drawn from the Central Person Register of Denmark. The year of questionnaire reply was entered as a continuous variable. Highest completed education was drawn from a national register (vocational education or less, higher education). Regarding psychosocial work factors we included 'influence at work' (two items, normalized on a scale of 0-100, continuous variable) based on the Copenhagen Psychosocial Questionnaire (COPSOQ) (26). Lifestyle included smoking status (categorical variable: daily, once in a while, ex-smoker, never), body mass index (continuous variable, BMI, kg/ m2), leisure-time physical activity (continuous variable, total weekly hours of leisure physical activity). Pain intensity at baseline (continuous, 0-10) was assessed as described above.

Occupational groups

We included register-based job codes to describe the distribution of clusters in different occupational groups for descriptive purposes only, and not as a confounder, as the ergonomic factors are somewhat related to the job codes. The Danish version of the International Standard Classification of Occupations (ISCO) [23] provides a six-digit classification, structured as a five-level hierarchical structure based on information from high-quality national registers. The skill requirements in each ISCO group range from I (most basic) to IV (most advanced). Using the first level of the hierarchy, we included the ten available groups: (i) Managers (level III and IV skill requirements), (ii) Professionals (level IV skill requirements), (iii) Technicians and Associate Professionals (level III skill requirements), (iv) Clerical Support Workers (level II skill requirements), (v) Services and Sales Workers (level II skill requirements), (vi) Skilled Agricultural, Forestry and Fishery Workers (level II skill requirements), (vii) Craft and Related Trades Workers (level II skill requirements), (viii) Plant and Machine Operators and Assemblers (level II skill requirements), (ix) Elementary Occupations (level I skill requirement), and (x) Military (level I, II and IV skill requirements).

Statistical analyses

Using a k-means cluster analysis (Proc FastClus, SAS version 9.4) of the ergonomic exposure variables at baseline, we identified naturally occurring clusters in the working population. This procedure calculates Euclidean distances between individuals, in this case in a 7-dimensional space, and through an iterative process maximizes variance between clusters while minimizing variance within clusters. Before running the cluster analysis, we checked the exposure variables for multicollinearity (r >0.70), which led to the exclusion of one of the variables, sitting at work, as described above. Then, the optimal number of clusters was determined by repeating the fastclus procedure with up to 15 clusters and plotting the cubic clustering criterion (CCC), pseudo F, and explained variance (R2) against the number of clusters. This showed local peaks in CCC at 7 and 9 clusters with values of 246.8 and 247.1, respectively, which indicates possible good clustering. The pseudo F values were high at both 7 clusters (pseudo F = 6625) and 9 clusters (pseudo F = 5839). The R2 value was slightly higher at 9 clusters (R2=0.71) than at 7 clusters (R2=0.68). Thus, we chose to use the model with 9 clusters for further analyses. Exposure estimates within clusters are reported as mean values for each separate ergonomic factor.

Using a survey regression model (Proc SurveyReg, SAS version 9.4), which incorporates the sample design into the analyses, we modelled the change in pain from baseline to follow-up in the identified clusters. Separate analyses were performed with neck-shoulder and low-back pain intensity, respectively, as outcomes. Cluster was the predictor variable (9 categories). The largest cluster - characterized by low exposure to the ergonomic factors - served as the reference cluster. Control variables included age, gender, education, year of questionnaire, BMI, smoking, leisure time physical activity, influence at work, and pain intensity at baseline. To ensure that the estimates were representative for wage earners in Denmark, each individual was assigned a weight value (model-assisted weights) based on information from high-quality national registers (gender, age, occupational industry, highest completed education, family income, family type and origin). Missing data were not imputed as the weight variable repairs both non-response and deviations of the probability sample from the population. For the change-score in pain intensity from baseline to follow-up, results are reported as differences of least-square means and 95% confidence intervals (CI) (ie, differences over time compared with the reference cluster).

Results

Table 1 shows the descriptive baseline characteristics of the 18 905 included participants in terms of age, gender, education, lifestyle, influence at work, and musculoskeletal pain. Pain intensity at baseline was 2.7 [standard deviation (SD) 2.8] and 2.4 (SD 2.8) in the neck-shoulder and low-back, respectively. Table 1 does not show the baseline values of each individual cluster, but for the continuous variables they differed only slightly in terms of age (mean range 44.5-47.9 years), BMI (mean range 25.4-26.3), leisure time physical activity (mean range 4.9-5.5 hours) and influence at work (mean range 72.4-82.2). For pain intensity in the neck-shoulder (means from cluster 1-9: 5.0, 4.6, 3.6, 3.8, 3.7, 3.7, 2.6, 2.6, 2.1, respectively) and low-back (means from cluster 1-9: 4.9, 3.9, 3.6, 3.9, 2.9, 2.9, 2.3, 2.4, 1.7, respectively), the differences between clusters were somewhat larger, underscoring the importance of adjusting for baseline pain intensity.

Table 2 shows the fully adjusted and weighted estimates for the development in neck-shoulder and lowback pain intensity from baseline to 2-year follow-up in the identified clusters compared with the reference cluster (cluster 9, low physical work demands). The mean percentage of working time exposed to each of the seven ergonomic factors in each cluster is visualized using color-intensities, ie, higher intensity of the color red signifies higher mean ergonomic exposure in that cluster. Cluster 1 and 2 were characterized by several combined ergonomic exposures for a relatively high percentage of the working time and showed the largest increase in neck-shoulder and low-back pain intensity. Some of the clusters characterized by a few specific exposures for a high percentage of the working were also relevant; cluster 3 and 4 were characterized by standing/walking combined with lifting/carrying (cluster 3) or working with the back twisted/bent (cluster 4) for about two-thirds of the working time and showed a significant increase in low-back pain. Cluster 5 and 6 were characterized by repetitive arm movements for about three quarter of the working time combined with prolonged standing/walking (cluster 5) and little standing/walking (cluster 6). Both clusters showed a significant increase in neck-shoulder pain. Cluster 7 and 8 were characterized by standing/walking for about half of the time (cluster 7) and almost all the time (cluster 8), respectively, while having low exposure to the other ergonomic factors. Both clusters showed a small, but statistically significant, increase in low-back pain.

Sensitivity analyses excluding those with moderateto-high pain intensity (>3) at baseline did not change the overall picture (not shown in the tables). For example, the increase in low-back pain remained highest for cluster 1 and 2 with change-scores of 0.80 (95% CI 0.29-1.31) and 0.80 (95% CI 0.36-1.25), respectively, compared with the reference cluster.

We also tested the interaction between cluster and age, as well as between cluster and gender, for the development of pain in the neck-shoulder and lowback, respectively. As none of these were statistically significant, we did not proceed with any age- or genderstratified analyses.

Table 3 shows the relative distribution of the nine clusters in each of the ten different occupational groups (ISCO). Workers in ISCO groups 1-4 (typically higher skill requirement and longer education) and 10 (military) mainly belonged to clusters 7 and 9, to some extent to cluster 8, with only a few percentages in clusters 1-6. Workers in ISCO groups 5-9 (typically lower skill requirement and shorter education) were more distributed across the different clusters.

Discussion

The main finding of this study is that combined occupational ergonomic exposures play an important role in the development of musculoskeletal pain. Specifically, clusters characterized by several combined ergonomic exposures for a relatively high percentage of the working time showed the largest increase in pain intensity from baseline to follow-up. However, clusters characterized by high exposure to a few specific ergonomic factors were also relevant.

First, some reflections on the type of analysis before discussing the results. The present analytic approach grouped individuals into clusters: ie, with exposure to the different ergonomic factors within each cluster as alike as possible and exposure between clusters as different as possible. The advantage of this approach is that it identifies naturally occurring groups of individuals with rather similar types of exposure while limiting the total number of groups. A shortcoming is that it does not isolate the effect of each type of exposure. While the majority of previous studies in this field have already used the latter approach, the present analyses provide an alternative. Thus, discussing similarities and differences between the present and previous findings is relevant for a better overall interpretation of ergonomic risk factors at the workplace.

Workers in clusters 1 and 2 were exposed to multiple combined ergonomic factors and showed the largest increase in neck-shoulder and low-back pain intensity. This concurs with a previous study evaluating the number of ergonomic exposures and the risk for long-term sickness absence (10). In that study, a simple count of exposures showed that a higher number of ergonomic exposures increases the risk for long-term sickness absence in an exposure-response manner. However, a simple count of exposures does not reveal anything about the most relevant combinations of ergonomic exposure and may therefore be of little practical relevance for the workplaces. The present study elaborates on previous findings by showing that workers in cluster 1 (ie, those exposed to a combination of lifting/carrying, pushing/pulling, working with the back twisted or bent for the majority of the working day while also doing repetitive arm movements, working with arms over the shoulder, and some kneeling or squatting work) experienced the largest increase in low-back pain. Also, both cluster 1 and 2 included repetitive arm movements, working with the arm above shoulder and lifting/carrying and showed the largest increase in neck-shoulder pain. The workers belonging to cluster 1 and 2 were found across ISCO groups 5-9, representing workers with shorter education and lower skill requirements.

Workers in clusters 3 and 4 stood or walked for more than two-thirds of the working time combined with lifting/carrying (cluster 3) or working with the back twisted/bent (cluster 4) for about two-thirds of the working time and showed a significant increase in low-back pain. Regarding single occupational ergonomic exposure, these are probably the most studied. On a day-today basis, higher total lifting load - and thus lifting for a larger part of the working time - increases low-back pain the following day (17). In the longer term, Coenen and coworkers (16) found that lifting loads >25 kg and lifting at a frequency of >25 lifts per day increased the annual incidence of low-back pain by about 3-4%. In another prospective study, Sterud and coworkers (7) found that awkward lifting, eg, twisting or bending the back, increased the risk for low-back pain at 3-year follow-up. Thus, the present study corroborates these findings and show that workers in clusters characterized by ergonomic exposures involving the low-back had the largest increase in low-back pain, although the combination with other ergonomic exposures seems to aggravate this to some extent.

Workers in clusters 5 and 6 performed repetitive arm movements for about three-quarters of the working day combined with prolonged standing/walking (cluster 5) and little standing/walking (cluster 6). Both clusters showed a significant increase in neck-shoulder pain. In accordance, a previous study in the general working population found that repetitive arm movement was associated with increased risk of long-term sickness absence (10). Likewise, repetitive shoulder work has also been shown to predict onset of neck-shoulder pain among industrial and service workers (27). In the present study, and concordant with these findings, workers in clusters involving high exposure to repetitive arm movement were more likely to experience increased neck-shoulder pain at follow-up, although this seemed to be aggravated when combined with other ergonomic exposures as in clusters 1 and 2. Interestingly, clusters characterized by lifting/carrying and working with bent/twisted back (clusters 3 and 4) increased neck-shoulder pain to the same magnitude as clusters 5 and 6, which may explain why neck-shoulder pain increased even more in clusters 1 and 2 having these combined exposures.

Lastly, workers in clusters 7 and 8 stood or walked for about half of the time (cluster 7) and almost all the time (cluster 8), respectively, while having low exposure to the other ergonomic factors. In comparison, workers in the reference cluster stood or walked for about onefifth of the time. Both clusters 7 and 8 showed a small, but statistically significant, increase in low-back pain, suggesting that excessive standing/walking may not be as health-promoting as often suggested, at least not in an occupational setting and in terms of musculoskeletal pain. In accordance with the present finding, a previous study using body-worn technical measurements suggested that long duration of sitting at work is associated with lower intensity of low-back pain among healthcare workers (28). Likewise, a systematic review - mainly including cross-sectional studies - found that substantial occupational standing was associated with higher low-back pain (29). Thus, while using standings desks and breaking up inactivity is often recommended, too much standing should probably be avoided. Providing standing workers with the opportunity for frequent breaks or job rotation, including seated tasks, may be a practical solution.

Further practical considerations

Within the methodological limitations of an observational study, we would like to consider some further practical aspects. Van der Beek and coworkers (30) provided a structured research framework for developing and implementing workplace interventions preventing musculoskeletal pain. Elaborating on this framework, the results of the present cohort study provide knowledge of the first two steps, including prevalence of and ergonomic risk factors for developing musculoskeletal pain. The third step of the framework considers underlying mechanisms. The underlying mechanisms of the present results may be related to the time-wise accumulation of specific and combined ergonomic exposures. As an example of specific ergonomic exposures, biomechanical studies show that heavy manual lifting and lifting with arms above shoulders are associated with high loads on the low-back and shoulders (31). Subsequent risk of musculoskeletal pain in these body parts may then accumulate with a higher exposure time leading to muscle fatigue with reduced possibility for recovery. As an example of combined ergonomic exposure, exposure to several ergonomic factors for a higher percentage of the working day may create a general fatigue of the body in addition to the specific effects. Thus, the mechanisms of pain development are likely related to an imbalance between both specific and combined ergonomic expo sure, relative to the capacity of the worker to adapt to and recover from those exposures between working days. The fourth to sixth steps of the framework consider development, evaluation and implementation of preventive interventions. An interesting observation of the present study is that even within the same ISCO groups - particularly for ISCO groups 5-9 - the ergonomic exposure varies considerably between workers. This underscores that an individual approach to reducing excessive ergonomic exposure is necessary, especially for these particular ISCO groups. An intervention strategy could be to reduce exposure time to multiple ergonomic risk factors. This may be achieved by using appropriate assistive devices (32) or organizing the work better, eg, by job rotation which also includes less physically demanding tasks. However, simply rotating between several physically demanding tasks would probably not be beneficial, as this would result in a high level of combined ergonomic exposure. Thus, adjusting the physical work demands to the capacity of the worker and including light work tasks or frequent rest break that allow for recovery could be a strategy to prevent development of musculoskeletal pain (33), especially among workers exposed to multiple ergonomic risk factors. Another possibility could be to introduce rest days without physical workload, eg, doing other types of work, to allow for a more complete recovery between strenuous days (17). A contrasting strategy could be to introduce physical exercise at the workplace (34). A recent systematic review found moderate evidence for a positive effect of physical exercise at the workplace for reducing musculoskeletal disorders among workers with physically demanding work (34). Importantly, within the domain of physical exercise, there was strong evidence for a positive effect of workplace strength training, entailing a recommendation of implementing strength training at the workplace in order to reduce musculoskeletal disorders among workers with physically demanding work. Thus, strength training at the workplace to increase physical capacity of the worker could build on top of ergonomic efforts to reduce the physical workload. Overall, this could create a better balance between physical work demands and the physical capacity of the worker.

Limitations and strengths

There are both limitations and strengths to the present study. The cluster approach is exploratory in nature as clusters are identified based on the actual data and therefore after data is collected. As a consequence, this excludes a priory hypothesis testing. Nevertheless, based on previous findings (10), we expected clusters characterized by high physical work demands to show the largest increase in pain. Another limitation is the use of questionnaires (self-report) to assess ergonomic exposure. Even though the analyses were adjusted for pain at baseline as well as several other possible confounders, misclassification bias of exposure may occur (35), eg, due to workers with high pain at baseline overrating their level of exposure. To minimize the risk of misclassification bias influencing the overall interpretation, we performed a sensitivity analysis excluding workers with moderate to high pain at baseline. The sensitivity analysis - although having less statistical power - did not change the overall picture. Furthermore, cluster did not interact with age or gender in the development of pain, suggesting that the identified clusters are relevant across age groups and for both men and women. Another limitation is that we did not discriminate between walking and standing, as these were included in the same questionnaire item. As walking is generally considered healthy (36), we recommend future studies to include walking and standing as two separate items. Furthermore, future studies should also include technical measurements to objectively quantify the different ergonomic exposures at work. This would allow for compositional data analyses and thereby avoid problems with multicollinearity and imprecision of selfreports. Non-response bias is a common limitation in questionnaire studies, and the response percentage in the present study was about 56%. However, the sample was based on a random sample of the general working population and we used model-assisted weights based on high-quality registers to adjust for eg, non-response. While generalizable to the general working population of Denmark, the results are also relevant in a broader European context. Based on the European Survey of Enterprises on New and Emerging Risks (ESENER) from 2019, ergonomic factors such as 'Lifting or moving people or heavy loads', 'Repetitive hand or arm movements' and 'Tiring or painful positions' are widespread across the EU-27. Furthermore, for these three ergonomic factors, the prevalence on the EU-27 level is highly comparable to the prevalence in Denmark; 51.7% versus 58.5%, 65.3% versus 65.0%, and 31.6% versus 30.1%, respectively (37). Thus, the present findings may be somewhat generalizable to the EU-27, although country-specific analyses should confirm this.

Concluding remarks

This study showed that combined ergonomic exposures play an important role in the development of musculoskeletal pain in the general working population. Thus, workers exposed to several combined ergonomic factors for a relatively high percentage of the working time showed the largest increase in pain intensity from baseline to follow-up. However, workers exposed to a few specific ergonomic factors also experienced increased pain intensity.

Data availability statement

The authors encourage collaboration and use of the data by other researchers. Data is stored on the secure server of Statistics Denmark, and researchers interested in using the data for scientific purposes should contact the authors.

Funding

Professor Lars L Andersen obtained a grant from the The Danish Working Environment Research Fund for this project (Arbejdsmiljøforskningsfonden, grant number 20195100758). The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the paper.

Conflicts of interest

The authors declare no conflicts of interest

Sidebar

Andersen LL, Vinstrup J, Sundstrup E, Skovlund SV, Villadsen E, Thorsen SV. Combined ergonomic exposures and development of musculoskeletal pain in the general working population: A prospective cohort study. Scand J Work Environ Health. 2021;47(4):287-295. doi:10.5271/sjweh.3954

Corresponding author: Professor Lars L. Andersen, National Research Centre for the Working Environment, Lersø

Parkalle105, DK-2100 Copenhagen, Denmark. [E-mail: lla@nfa.dk]

References

References
1. Jin Z, Wang D, Zhang H, Liang J, Feng X, Zhao J et al. Incidence trend of five common musculoskeletal disorders from 1990 to 2017 at the global, regional and national level: results from the global burden of disease study 2017. Ann Rheum Dis 2020 Aug;79(8):1014-22. https://doi. org/m.1136/annrheumdis-2020-217050.
2. Wu A, March L, Zheng X, Huang J, Wang X, Zhao J et al. Global low back pain prevalence and years lived with disability from 1990 to 2017: estimates from the Global Burden of Disease Study 2017. Ann Transl Med 2020 Mar;8(6):299. https://doi.org/10.21037/atm.2020.02.175.
3. Safiri S, Kolahi AA, Hoy D, Buchbinder R, Mansournia MA, Bettampadi D et al. Global, regional, and national burden of neck pain in the general population, 1990-2017: systematic analysis of the Global Burden of Disease Study 2017. BMJ 2020 Mar;368:m791. https://doi.org/10.1136/ bmj.m791.
4. Nygaard PP, Skovlund SV, Sundstrup E, Andersen LL. Is low-back pain a limiting factor for senior workers with high physical work demands? A cross-sectional study. BMC Musculoskelet Disord 2020 Sep;21(1):622. https://doi. org/10.1186/s12891-020-03643-1.
5. Andersen LL, Mortensen OS, Hansen JV, Burr H. A prospective cohort study on severe pain as a risk factor for long-term sickness absence in blue- and white-collar workers. Occup Environ Med 2011 Aug;68(8):590-2. https://doi.org/10.1136/oem.2010.056259.
6. Moseley GL, Butler DS. Fifteen Years of Explaining Pain: The Past, Present, and Future. J Pain 2015 Sep;16(9):80713. https://doi.org/10.1016/jjpain.2015.05.005.
7. Sterud T, Tynes T. Work-related psychosocial and mechanical risk factors for low back pain: a 3-year followup study of the general working population in Norway. Occup Environ Med 2013 May;70(5):296-302. https://doi. org/10.1136/oemed-2012-101116.
8. Sterud T, Johannessen HA, Tynes T. Work-related psychosocial and mechanical risk factors for neck/shoulder pain: a 3-year follow-up study of the general working population in Norway. Int Arch Occup Environ Health 2014 Jul;87(5):471-81. https://doi.org/10.1007/s00420-0130886-5.
9. Hulshof CT, Pega F, Neupane S, van der Molen HF, Colosio C, Daams JG et al. The prevalence of occupational exposure to ergonomic risk factors: A systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. Environ Int 2021 Jan; 146:106157. https://doi.org/10.1016jj. envint.2020.106157.
10. Andersen LL, Fallentin N, Thorsen SV, Holtermann A. Physical workload and risk of long-term sickness absence in the general working population and among blue-collar workers: prospective cohort study with register follow-up. Occup Environ Med 2016 Apr;73(4):246-53. https://doi. org/10.1136/oemed-2015-103314.
11. Sterud T. Work-related mechanical risk factors for long-term sick leave: a prospective study of the general working population in Norway. Eur J Public Health 2014 Feb;24(1):111-6. https://doi.org/10.1093/eurpub/ckt072.
12. Thorsen SV, Flyvholm MA, Pedersen J, Bültmann U, Andersen LL, Bjorner JB. Associations between physical and psychosocial work environment factors and sickness absence incidence depend on the lengths of the sickness absence episodes: a prospective study of 27 678 Danish employees. Occup Environ Med 2021 Jan;78(1):46-53. https://doi.org/10.1136/oemed-2020-106554.
13. Swain CT, Pan F, Owen PJ, Schmidt H, Belavy DL. No consensus on causality of spine postures or physical exposure and low back pain: A systematic review of systematic reviews. J Biomech 2020 Mar;102:109312. https://doi.org/10.1016/jjbiomech.2019.08.006.
14. Wærsted M, Koch M, Veiersted KB. Work above shoulder level and shoulder complaints: a systematic review. Int Arch Occup Environ Health 2020 Nov;93(8):925-54. https://doi. org/10.1007/s00420-020-01551-4.
15. Mayer J, Kraus T, Ochsmann E. Longitudinal evidence for the association between work-related physical exposures and neck and/or shoulder complaints: a systematic review. Int Arch Occup Environ Health 2012 Aug;85(6):587-603. https://doi.org/10.1007/s00420-011-0701-0.

16. Coenen P, Gouttebarge V, van der Burght AS, van Dieen JH, Frings-Dresen MH, van der Beek AJ, et al. The effect of lifting during work on low back pain: a health impact assessment based on a meta-analysis. Occup.Environ.Med. . 2014 Dec;71(1470-7926 (Electronic)):871-7.
17. Andersen LL, Fallentin N, Ajslev JZ, Jakobsen MD, Sundstrup E. Association between occupational lifting and day-to-day change in low-back pain intensity based on company records and text messages. Scand J Work Environ Health 2017 Jan;43(1):68-74. https://doi.org/10.5271/ sjweh.3592.
18. da Costa BR, Vieira ER. Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. Am J Ind Med 2010 Mar;53(3):285323.
19. Øverås CK, Villumsen M, Axén I, Cabrita M, LeboeufYde C, Hartvigsen J et al. Association between objectively measured physical behaviour and neck- and/or low back pain: A systematic review. Eur J Pain 2020 Jul;24(6):100722. https://doi.org/10.1002/ejp.1551.
20. van der Molen HF, Foresti C, Daams JG, Frings-Dresen MH, Kuijer PP. Work-related risk factors for specific shoulder disorders: a systematic review and meta-analysis. Occup Environ Med 2017 Oct;74(10):745-55. https://doi. org/10.1136/oemed-2017-104339.
21. Andersen LL, Thorsen SV, Flyvholm M-A, Holtermann A. Long-term sickness absence from combined factors related to physical work demands: prospective cohort study. Eur J Public Health . 2018 01;28(5):824-9.
22. Johnsen NF, Thomsen BL, Hansen JV, Christensen BS, Rugulies R, Schlünssen V. Job type and other sociodemographic factors associated with participation in a national, cross-sectional study of Danish employees. BMJ Open . 2019 18;9(8):e027056.
23. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ et al.; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. PLoS Med 2007 Oct;4(10):e297. https://doi.org/10.1371/ journal.pmed.0040297.
24. Orhede E. Nordic cooperation in research on the work environment. Scand J Work Environ Health 1994 Feb;20(1):65-6. https://doi.org/10.5271/sjweh.1426.
25. Pincus T, Bergman M, Sokka T, Roth J, Swearingen C, Yazici Y. Visual analog scales in formats other than a 10 centimeter horizontal line to assess pain and other clinical data. J Rheumatol 2008 Aug;35(8):1550-8.
26. Pejtersen JH, Kristensen TS, Borg V, Bjorner JB. The second version of the Copenhagen Psychosocial Questionnaire. Scand J Public Health 2010 Feb;38(3 Suppl):8-24. https:// doi.org/10.1177/1403494809349858.
27. Andersen JH, Kaergaard A, Mikkelsen S, Jensen UF, Frost P, Bonde JP et al. Risk factors in the onset of neck/shoulder pain in a prospective study of workers in industrial and service companies. Occup Environ Med 2003 Sep;60(9):649-54. https://doi.org/10.1136/oem.60.9.649.
28. Lunde LK, Koch M, Knardahl S, Veiersted KB. Associations of objectively measured sitting and standing with low-back pain intensity: a 6-month follow-up of construction and healthcare workers. Scand J Work Environ Health 2017 May;43(3):269-78. https://doi.org/10.5271/sjweh.3628.
29. Coenen P, Willenberg L, Parry S, Shi JW, Romero L, Blackwood DM et al. Associations of occupational standing with musculoskeletal symptoms: a systematic review with meta-analysis. Br J Sports Med 2018 Feb;52(3): 176-83. https://doi.org/10.1136/bjsports-2016-096795.
30. van der Beek AJ, Dennerlein JT, Huysmans MA, Mathiassen SE, Burdorf A, van Mechelen W et al. A research framework for the development and implementation of interventions preventing work-related musculoskeletal disorders. Scand J Work Environ Health 2017 Nov;43(6):526-39. https://doi. org/10.5271/sjweh.3671.
31. Skals S, Bláfoss R, Andersen LL, Andersen MS, de Zee M. Manual material handling in the supermarket sector. Part 2: Knee, spine and shoulder joint reaction forces. Appl Ergon 2021 Apr;92:103345. https://doi.org/10.1016/j. apergo.2020.103345.
32. Vinstrup J, Jakobsen MD, Madeleine P, Andersen LL. Physical exposure during patient transfer and risk of back injury &low-back pain: prospective cohort study. BMC Musculoskelet Disord 2020 Oct;21(1):715. https://doi. org/10.1186/s12891-020-03731-2.
33. Faucett J, Meyers J, Miles J, Janowitz I, Fathallah F. Rest break interventions in stoop labor tasks. Appl Ergon

2007 Mar;38(2):219-26. https://doi.org/10.1016/j. apergo.2006.02.003.
34. Sundstrup E, Seeberg KG, Bengtsen E, Andersen LL. A Systematic Review of Workplace Interventions to Rehabilitate Musculoskeletal Disorders Among Employees with Physical Demanding Work. J Occup Rehabil 2020 Dec;30(4):588-612. https://doi.org/10.1007/s10926-02009879-x.
35. Gupta N, Heiden M, Mathiassen SE, Holtermann A. Is self-reported time spent sedentary and in physical activity differentially biased by age, gender, body mass index, and low-back pain? Scand J Work Environ Health 2018 Mar;44(2):163-70.
36. Hansen BH, Dalene KE, Ekelund U, Wang Fagerland M, Kolle E, Steene-Johannessen J et al. Step by step: association of device-measured daily steps with all-cause mortality-A prospective cohort Study. Scand J Med Sci Sports 2020 Sep;30(9):1705-11. https://doi.org/10.1111/ sms.13726.
37. EU-OSHA. European Survey of Enterprises on New and Emerging Risks (ESENER), results visualisation [Internet]. 2019 [cited 2021 Mar 11]. Available from: https://visualisation.osha.europa.eu/esener#!/en/survey/ detailpage-european-bar-chart/2019/osh-management/en_1/ E3Q200_1/activity-sector/14/11.
Received for publication: 2 February 2021

DETAILS

Subject:	Back pain; Population; Working conditions; Neck; Work environment; Regression models; Risk factors; Questionnaires; Low back pain; Pain; Risk assessment; Exposure; Shoulder; Longitudinal studies; Working hours; Cluster analysis; Variables; Public health; Neck pain; Arm; Population studies; Polls &surveys; Cohort analysis
Business indexing term:	Subject: Work environment Risk assessment Working hours Cluster analysis
Location:	De nmark
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	287-295
Publication year:	2021
Publication date:	2021
Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140

e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3954
ProQuest document ID:	2530522599
Document URL:	https://www.proquest.com/scholarly-journals/combined-ergonomic-exposures-development/docview/2530522599/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2023-07-21
Database:	Public Health Database

Efficacy of an indicated prevention strategy on sickness absence and termination of the employment contract: a 5-year follow-up study

Klasen, Sophie H, MSc [1] ; van Amelsvoort, Ludovic GPM, PhD [1] ; Jansen, Nicole WH, PhD [1] ; Slangen, Jos JM [1] ; Ton, Gladys Tjin A, MD [2] ; Kant, IJmert, PhD [1] CAPHRI School for Public Health and Primary Care, Department of Epidemiology, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands [2] Occupational Health Service Beter, Amsterdam, The Netherlands

ProQuest document link

ABSTRACT (ENGLISH)

Objective It was shown that an indicated prevention strategy (IPS), based on screening and early intervention, can considerably decrease future risk of long-term sickness absence (LTSA>28 days) over one year. Given the nature of the interventions, the potential of an effect extending beyond the original one year of follow-up might be present. This study aims to determine the efficacy of this IPS on LTSA and termination of employment contract over five years by extended follow up of IPS trials. Methods Company records on sickness absence and termination of employment contract over five years were used from two randomized controlled trials (RCT) on the efficacy of the IPS (RCT I employees at high-risk for LTSA: intervention: N=263; RCT II high-risk employees with concurrent mild depressive complaints: intervention: N=139). Survival analysis was used to model time until the first LTSA episode and termination of employment contract. Results RCT I showed a decrease of 43.2 days of sickness absence (P=0.05) and a lower 5-year risk of LTSA in the intervention, as compared to the control group [hazard ratio (HR) 0.61, 95% confidence interval (CI) 0.41-0.90], however no considerable impact on employment contract (HR 0.85, 95% CI 0.54-1.35) (intention-to-treat, ITT). For RCT II, we found no large difference in days of SA and no difference in LTSA risk over five years (HR 1.31, 95% CI 0.70-2.47), whereas the risk of termination of the employment contract was lower (HR 0.62, 95% CI 0.39-0.99) (ITT). Conclusion Effects of the IPS were observed over five years, albeit differential between the two approaches. A combination of elements of both interventions might lead to optimal results but needs further study.

FULL TEXT

Headnote

Klasen SH, van Amelsvoort LGPM, Jansen NWH, Slangen JJM, Tjin A Ton G, Kant I. Efficacy of an indicated prevention strategy on sickness absence and termination of the employment contract: a 5-year follow-up study. Scand J Work Environ Health. 2021;47(4):258-267. doi:10.5271/sjweh.3945

Objective It was shown that an indicated prevention strategy (IPS), based on screening and early intervention, can considerably decrease future risk of long-term sickness absence (LTSA>28 days) over one year. Given the nature of the interventions, the potential of an effect extending beyond the original one year of follow-up might be present. This study aims to determine the efficacy of this IPS on LTSA and termination of employment contract over five years by extended follow up of IPS trials.

Methods Company records on sickness absence and termination of employment contract over five years were used from two randomized controlled trials (RCT) on the efficacy of the IPS (RCT I employees at high-risk for LTSA: intervention: N=263; RCT II high-risk employees with concurrent mild depressive complaints: intervention: N=139). Survival analysis was used to model time until the first LTSA episode and termination of employment contract.

Results RCT I showed a decrease of 43.2 days of sickness absence (P=0.05) and a lower 5-year risk of LTSA in the intervention, as compared to the control group [hazard ratio (HR) 0.61, 95% confidence interval (CI) 0.41-0.90], however no considerable impact on employment contract (HR 0.85, 95% CI 0.54-1.35) (intention-to-treat, ITT). For RCT II, we found no large difference in days of SA and no difference in LTSA risk over five years (HR 1.31, 95% CI 0.70-2.47), whereas the risk of termination of the employment contract was lower (HR 0.62, 95% CI 0.39-0.99) (ITT).

Conclusion Effects of the IPS were observed over five years, albeit differential between the two approaches. A combination of elements of both interventions might lead to optimal results but needs further study.

Key terms preventive intervention; RCT; sick leave.

Long-term sickness absence (LTSA) has large consequences in terms of health and costs for employees, employers, and society (1-3). LTSA is seen as a precursor of permanent work disability, early retirement due to ill health, and even mortality (3, 4). Many studies have shown that returning to work after a period of LTSA remains very difficult and may even result in financial difficulties over time due to unemployment (1, 2, 5, 6). Perceived poor health, mental health issues, or chronic conditions are known factors that could determine the termination of the employment contract with the company, as a result of disability pensions or unemployment (7). Therefore, preventing LTSA may be positively associated with fewer employees having to exit employment due to ill health. In The Netherlands, termination of the employment contract can be related to disability, retirement, job loss, or voluntary leave. Preventing LTSA is of utmost importance and may result in improving the health of employees, fewer costs due to a decrease in days of sickness absence (SA), and the prevention of work disability (3).

Musculoskeletal disorders and stress-related ill health are seen as the most important reasons for LTSA (8, 9). However, the etiology of SA is often multifactorial which makes it difficult to comprehend and requires a holistic understanding (10-12). Many factors have been associated with an increased LTSA risk, for example, age, gender, lifestyle, poor health, SA records, physical workload, and psychosocial working conditions (10, 13-15). Therefore, individual or indicated prevention might result in better outcomes since it focuses on a broad range of potentially interrelated factors, in contrast to population or general prevention, which is often restricted to one or two factors. Essential is here the focus on treating individuals who are at risk of reporting sick in the future but are not yet currently on sick leave.

Two prerequisites for a successful indicated prevention strategy (IPS) to prevent LTSA are the ability to (i) detect individuals who are at high risk for future LTSA and (ii) provide these individuals with effective treatment at an early stage. A strategy meeting both prerequisites has shown its efficacy in two Dutch randomized controlled trials (RCT) (16, 17). While the RCT differed in study population and type of early intervention, both used screening and structured early intervention (16-18). Earlier studies have shown the efficacy of this prevention strategy in reducing days of SA over a 12-month interval (16, 17). Furthermore, a recent meta-analysis (19) showed that other interventions based on the principles of IPS could have considerable effects on SA. Duijts et al (20) reported 15.5 compared to 18.8 SA days [hazard ratio (HR) of -0.15, 95% confidence interval (CI) -0.23-0.07], Lerner et al (21) showed 7.1% improvement in productivity due to less SA (P<0.01) and 29.5 compared to 26.0 effective weekly hours (P=0.008) and, over a period of one year, Taimela et al (22) showed a mean difference of 11 days between intervention and control group in favor of the intervention group (20-22). The results from comparable IPS only showed short-term effects (4-24 months), all of which were comparable to the average one-year results for RCT I=12.1 days and RCT II=23.3 days.

However, the long-term efficacy of an IPS has not yet been studied in terms of SA. While the efficacy in terms of decreasing SA during one year of follow-up was large in RCT I, this could indicate that the intervention has lasting effects on help seeking behavior, which could possibly decrease SA over a long time period (23-25). Especially since one might assume that early contact with the occupational physician (OP) could result in sustainable work adjustments or other improvements in working conditions. With regards to the preventive intervention used in RCT II, which was based on Problem Solving Therapy (PST) and Cognitive behavioral Therapy (CBT), it was found that, over one year, SA as well as depressive complaints decreased (17). However, given the aim of the intervention (ie, to enhance coping ability), long-lasting effects beyond the reported one year might also be expected for this intervention. Nonetheless, so far, long-lasting effects have not yet been described for this or similar interventions, as apparent from a recent meta-analysis (19). The expectation of long-lasting effects comes from studies on the effect of CBT in terms of depressive complaints, which suggests that CBT might have enduring effects that extend beyond the end of treatment, supporting our hypothesis that the intervention from RCT II could also lead to a sustainable decrease in SA at 5-years follow-up (26-31). Demonstrated long-term efficacy is highly relevant for social and economic reasons since LTSA often is associated with high costs (2). Therefore, this study aimed to examine the efficacy of an indicated prevention strategy to prevent LTSA, through record linkage of the RCT participant's data on SA parameters and termination of employment over a 5-year follow-up period.

Methods

Design, procedure and participants

Two RCT were conducted among office workers who were classified as high risk for future LTSA by a screening questionnaire called the 'Balansmeter' in Dutch. The current paper describes a follow-up study on indicators of labor participation with a focus on SA parameters and termination of the employment contract. Similarities can be found between the preventive interventions in RCT I and RCT II in the timing of the preventive intervention and the use of a screening instrument to classify employees as high risk for LTSA. However, the preventive interventions differ in the type and intensity of treatment.

Screening instrument

The screening instrument (Balansmeter) was developed to identify employees at high risk for future LTSA in an office environment before they report sick. The Balansmeter was internally validated on data of the Maastricht Cohort study and externally validated on a large sample of employees from the same company in which both RCT were conducted (18, 32). Detailed information about the screening instrument can be found in the supplementary material (www.sjweh.fi/show_abstract. php?abstract_id=3945).

RCT I

Starting in 2003, RCT I invited 9863 employees to participate in the study, of which 4950 responded to the questionnaire. Employees were selected if they scored above the cut-off point of the Balansmeter, which indicated that they were at high risk for future LTSA. Exclusion criteria were employees (i) already on sick leave, (ii) receiving OP care at the time of completing the screening questionnaire, (iii) who left the company during the RCT period, and

(iv) who were pregnant. This resulted in N=263 employees eligible for allocation in the intervention or control groups. A detailed description of the selection procedure of participants is described elsewhere (16). The original follow-up period for RCT I was one year, extended to five for the current study. The allocation of participants in RCT I is shown in supplementary figure S1. The number of study participants decreased over time due to the departure of employees from the company because of disability, retirement, job loss, or voluntary leave.

For RCT I, employees in the intervention group received a structured early consultation by the OP/OHP, which may already be viewed as a short intervention due to the time involvement, often followed by further consultations within the occupational health service. The consultation was held according to a protocol consisting of different steps, in which the main symptoms were discussed and the relation between their symptoms and the risk for future LTSA explained. Finally, the expectations and benefits of early treatment were discussed with the employee. The consultation could then be followed by a targeted intervention to focus directly on the identified issues. Different interventions were applied (eg, psychological interventions, lifestyle interventions, and interventions by company counselors). This resulted in 84 employees having a consult with the OP of which 14 received additional treatment, as retrieved from questionnaires completed by the OP (16). The focus of this IPS is the early timing - before SA occurs - rather than the type of intervention. The control group received care as usual (ie, when there was a need). A detailed overview of this preventive intervention can be found at Kant et al (16).

RCT II

The selection process for RCT II started in 2007, with 9157 employees responding to the study invitation. Employees were eligible if they were classified as being at high risk for future LTSA and additionally had mild depressive complaints. Depressive complaints were assessed using the depression subscale of the Hospital Anxiety and Depression Scale (HAD-D) which consists of 7 items ranging from 0-21 (33). The employees were classified as having mild depressive complaints when they scored >8 points on the HAD-D. Exclusion criteria were: fully or partly absent from work, already receiving treatment by the psychologist/psychiatrist at the time of completing the screening questionnaire, pregnant or on maternity leave. This resulted in N=139 employees who were eligible for randomization in the intervention or control groups. Lexis et al (17) described RCT II in detail.

The original follow-up period for RCT II was 12 months, extended to five years for the current study. The number of study participants decreased over time due to termination of the employment contract as a result of pension, disability benefits, voluntary leave or, involuntary leave. A flow diagram of study participants is shown in supplementary figure S2.

Employees in the intervention group received a psychological treatment based on principles of PST and CBT to enhance their coping ability to prevent LTSA and stimulate personal well-being. Seven individual sessions of 45 minutes each were provided. After each session, homework assignments were given to the employees and discussed in the following session. The number of sessions could be extended to 13 sessions if needed. Ten psychologists conducted the sessions and received a 2-day training session before the intervention and a 1-day booster session during the study (17). The focus of this IPS is the early timing - before SA occurs - as well as the intensity of the individual sessions. Employees in the control group received care a usual.

Outcome measures

Primary outcome. Indicators of labor participation were investigated by SA parameters, which entailed the mean duration of SA (including >28 SA days), SA frequency, the percentage of LTSA (>28 days SA), and the time until the first onset of LTSA. The percentage of LTSA was calculated for each year separately even if the period of LTSA has started the previous year. The occupational health service from a financial service provider 'Beter', provided us with SA data through record linkage on an individual level with company sick-leave registries and anonymized according to the current General Data Protection Regulation. SA duration was measured in both RCT in calendar days according to the defined time window: 1-5 years of follow-up.

Secondary outcome. Termination of the employment contract was characterized by the time (in months) until an employee departed the company during the follow-up period. Termination of employment could be due to disability, retirement, job loss, or voluntary leave. The HR office from the company under study provided us with the termination of employment contract dates. Especially the relation between IPS for RCT II employees might be of interest, while work disability studies have shown a strong relation with coping abilities and return to work behavior (30, 35). Termination of the employment contract was perceived to be important, especially for RCT II employees, where the preventive intervention was developed to improve their coping abilities. Further it was investigated if SA and LTSA were precursors for the time until termination of the employment contract.

Statistical analysis

The indicators of labor participation were analyzed according to the intention-to-treat (ITT) principle. Per protocol analyses are provided in the supplementary material. Poisson regression was used to estimate the efficacy of the IPS in terms of the mean duration of SA, SA frequency, and the percentage of LTSA. The time until the first onset of LTSA and the time until termination of the employment contract was examined with multivariate Cox regression analyses. All analyses were conducted for RCT I and RCT II separately. The analyses were adjusted for the following covariates: age, gender, job function/education level (available data differed between RCT I and RCT II), and long-term illness previous to the screening questionnaire. These covariates were chosen due to their important predicting ability for SA (36, 37). A Chi-square test was used to investigate if SA or LTSA were precursors for the departure of employees from the company. All analyses were conducted per year for five years of follow-up, except for the multivariate Cox regression which was estimated for five years of followup. All analyses were conducted with the use of SPSS version 25 (IBM Corp, Armonk, NY, USA).

Results

Baseline characteristics of the participants from RCT I and II are displayed in table 1. Age, mean number of years working for the company and working hours per week were similar for the control and intervention groups. Small differences were apparent with regards to gender, educational level, and long-term illness.

Results sickness absence parameters and termination of employment contract (RCT I)

Table 2 presents the results according to the ITT principle for RCT I. On average, the intervention group had fewer mean days of SA in each year compared to the control group. Mean days of SA differed only borderline statistically significant for the five years of follow-up with a difference of 43.2 days of SA between the control and intervention groups. The Per Protocol analysis showed statistically significant differences between the intervention and control group for each year except four years of follow-up. After five years a difference of 52.8 mean days of SA (95% CI 3.21-123.31) between the control and intervention groups in favor of the latter was found. Results from the PP analysis are available in the supplementary material (table S1 and figures S1 and S2). The percentage of LTSA was lower in the intervention compared to control group and was statistically significant after three, four, and five years of follow-up according to both ITT and PP analysis.

The course over time until the first onset of LTSA for the intervention and control groups is shown for RCT I in figure 1A. According to this survival curve of figure 1A, after five years, 35% of the intervention group was on sick leave for >28 days as compared to 50% of the control group. For the intervention group, this resulted in an average time until the first onset of LTSA of 42.3 months compared to 36.1 months for the control group. According to the ITT principle, adjusted for the covariates age, gender, job function, and long-term illness this gave a HR of 0.61 (95% CI 0.41-0.90).

The average time until termination of the employment contract was 53.8 and 51.8 months for the intervention and control groups, respectively, HR 0.85 (95% CI 0.54-1.35) (adjusted, figure 1B). Employees who left the company during the five years' follow-up did not differ statistically significant in terms of days of SA or LTSA from those who did not leave the company.

Results sickness absence parameters and termination of employment contract (RCT II)

The SA results for RCT II according to the ITT are presented in table 3. No differences were found in SA duration and frequency between the intervention and control group according to the ITT and PP analysis. Cumulative after 3-5 years, the control group had less SA days compared to the intervention group, however this evidence is very uncertain and not statistically significant according to both ITT and PP analysis. Results from the PP analysis are available in the supplementary material (table S2 and figures S3 and S4).

The average time until the first onset of LTSA was 38.1 and 33.1 months for the intervention and control groups, respectively, as shown in figure 2A. However, this difference was not statistically significant given the adjusted HR 1.31 (95% CI 0.70-2.47).

The average time until termination of the employment contract for the intervention group was 48.7 months and for the control group 40.2 months. As shown in Figure 2B, according to the ITT principle, after five years 45% of the intervention group as compared to 62% of the control group departed the company. The difference between the groups was significant with a HR 0.62 (95% CI 0.39-0.99) (adjusted). According to the PP analysis, 35% of the intervention group departed from the company as compared to 60% from the control group with a HR 0.48 (95% CI 0.27-0.85) (adjusted, see supplementary figure S4). The employees who departed the company did not differ statistically significant from the employees who stayed with the company during the five years in terms of SA and LTSA.

Discussion

The study aimed to estimate the efficacy of an IPS on the prevention of LTSA and termination of the employment contract over five years of follow-up. This was a follow-up study on employees from two Dutch RCT with an original follow-up of 12 months. The focus was on employees classified by a screening questionnaire as being at high risk for future LTSA. Additionally, RCT II only included employees with mild depressive complaints. The RCT also differed in type and treatment intensity. Previous results from 12 months' follow-up showed statistically significant reductions in days of SA in favor of the intervention group (RCT I and RCT II), as well as a reduction of depressive symptoms in the intervention group (RCT II).

This study showed over five years that, on average, the intervention group (RCT I) had 43.1 fewer days of SA compared to the control group (P=0.05) and showed significantly less LTSA (24.2% versus 35.9%; P=0.019). The intervention group had a significantly longer time until their first period of LTSA (42.3 versus 36.1 months) (HR 0.61, 95% CI 0.41-0.90). Termination of the employment contract did not differ between the control and intervention group. For RCT II participants, no significant differences in days of SA and LTSA were found between the groups after 12 months of follow-up. The time until the first onset of LTSA was somewhat longer in the intervention compared to control group over five years (HR 1.31, 95% CI 0.70-2.47). Whereas, the risk of termination of the employment contract was significantly lower in the intervention group (HR 0.62, 95% CI 0.39-0.99).

Only six other studies to date reported results of an IPS on SA or work-related outcomes (20-22, 38-40). However, none of these reported outcomes beyond 24 months of follow-up, and five of the six only covered at most one year follow-up. This means that beyond the two RCT described here, comparison with other results from studies describing long-term effects (five years) is not possible. The comparison of our study results with other preventive approaches aimed at SA, not based on indicated prevention, is also challenging as the majority of these studies either focused on the general population or employees already on sick leave and showed different results (41-43). The 5-year follow-up of our study with regards to the efficacy of LTSA or work disability interventions seems rather unique, as even with a general focus of studies on SA reduction, no other studies were found for comparison.

The 5-year study period was chosen due to the expected long-term effects as potential changes in helpseeking behavior might occur among the employees at high-risk for future SA and subsequently could lower the threshold to visit a physician, especially visits to an OP, who can also advise in adjustments to the work situation or stimulate addressing potential issues with a supervisor, management or colleagues (23). The healthcare usage is currently being analyzed and the preliminary results show that the IPS for both RCT increases short-term healthcare usage (Klasen et al, unpublished). Regrettably, due to privacy reasons, no further information could be retrieved on the content and number of consults with the OP and the decisions made. Therefore, one can only hypothesize that the early consult with the OP led to a long-lasting decrease in SA due to the early awareness of a health problem/personal issue. But also the process of problem identification and the drafting of a concrete plan of action by the OP might have contributed in long lasting effects as reported. However, further studies should ideally verify these results in similar and other study populations.

The results of RCT II were unexpected, as no decrease in SA was observed during 2-5 years followup. Due to the long-term results from CBT regarding depressive complaints, as reported in several long-term studies (covering 3-6 years), one might expect that a more lasting effect would exist also for SA (28-30). However, in the current study, no evidence was found for a sustainable decrease in SA after one year. It might be that the number of subjects was insufficient to find potential small effects. Additionally, the difference in efficacy of long-term effects of CBT interventions might be the result of more severe depressive complaints as compared to the less severe ones of the current study participants (29). Furthermore, the current study did not include booster sessions during the prolonged follow-up, which is expected to have led to better outcomes (28). Further studies might focus more on the sustainable spectrum of effects on the early consultation with the OP and the PST/CBT intervention and investigate the efficacy elements of each strategy.

The efficacy differences between the RCT might at least partially be due to the different selection criteria of RCT participants. In addition to being at high risk for future SA, RCT II participants were selected for experiencing mild depressive complaints. Therefore, other factors might be of importance for an approach to prevent future SA compared to the general high-risk population. Depressive complaints might give rise to, eg, stigmatization, lower socioeconomic status, loss of a valuable source of social support (44, 45). Possibly, more holistic care is needed for these people, while their healthcare needs will be larger, due to different health and personal influences as a result of their illness. A difference in efficacy may also be explained by different intervention characteristics. RCT I focused on issues that emerged from the early consultation with a suited intervention, while RCT II was based on a psychological treatment with principles of PST/CBT and was developed to improve employees coping skills. Moreover, the intervention in RCT II involved many different sessions and was, therefore, more intense than RCT I.

This is the first study, as far as we know which investigated the termination of the employment contract in an indicated preventive setting. In general preventive interventions, it was often studied as work disability or workability (46, 47). The termination of employment contract in this study is less specific, it could be due to disability, retirement, job loss, or voluntary leave and is therefore difficult to compare to other studies. Although in RCT II the risk of termination of employment was found to be substantially lower in favor of the intervention group, we do not have a clear explanation for this positive and relevant effect. Possibly, PST/CBT makes the intervention group more resilient and more proactive with regards to solving potential participation problems.

The strengths of this study are its randomized and longitudinal design, objective measurement of SA, and termination of the employment contract, data availability of two RCT, and no large differences in the ITT and PP outcomes within the RCT were observed. The termination of the employment contract dates provided by the company is expected to be the golden standard (48). There was no differential loss to follow-up, which resulted in an even comparison over the years. Employees who left the company did not differ in terms of SA and LTSA compared to those who stayed and, therefore, we expect it did not have a large impact on the average days of SA per year. As one might assume that censored employees have similar prospects of reaching the outcome as those who continued to be followed, bias of the survival analysis due to right-censoring is assumed to be low. The researcher who analyzed the data was blinded due to anonymized personnel numbers. Contamination in the first three years of study was not observed while the control group did not receive an early OP consultation. Possibly other healthcare or interventions were used but, in the strict sense of the early consultation as being an essential part of the intervention, these were not seen as co-interventions.

It is conceivable that contamination between the intervention and control groups occurred as both groups received the IPS according to the protocol of the first RCT after three years (if identified as high risk yet again). Unfortunately, we were not able to retrieve if, and how often, this occurred. This might have reduced the contrast between the groups and most likely this bias has led to an underestimation of the efficacy, assuming the intervention is effective. The underlying reason for the termination of the employment contract was unavailable to the researchers due to the EU's strict General Data Protection Regulation. No distinction could be made between the termination of the employment contract due to disability, retirement, job loss or, voluntary leave. Therefore, the results from this study may be seen as the first step towards better understanding the efficacy of an IPS on termination of the employment contract, and future studies may further distinguish the reasons for leaving the company.

In addition, a technical malfunction in the data merge resulted in a loss to follow-up in the first year, of N=14 for RCT I and N=10 for RCT II. There were no indications that this loss to follow-up was selective and unlikely to be related to the outcome or the interventions and, therefore, would not have biased the results. The trials were carried out in a large company in The Netherlands in the context of its specific social system, and RCT participants were office workers with access to an occupational health service with a very high service level. Although such an indicated preventive approach could be effective in many countries and contexts, extrapolation of the reported results should take the national and labor context into account while SA and its prevention is highly dependent on cultural as well as legislative factors (3). Thus, adaptation should be done with care, tailoring and testing of the screening and interventions under study. In companies with a lower occupational health care service level, the contrast between intervention and control groups may be different, resulting in higher or lower effect sizes.

For future studies, the first step should be to validate the results from this study in a different study population. Possibly, with additional data gathering concerning healthcare usage or workplace involvement to better understand the effective elements of both interventions. Moreover, future studies should extend their follow-up period to investigate the full potential of their intervention while currently, similar studies often focused on a short period. Furthermore, it would be interesting to investigate if IPS differs in efficacy for mental or physical health complaints and leads to medicalization. The IPS is focused on individual health/general problems and the company was only involved when the employees wanted to express their issues. However, the problems might be related to the organization itself, and possibly involving the organization could improve the shared responsibility for employees' health. Especially the multifactorial factors of LTSA give a lead to a more holistic approach. However, this could encounter inherent difficulties due to privacy issues. Future studies should investigate if a holistic IPS is feasible in an organization where the focus remains on individual treatment, valuing the doctor/patient relationship and privacy issues.

The screening interval of three years of this IPS seems suited to create long-term effects while especially the efficacy of LTSA is visible after two years. However, the screening interval period has not yet been validated, and it would be interesting for future studies to investigate what is acceptable in terms of costs and benefits for both employees and employers.

To conclude, after one year, the IPS resulted in a large reduction in days of SA. With an extended followup of five years, this strategy showed a reduction in days of SA and LTSA for the intervention compared to control group (in RCT I). However, this decrease was not found for participants with mild depressive complaints after the first year (RCT II). For participants receiving a psychological treatment based on PST/CBT, RCT II showed that the intervention had a positive effect on preventing termination of the employment contract. This relation was not found in RCT I. A different type of intervention and study population might have resulted in different results for the RCT. Thus, the best elements of both interventions should be further studied.

Acknowledgements

RCT I is registered under NTR214. The study protocol of RCT II was submitted to and financially supported by The Netherlands Organisation for Health Research and Development (grant no. 62200024). The RCT were performed in agreement with the ethical and medical guidelines at the time of the studies. RCT I complied with the Declaration of Helsinki (34). For RCT II, study approval was provided by the Medical and Ethical Committee of Maastricht University (MEC 06-3-018), which was not applicable at the time of the RCT I.

Sidebar

Correspondence to: Sophie H Klasen, CAPHRI School for Public Health and Primary Care. Department of Epidemiology, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands. [E-mail: sophie.klasen@maastrichtuniversity.nl]

References

References

1. Labriola M. Conceptual framework of sickness absence and return to work, focusing on both the individual and the contextual level. Work 2008;30(4):377-87.

2. Lund T, Kivimäki M, Labriola M, Villadsen E, Christensen KB. Using administrative sickness absence data as a marker of future disability pension: the prospective DREAM study of Danish private sector employees. Occup Environ Med 2008 Jan;65(1):28-31. https://doi.org/10.1136/ oem.2006.031393.
3. van Amelsvoort LG, Jansen NW, Kant I. Addressing longterm sickness absence: moving beyond disease, illness and work-related factors for effective prevention. Scand J Work Environ Health 2017 Jan;43(1):1-4. https://doi.org/10.5271/ sjweh.3605.
4. Helgesson M, Johansson B, Nordqvist T, Lundberg I, Vingård E. Sickness absence at a young age and later sickness absence, disability pension, death, unemployment and income in native Swedes and immigrants. Eur J Public Health 2015 Aug;25(4):688-92. https://doi.org/10.1093/ eurpub/cku250.
5. Vingård E, Alexanderson K, Norlund A. Chapter 9. Consequences of being on sick leave. Scand J Public Health. 2004;32(63_suppl):207-15.
6. Wiencke M, Cacace M, Fischer S. Healthy at Work: Interdisciplinary Perspectives: Springer; 2016.
7. van Rijn RM, Robroek SJ, Brouwer S, Burdorf A. Influence of poor health on exit from paid employment: a systematic review. Occup Environ Med 2014 Apr;71(4):295-301. https://doi.org/10.n36/oemed-2013-101591.
8. Waddell G, Burton AK. Concepts of rehabilitation for the management of low back pain. Best Pract Res Clin Rheumatol 2005 Aug;19(4):655-70. https://doi. org/10.1016/j.berh.2005.03.008.
9. Munir F, Yarker J, Haslam C. Sickness absence management: encouraging attendance or 'risk-taking' presenteeism in employees with chronic illness? Disabil Rehabil 2008;30(19):1461-72. https://doi. org/10.1080/09638280701637380.
10. Beemsterboer W, Stewart R, Groothoff J, Nijhuis F. A literature review on sick leave determinants (1984-2004). Int J Occup Med Environ Health 2009;22(2):169-79. https:// doi.org/10.2478/v10001-009-0013-8.
11. Notenbomer A, Roelen C, Groothoff J, van Rhenen W, Bültmann U. Effect of an eHealth Intervention to Reduce Sickness Absence Frequency Among Employees With Frequent Sickness Absence: Randomized Controlled Trial. J Med Internet Res 2018 Oct;20(10):e10821. https://doi. org/10.2196/10821.
12. Schultz IZ, Gatchel RJ. Handbook of return to work: From research to practice: Springer; 2015.
13. Vingård E, Lindberg P, Josephson M, Voss M, Heijbel B, Alfredsson L et al. Long-term sick-listing among women in the public sector and its associations with age, social situation, lifestyle, and work factors: a three-year follow-up study. Scand J Public Health 2005;33(5):370-5. https://doi. org/10.1080/14034940510005860.
14. Andersen LL, Thorsen SV, Flyvholm MA, Holtermann A. Long-term sickness absence from combined factors related to physical work demands: prospective cohort study. Eur J Public Health 2018 Oct;28(5):824-9. https://doi. org/10.1093/eurpub/cky073.
15. Aronsson V, Toivanen S, Leineweber C, Nyberg A. Can a poor psychosocial work environment and insufficient organizational resources explain the higher risk of ill-health and sickness absence in human service occupations? Evidence from a Swedish national cohort. Scand J Public Health 2019 May;47(3):310-7. https://doi. org/10.1177/1403494818812638.
16. Kant I, Jansen NW, van Amelsvoort LG, van Leusden R, Berkouwer A. Structured early consultation with the occupational physician reduces sickness absence among office workers at high risk for long-term sickness absence: a randomized controlled trial. J Occup Rehabil 2008 Mar;18(1):79-86. https://doi.org/10.1007/s10926-0079114-z.
17. Lexis MA, Jansen NW, Huibers MJ, van Amelsvoort LG, Berkouwer A, Tjin A Ton G et al. Prevention of longterm sickness absence and major depression in high-risk employees: a randomised controlled trial. Occup Environ Med 2011 Jun;68(6):400-7. https://doi.org/10.1136/ oem.2010.057877.
18. Duijts SF, Kant IJ, Landeweerd JA, Swaen GM. Prediction of sickness absence: development of a screening instrument. Occup Environ Med 2006 Aug;63(8):564-9. https://doi. org/10.1136/oem.2005.024521.
19. Salomonsson S, Hedman-Lagerlöf E, Öst LG. Sickness absence: a systematic review and meta-analysis of psychological treatments for individuals on sick leave due to common mental disorders. Psychol Med 2018 Sep;48(12):1954-65. https://doi.org/10.1017/ S0033291718000065.
20. Duijts SF, Kant I, van den Brandt PA, Swaen GM. Effectiveness of a preventive coaching intervention for

employees at risk for sickness absence due to psychosocial health complaints: results of a randomized controlled trial. J Occup Environ Med 2008 Jul;50(7):765-76. https://doi. org/10.1097/JOM.0b013e3181651584.
21. Lerner D, Adler D, Hermann RC, Chang H, Ludman EJ, Greenhill A et al. Impact of a work-focused intervention on the productivity and symptoms of employees with depression. J Occup Environ Med 2012 Feb;54(2):128-35. https://doi.org/10.1097/JOM.0b013e31824409d8.
22. Taimela S, Justén S, Aronen P, Sintonen H, Läärä E, Malmivaara A et al. An occupational health intervention programme for workers at high risk for sickness absence. Cost effectiveness analysis based on a randomised controlled trial. Occup Environ Med 2008 Apr;65(4):242-8. https://doi.org/10.1136/oem.2007.033167.
23. Lexis MA, Jansen NW, Stevens FC, van Amelsvoort LG, Kant I. Experience of health complaints and help seeking behavior in employees screened for depressive complaints and risk of future sickness absence. J Occup Rehabil 2010 Dec;20(4):537-46. https://doi.org/10.1007/s10926-0109244-6.
24. Steenbeek R. Workers' opinions on the effect of contact with health care providers on sickness absence duration. Work 2014;49(3):495-504. https://doi.org/10.3233/WOR131714.
25. Mortelmans AK, Donceel P, Lahaye D, Bulterys S. Workrelated sickness absences and mandatory occupational health surveillance. Occup Med (Lond) 2008 Oct;58(7):464-7. https://doi.org/10.1093/occmed/kqn089.
26. Driessen E, Hollon SD. Cognitive behavioral therapy for mood disorders: efficacy, moderators and mediators. Psychiatr Clin North Am 2010 Sep;33(3):537-55. https:// doi.org/10.1016/j.psc.2010.04.005.
27. Hollon SD. Does cognitive therapy have an enduring effect? Cognit Ther Res 2003;27(1):71-5. https://doi. org/10.1023/A:1022538713914.
28. Fava GA, Ruini C, Rafanelli C, Finos L, Conti S, Grandi S. Six-year outcome of cognitive behavior therapy for prevention of recurrent depression. Am J Psychiatry 2004 Oct;161(10):1872-6. https://doi.org/10.1176/ ajp.16U0.1872.
29. Bockting CL, Spinhoven P, Wouters LF, Koeter MW, Schene AH; DELTA Study Group. Long-term effects of preventive cognitive therapy in recurrent depression: a 5.5-year followup study. J Clin Psychiatry 2009 Dec;70(12):1621-8. https:// doi.org/10.4088/JCP.08m04784blu.
30. Øyeflaten I, Midtgarden IJ, Maeland S, Eriksen HR, Magnussen LH. Functioning, coping and work status three years after participating in an interdisciplinary, occupational rehabilitation program. Scand J Public Health 2014 Jul;42(5):425-33. https://doi. org/10.1177/1403494814528291.
31. Nigatu YT, Huang J, Rao S, Gillis K, Merali Z, Wang J. Indicated Prevention Interventions in the Workplace for Depressive Symptoms: A Systematic Review and Metaanalysis. Am J Prev Med 2019 Jan;56(1):e23-33. https:// doi.org/10.1016/j.amepre.2018.08.027.
32. Kant I, Jansen NW, van Amelsvoort LG, Swaen GM, van Leusden R, Berkouwer A. Screening questionnaire Balansmeter proved successful in predicting future longterm sickness absence in office workers. J Clin Epidemiol 2009;62(4):408-14. e2.
33. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983 Jun;67(6):361-70. https:// doi.org/10.1111/j.1600-0447.1983.tb09716.x.
34. Association WM; World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013 Nov;310(20):2191-4. https://doi.org/10.1001/ jama.2013.281053.
35. Odéen M, Kristensen LO, Ursin H. Coping and return to work: measurement and theoretical issues. Nor Epidemiol 2009;19(2). https://doi.org/10.5324/nje.v19i2.588.
36. Notenbomer A, van Rhenen W, Groothoff JW, Roelen CA. Predicting long-term sickness absence among employees with frequent sickness absence. Int Arch Occup Environ Health 2019 May;92(4):501-11. https://doi.org/10.1007/ s00420-018-1384-6.
37. Andrea H, Beurskens AJ, Metsemakers JF, van Amelsvoort LG, van den Brandt PA, van Schayck CP. Health problems and psychosocial work environment as predictors of long term sickness absence in employees who visited the occupational physician and/or general practitioner in relation to work: a prospective study. Occup Environ Med

2003 Apr;60(4):295-300. https://doi.org/10.1136/oem.60.4.295.
38. Adler DA, Lerner D, Visco ZL, Greenhill A, Chang H, Cymerman E et al. Improving work outcomes of dysthymia (persistent depressive disorder) in an employed population. Gen Hosp Psychiatry 2015 Jul-Aug;37(4):352-9. https:// doi.org/10.1016/j.genhosppsych.2015.04.001.
39. de Boer AG, van Beek JC, Durinck J, Verbeek JH, van Dijk FJ. An occupational health intervention programme for workers at risk for early retirement; a randomised controlled trial. Occup Environ Med 2004 Nov;61(11):924-9. https:// doi.org/10.1136/oem.2003.009746.
40. Wang PS, Simon GE, Avorn J, Azocar F, Ludman EJ, McCulloch J et al. Telephone screening, outreach, and care management for depressed workers and impact on clinical and work productivity outcomes: a randomized controlled trial. JAMA 2007 Sep;298(12):1401-11. https://doi. org/10.1001/jama.298.12.1401.
41. Aasdahl L, Pape K, Vasseljen O, Johnsen R, Gismervik S, Halsteinli V et al. Effect of Inpatient Multicomponent Occupational Rehabilitation Versus Less Comprehensive Outpatient Rehabilitation on Sickness Absence in Persons with Musculoskeletal- or Mental Health Disorders: A Randomized Clinical Trial. J Occup Rehabil 2018 Mar;28(1):170-9. https://doi.org/10.1007/s10926-0179708-z.
42. Milligan-Saville JS, Tan L, Gayed A, Barnes C, Madan I, Dobson M et al. Workplace mental health training for managers and its effect on sick leave in employees: a cluster randomised controlled trial. Lancet Psychiatry 2017 Nov;4(11):850-8. https://doi.org/10.1016/S22150366(17)30372-3.
43. Beiwinkel T, Eißing T, Telle NT, Siegmund-Schultze E, Rössler W. Effectiveness of a Web-Based Intervention in Reducing Depression and Sickness Absence: Randomized Controlled Trial. J Med Internet Res 2017 Jun;19(6):e213. https://doi.org/10.2196/jmir.6546.
44. Lépine JP, Briley M. The increasing burden of depression. Neuropsychiatr Dis Treat 2011;7 Suppl 1:3-7.
45. Plaisier I, Beekman AT, de Bruijn JG, de Graaf R, Ten Have M, Smit JH et al. The effect of social roles on mental health: a matter of quantity or quality? J Affect Disord 2008 Dec;111(2-3):261-70. https://doi.org/10.1016/j. jad.2008.03.007.
46. Oakman J, Neupane S, Proper KI, Kinsman N, Nygård CH. Workplace interventions to improve work ability: A systematic review and meta-analysis of their effectiveness. Scand J Work Environ Health 2018 Mar;44(2):134-46. https://doi.org/10.5271/sjweh.3685.
47. Midtsundstad TI, Nielsen RA. Do workplace interventions reduce disability rates? Occup Med (Lond) 2016 Dec;66(9):691-7. https://doi.org/10.1093/occmed/kqw169.
48. Stapelfeldt CM, Jensen C, Andersen NT, Fleten N, Nielsen CV. Validation of sick leave measures: self-reported sick leave and sickness benefit data from a Danish national register compared to multiple workplace-registered sick leave spells in a Danish municipality. BMC Public Health 2012 Aug;12(1):661. https://doi.org/10.1186/1471-2458-12-661.
Received for publication: 15 June 2020

DETAILS

Subject:	Strategy; Terminations; Employment contracts; Employment; Confidence intervals; Sick leave; Prevention; Employees; Working conditions; Questionnaires; Clinical trials; Risk; Survival analysis
Business indexing term:	Subject: Terminations Employment contracts Sick leave Employees Working conditions
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47

Issue:	4
Pages:	258-267
Publication year:	2021
Publication date:	2021
Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3945
ProQuest document ID:	2530522463
Document URL:	https://www.proquest.com/scholarly-journals/efficacy-indicated-prevention-strategy-on/docview/2530522463/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2021-05-24
Database:	Public Health Database

Impact of anxiety and depression disorders on sustained return to work after workrelated musculoskeletal strain or sprain: a gender-stratified cohort study

Jones, Andrea Marie, PhD [1] ; Koehoorn, Mieke, PhD [1] ; Bültmann, Ute, PhD [2] ; McLeod, Christopher B, PhD [1] [1] Partnership for Work Health and Safety, School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada [2] Department of Health Sciences, Community and Occupational Medicine, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

ProQuest document link

ABSTRACT (ENGLISH)

Objective The aim of this study was to examine the impact of anxiety and depression disorders on sustained return to work (RTW) for men and women with musculoskeletal strain or sprain. Methods Accepted lost-time claims for spine and upper-extremity strain or sprain were extracted for workers in the Canadian province of British Columbia from 2009 to 2013 (N=84 925). Pre-existing and new onset anxiety and depression disorders were identified using longitudinal health claims data. Probability of sustained RTW was analyzed using Cox proportional hazards models, stratified by gender and adjusted for potential confounders. Results For pre-existing disorders, compared to men with no anxiety and no depression, men with anxiety only [hazard ratio (HR) 0.88, 95% confidence interval (CI) 0.84-0.93], depression only (HR 0.94, 95% CI 0.89-1.00), and anxiety and depression (HR 0.93, 95% CI 0.90-0.97) had lower probabilities of sustained RTW in adjusted models. The same direction of effect was found for women, but anxiety only had a smaller effect size among women compared to men (HR anxiety only 0.95, 95% CI 0.92-0.99; HR depression only 0.98, 95% CI 0.93-1.03, HR anxiety and depression 0.94, 95% CI 0.91-0.97). Among men and women, new onset disorders were associated with lower probability of sustained RTW and the effect estimates were larger than for pre-existing disorders. Conclusions Findings suggest that workers' compensation benefits and programs intended to improve RTW after musculoskeletal injury should take pre-existing and new onset anxiety and depression disorders into consideration and that gender-sensitive work disability strategies may be warranted.

FULL TEXT

Headnote

Objective The aim of this study was to examine the impact of anxiety and depression disorders on sustained return to work (RTW) for men and women with musculoskeletal strain or sprain.

Methods Accepted lost-time claims for spine and upper-extremity strain or sprain were extracted for workers in the Canadian province of British Columbia from 2009 to 2013 (N=84 925). Pre-existing and new onset anxiety and depression disorders were identified using longitudinal health claims data. Probability of sustained RTW was analyzed using Cox proportional hazards models, stratified by gender and adjusted for potential confounders.

Results For pre-existing disorders, compared to men with no anxiety and no depression, men with anxiety only [hazard ratio (HR) 0.88, 95% confidence interval (CI) 0.84-0.93], depression only (HR 0.94, 95% CI 0.89-1.00), and anxiety and depression (HR 0.93, 95% CI 0.90-0.97) had lower probabilities of sustained RTW in adjusted models. The same direction of effect was found for women, but anxiety only had a smaller effect size among women compared to men (HR anxiety only 0.95, 95% CI 0.92-0.99; HR depression only 0.98, 95% CI 0.93-1.03, HR anxiety and depression 0.94, 95% CI 0.91-0.97). Among men and women, new onset disorders were associated with lower probability of sustained RTW and the effect estimates were larger than for pre-existing disorders.

Conclusions Findings suggest that workers' compensation benefits and programs intended to improve RTW after musculoskeletal injury should take pre-existing and new onset anxiety and depression disorders into consideration and that gender-sensitive work disability strategies may be warranted.

Key terms British Columbia; Canada; common mental disorder; comorbid condition; mental health; RTW; sickness absence; work disability; workers' compensation; workplace.

Disability due to work-related musculoskeletal injury is a significant burden in Canada and other high-income countries around the world. In the Canadian province of British Columbia, musculoskeletal strain or sprain accounts for over half of all lost-time workers' compensation claims, 57% of all registered lost workdays due to work-related injury or illness, and $347 million (CDN) in disability costs annually (1). Anxiety and depression disorders are common in workers with work-related musculoskeletal injury (2-4); however, evidence of their impact on sustained return to work (RTW) is incomplete.

Both pre-existing anxiety and depression disorders from before injury and new onset anxiety and depression disorders that arise after the injury but before sustained RTW may contribute to poor RTW outcomes. Pre-existing anxiety or depression disorders may impact RTW through ongoing symptoms that persist after the injury or the exacerbation of pre-existing symptoms by the injury. Likewise, new onset disorders that arise after the injury may impact RTW through the emergence of new anxiety and depression symptoms. Mechanisms through which pre-existing and new onset anxiety and depression disorders could impact RTW after musculoskeletal injury include increased pain (5, 6), disruption to treatment or other rehabilitation activities (7, 8), low self-efficacy (9), unmet need for work accommodation, negative interactions with the compensation system (10) and stigmatization (11).

A 2008 systematic review found strong evidence that depression, and moderate evidence that anxiety, were not predictive of work outcomes after non-chronic, non-specific low-back pain (12). Inclusion of studies with short follow up time, small sample size, and varying anxiety and depression measurement methods often based on self-report may explain these null results. Other systematic reviews on this topic are limited by a lack of eligible studies, sometimes drawing conclusions on as few as one or two studies (13-17). Two recent Canadian prospective cohort studies also present inconsistent evidence. Depressive symptoms were associated with poor RTW in a sample of 332 Ontario workers (18), while neither anxiety nor depression were associated with RTW in a sample of 62 Quebec workers with work-related musculoskeletal injury (19).

Anxiety and depression disorders may impact men and women differentially following musculoskeletal injury. However, there is little-to-no empirical research on this topic. Prior studies have either adjusted or matched for gender effects, rather than quantifying them using stratification or interaction/effect modification methods (12-19). Possible reasons why anxiety and depression might be stronger risk factors for work disability after musculoskeletal injury among men compared to women include (i) a lower frequency of help seeking behavior among men, leading to under treatment and a lack of mental health-related support, that in turn allows symptoms to persist or grow in severity (20) and (ii) higher societal and personal valuation of income production and physical labor among men (20). The latter could result in greater feelings of loss or inadequacy among men during periods of work disability that in turn, further extenuate the condition of work disability, especially among men with pre-existing anxiety or depression or a diathesis for these disorders. Conversely, a greater number of hours spent on combined paid and unpaid work activities by women (21) could slow down women's recovery and deplete the emotional, physical, or motivational resources necessary to cope with work re-entry. Further, gendered differences in interactions with healthcare systems and services may contribute to differences in disability management and RTW outcomes. Each of these gendered characteristics, behaviors, and social roles could increase vulnerability to the psychological challenges of work disability and musculoskeletal injury or interfere with recovery and RTW capacity, especially when combined with anxiety or depression.

Research in this area can inform RTW policy and programming for musculoskeletal work injury by disability management systems, in particular the inclusion and use of mental health services, and the importance of gender-sensitive strategies for mental health and RTW services. The objective of the current study was to address existing gaps and limitations in the literature by conducting a large population-based cohort study for injured workers in British Columbia. Using linked administrative databases, the impact of anxiety and depression disorders (alone and co-morbid), as diagnosed by a physician, on the probability of sustained RTW following lost-time upper limb or spine strain or sprain work injury was examined for both men and women in stratified models. These relationships were examined using multivariable models adjusted for known and potential confounders. Up to two years of follow-up data was used to identify sustained return to non-modified job duties with no further recurrence of lost-time associated with the claim.

Methods

Study sample

A retrospective population-based cohort study was conducted using linked administrative data from the provincial workers' compensation (WorkSafeBC) and public health care (Ministry of Health) systems (22-26). During the study period, 93-95% of British Columbian workers were covered by workers' compensation (27) and registration in the public health plan was mandatory for all residents. Accepted lost-time claims for upper limb or spine strain/sprain [International Classification for Disease version 9 (ICD-9) codes 840, 841, 842, 846, and 847 (28)] from 2009 to 2013, for workers aged 19-64 years of age, and registered in the provincial public health care plan were selected (N=96 870). To increase the probability that claims in the reference group did not have anxiety or depression, 7967 (8.2%) claims with an anxiety or depression-related healthcare event that did not meet the case definitions (described below) in the year before injury were excluded. Of the remaining 88 903 claims, 3987 (4.5%) were excluded due to missing data. The final study sample consisted of 84 925 claims.

Study variables

Outcome variable, Sustained RTW was defined as the number of days from injury date to the date where the worker returned to non-modified or full job duties and hours (based on their pre-injury job duties and hours), and had no further wage loss benefits or modified work days associated with the claim for at least 365 days (supplementary material, www.sjweh.fi/show_abstract. php?abstract_id=3951, figure S1). Two years of followup data were used to determine sustained RTW, prior to censoring at 365 calendar days. By censoring, up to 365 total disability days of observation following injury were included in the analytic models, but a full 730 day window was used to ensure sustained RTW (supplementary figure S1).

Primary explanatory variable. Claims were classified as having anxiety only, depression only, co-morbid anxiety and depression, or none (no anxiety and no depression) in the year prior to injury. Claims meeting one of the following conditions were classified as depression (i) a hospitalization index event with a depression diagnosis, (ii) an anti-depressant index event and a physician or hospital visit with a depression diagnosis within 12 months of the anti-depressant index event, or (iii) a physician index visit with a depression diagnosis and a second physician or hospital visit for depression, or an anti-depressant event within 12 months of the index visit. Only index events occurring in the 365 days prior to injury were considered. Similar rules were used to classify anxiety, with the exception that anxiety diagnoses were used and dispensing events included anxiolytics in addition to anti-depressants. Both anxiolytics and anti-depressants are common treatments for anxiety disorders and anti-depressants are a recommended firstline pharmacotherapy agent for panic disorders, social anxiety disorders, and generalized anxiety disorders 29, 30). The Anatomical Therapeutic Chemical classification system was used to identify Anxiolytics (N05B) and Anti-depressants (N06A) (31) while the ICD-9 and ICD-10 systems were used to identify anxiety (ICD-9 300, 308, 309; ICD-10 F4, F68, F341) and depression (ICD-9 311, 296; ICD-10 F3 [F341 excluded]) diagnoses. Lastly, diagnostic code 50b (anxiety/depression) unique to British Columbian physician billing claims was also included as a diagnosis for both anxiety and depression. New onset anxiety and depression disorders occurring after injury but before sustained RTW were also identified in workers with no anxiety or depression related healthcare events in the year prior to injury.

Potential confounders

Potential confounders included: (i) sociodemographic characteristics: gender, age, income, dependents in the home; (ii) injury characteristics: body part, incident type, secondary diagnosis on the claim; (iii) clinical characteristics: somatic co-morbidity, other mental comorbidity (not including anxiety or depression), and prior claims; and (iv) work characteristics: firm size and occupation (see table 1 for detailed variable categories). Somatic comorbidity was measured as the number of ICD-9 disease categories represented in diagnoses from physician and hospital visits in the year before injury (mental diagnoses and diagnoses identical to the primary diagnoses on the claim excluded) (32).

Analyses

Descriptive statistics were used to examine the injured worker cohort by socio-demographic, injury, clinical, and work-related characteristics overall and by preinjury mental health status for both men and women. All analyses were conducted using SAS software, version 9.4 (SAS Institute, Cary, NC, USA).

Impact of pre-existing anxiety and depression prevalent in the year prior to injury

Unadjusted and adjusted Cox models (33) stratified by gender were used to examine the impact of anxiety and depression disorders from the year before injury on the probability of sustained RTW by calculating hazard ratios (HR) with 95% confidence intervals (CI). The proportionality assumption was tested for the anxiety and depression variable using Kaplan-Meier curves and by testing for interaction with the log of the time variable (number of days since injury) in the Cox models. No evidence of non-proportionality was found. Confounder strength was analyzed by examining the change in the anxiety and depression hazard ratio estimates when individual confounders were added to the unadjusted models. Only minor changes were observed (<10% change) (data not shown). The strongest confounder in the men's and women's models was somatic co-morbidity with a change of <4% for each HR respectively.

While multiplicative Cox models are the most common tool for analyzing time to event data with censoring in observational epidemiology, additive effect measures are more easily interpreted and policy relevant. To address this, the impact of pre-existing anxiety and depression disorders prevalent in the year before injury were examined on the additive scale using directadjusted survival curves and life table methods stratified by gender (34). Using this method, unadjusted and adjusted median times to sustained RTW and interquartile ranges were calculated by anxiety and depression case status in the year before injury. Censoring the sustained RTW variable at 365 days did not affect the median or interquartile range estimates, as these values were all <365.

Effect modification of the primary relationship between pre-existing anxiety and depression on sustained RTW by gender was examined on the multiplicative and additive scales. For the multiplicative scale, the ratio of ratios was calculated for the mental health variable within strata of the gender/sex variable (women's HR: men's HR) (35). For the additive scale, the relative excess risk due to interaction (RERI) was calculated (36).

Impact of new onset anxiety and depression occurring during the RTW period

The impact of new onset anxiety and/or depression on the probability of sustained RTW was also examined. Cox models stratified by gender, adjusted for all confounders were replicated with a study sample restricted to workers with no anxiety or depression related health care events in the year prior to injury. The anxiety or depression variable was time varying but once a claim was classified as having anxiety only, depression only, or co-morbid anxiety and depression, it remained in this classification until the end of follow-up. The median time to case onset for workers who developed a new anxiety or depression episode during the RTW period was calculated.

Results

The study sample included 48 951 men and 35 974 women (table 1). The majority of claims for both men (85.5%) and women (68.6%) had no anxiety and no depression (ie, 'none') in the year before injury. The prevalence of anxiety only, depression only, and anxiety and depression in the year before injury was approximately twice as high among women (8.6%, 5.6%, and 17.1% respectively) than men (4.0%, 3.0%, and 7.4%). The majority of claims reached sustained RTW within 365 days (men 80.4%; women 85.3%).

Impact of pre-existing anxiety and depression prevalent in the year prior to injury

In the unadjusted Cox models, compared to workers with no anxiety and no depression in the year prior to injury, workers with anxiety only (men HR 0.85, 95% CI 0.800.89, women HR 0.94, 95% CI 0.90-0.98), depression only (men HR 0.91, 95% CI 0.86-0.97, women HR 0.96, 95% CI 0.92-1.01), or co-morbid anxiety and depression (men HR 0.89, 95% CI 0.86-0.93, women HR 0.93, 95% CI 0.90-0.96) had lower probability of sustained RTW (table 2 and supplementary table S1). Similar but attenuated associations were observed in the adjusted Cox models with all potential confounders, although the 95% CI around the estimates included '1' for depression only in the both the men's and women's models.

The unadjusted median time to sustained RTW was 34 days for men with no anxiety and no depression, and 52, 43, and 45 days for men with anxiety only, depression only, and co-morbid anxiety and depression (table 3). Stated differently, compared to men with no anxiety and no depression, men with anxiety only, depression only, and co-morbid anxiety and depression took 18, 9, and 11 days longer, respectively, to reach sustained RTW. The same pattern for the unadjusted median time to sustained RTW by baseline exposure status was observed for women, but the unadjusted absolute differences between the no anxiety and no depression group and the case groups were less pronounced (no anxiety and no depression 40 days, anxiety only 46 days, depression only 42 days, co-morbid anxiety and depression 44 days). Women with anxiety only, depression only, and co-morbid anxiety and depression took 6, 2, and 4 days longer to reach sustained RTW than women with no anxiety and no depression, respectively. Similar results were found in the direct adjusted survival curves with all potential confounders but the effects of anxiety and depression were attenuated. After adjustment for potential confounders, men with anxiety only, depression only, and co-morbid anxiety and depression took 15, 8, and 8 days longer to reach sustained RTW than men with no anxiety and no depression, respectively; and these same corresponding values for women were 5, 2, and 4 days longer.

The ratio of ratio estimate's for the mental health variable within strata of the gender/sex variable (women's HR: men's HR) were all >1 (anxiety only 1.09, 95% CI 1.02-1.07, depression only 1.05, 95% CI 0.97-1.13, anxiety and depression 1.02, 95% CI 0.97-1.07), but only the estimate for anxiety only had a 95% CI that excluded '1' (table 2). This means that the effect size of the relationship between anxiety only and sustained RTW in women was 1.09 times smaller (ie, closer to 1) than would have been expected based on the effect size of this relationship in men. In other words, while anxiety only (compared to no anxiety and no depression) was associated with a lower probability of sustained RTW for both women and men on the multiplicative scale, the strength of this relationship was significantly greater for men than for women (ie, men experienced a lower probability of sustained RTW attributable to anxiety than women, even though anxiety was associated with a lower probability of RTW in women as well). Similar results were found on the additive scale with the RERI indicating that the effects of anxiety only on the lower probability of sustained RTW were significantly greater for men than women, and the negative effects of depression only and co-morbid anxiety and depression were non-significantly greater for men than women (table 2).

Impact of new onset anxiety and depression occurring during the RTW period

For both men and women, new onset anxiety only (men HR 0.82, 95% CI 0.72-0.95, women HR 0.89, 95% CI 0.79-1.01), depression only (men HR 0.69, 95% CI 0.56-0.86, women HR 0.72, 95% CI 0.58- 0.90,), and co-morbid anxiety and depression (men HR: 0.63, 95% CI 0.54- 0.74, women HR 0.65, 95% CI 0.57-0.74) that developed after injury but before sustained RTW were associated with lower probability of sustained RTW, in Cox models adjusted for confounders (table 4). New onset anxiety only, depression only and anxiety and depression were associated with lower probability of sustained RTW for both men and women, but the effect sizes were descriptively greater for men. This is indicated by the lower adjusted hazard ratio (further away from 1 and <1) for men compared to women (table 4).

Discussion

Summary of main findings

For men and women, pre-existing and new onset anxiety only, depression only, and co-morbid anxiety and depression were consistently associated with lower probability of sustained RTW after lost-time upper limb or spine strain or sprain work injury. For pre-existing disorders, anxiety only was associated with the longest time to sustained RTW in both men and women, however, the number of excess days attributable to pre-existing anxiety only (compared to no anxiety and no depression) was greater for men than women (an excess of 15 calendar days for men versus 5 for women). A similar direction of this gendered effect was observed for all other preexisting and new onset disorders, although in some cases, the magnitude of the difference between men and women was small or not statistically significant. Lastly, new onset disorders had a larger detrimental impact on RTW than pre-existing disorders for both men and women.

Anxiety and depression and RTW

The current findings are consistent with the broader psychiatric and disability literature where anxiety and depression disorders are risk factors for work disability (37-43), including a prospective cohort study on depressive symptoms in workers with work-related musculoskeletal strain or sprain (18). However, they are not consistent with a 2008 systematic review by Iles et al (12) where depression and anxiety were not predictive of work outcomes after non-chronic, non-specific low back pain. This discrepancy could be due to methodological limitations of previous research including small sample sizes, short follow-up time, and the use of a work outcome variable that does not capture lost-time recurrence (12). Differences in study sample selection and anxiety and depression measurement methods may also explain differences in findings. For the latter, scale measures of self-reported anxiety and depressive symptoms capture a separate mental construct than clinical diagnoses.

As anxiety and depression disorders have overlapping symptom profiles (44) the mechanisms that link these disorders to poor RTW outcomes after musculoskeletal injury are hypothesized to be similar. These include: (i) increased pain due to shared neuroanatomical pathways and neurotransmitters (5, 6); (ii) activity disruption or a general loss of interest in activities that promote well-being and RTW processes (8); (iii) resistance or non-adherence to musculoskeletal injury therapeutic treatment (7); (iv) self-assessed inability to perform work tasks effectively (9) due to symptoms like fatigue, worry, or worthlessness, especially in the context of returning to a work environment that caused musculoskeletal injury; (v) difficulty navigating social interactions involved in the RTW process possibly due to mental health stigma or a negative response to mental symptoms by others (11); (vi) exacerbation of mental symptoms by procedural aspects of the workers' compensation experience such as adjudication decisions and medical assessments (10); and (vii) a greater need for work accommodation due to the compounding effects of mental symptoms in combination with physical ones. It is hypothesized here that these potential mechanisms likely play a role for both pre-existing and new onset anxiety and depression disorders, however the extent of their impacts are likely greater for new onset disorders due to the lack of an existing treatment plan and the absence of coping strategies.

Gender differences

The finding that the detrimental impact of pre-existing anxiety on RTW is significantly greater for men than for women is similar to a study of short-term disability leave for non-occupational depression where men were less likely to RTW than women (45). One hypothesis for the current finding is lower use of anxiety treatments after diagnosis among men compared to women that would otherwise buffer the potential negative effects of anxiety on RTW, as well as buffer the negative mental health effects of a significant life event such as being injured and off work/on disability benefits. Other hypotheses as proposed by Scott (20) include: (i) men's high occupational performance expectations in combination with anxiety symptoms (eg, fear or worry) that may lead men with anxiety to self-assess themselves as unable to work; (ii) men may be less likely to disclose negative emotions related to an episode of anxiety that in turn may create feelings of isolation or less opportunities for mental health support; and (iii) men may have smaller social support networks than women that may also lead to less opportunities for mental health support during a significant health/life event, although the evidence for this latter point is mixed (20). Lastly, evidence suggests that men with work injury in British Columbia have fewer graduated RTW options than women (46). A longer detachment from the workplace (due to an absence of graduated RTW and thus an absence of the therapeutic effects of work) may facilitate the bi-directional relationships of anxiety with work disability, resulting in longer time to sustained RTW.

Strengths and limitations

Strengths of the current study include the use of a longitudinal population-based dataset, measures of anxiety and depression diagnoses from before and after injury based on health claims data, a two year follow-up period, minimal loss to follow-up, and use of a RTW outcome that accounts for recurring lost-time. Despite this, there are some potential limitations. First, workers with an anxiety or depression disorder could be misclassified as not having the disorder due to under treatment and under diagnoses of these disorders, or use of private mental health services (not captured in the public health claims data). This would have resulted in an underestimation of the main effects observed in the current study. Building on this issue, differential misclassification of workers with depression or anxiety by gender could have contributed to the findings for gender modification. Men are less likely to receive anxiety or depression treatment from a general practitioner than women but equally as likely to receive treatment from a specialist (47-50). It is unknown if this phenomenon is due to (i) lower incidence of mild anxiety and depression in men compared to women, (ii) under treatment of mild anxiety and depression in men, (iii) a higher likelihood of referral to a mental health specialist for men, (iv) delayed treatment among men resulting in more severe cases by the time of diagnosis, or (v) a combination of these making it difficult to ascertain how this might impact the current study. To minimize these biases, workers with an anxiety or depression health care event not sufficient to meet the case definitions were excluded. These excluded workers likely represent potential false positives or mild or transient cases. Lastly, as with all observational study designs, despite adjustment for a range of sociodemographic, clinical, injury and work-related potential confounders, there remains the possibility of some residual confounding.

Concluding remarks

Workers' compensation benefits and programs intended to improve RTW after lost-time upper limb or spine strain or sprain work injury should take pre-existing anxiety and depression disorders into consideration, in addition to new onset disorders attributable to the injury; and, gender-sensitive strategies may be warranted to optimize RTW outcomes. Based on these findings, further investigation of how anxiety and depression affect RTW processes and transitions, during the time course from injury to sustained RTW, and the identification of gender-sensitive strategies to address this, is warranted.

Acknowledgments

Andrea Marie Jones was supported by a WorkSafeBC Research Training Award, Centre for Research on Work Disability Policy Student Trainee Award, and Bridge Canadian Institutes for Health Research (CIHR) Strategic Training Fellowship. Mieke Koehoorn was supported in part by a CIHR Chair in Gender, Work and Health. Christopher McLeod was supported by a CIHR New Investigator Award and is supported by a Michael Smith Foundation for Health Research Scholar Award. Andrea Marie Jones, Mieke Koehoorn, and Christopher McLeod are supported by research operating funds through the Partnership for Work Health and Safety - a research partnership between WorkSafeBC (the provincial workers' compensation system) and the University of British Columbia.

Disclaimer

All inferences, opinions, and conclusions drawn in this paper are those of the authors, and do not reflect the opinions or policies of the Data Stewards.

Conflict of interest

The authors declare no conflicts of interest.

Sidebar

Jones AM, Koehoorn M, Būltmann U, McLeod CB. Impact of anxiety and depression disorders on sustained return to work after work-related musculoskeletal strain or sprain: a gender-stratified cohort study. Scand J Work Environ Health. 2021;47(4):296305. doi:10.5271/sjweh.3951

Correspondence to: Andrea Marie Jones, School of Population and Public Health, 2206 East Mall, University of British Columbia, Vancouver, British Columbia, Canada, V6T 1Z3. [E-mail: andrea.jones@alumni.ubc.ca]

References

References

1. WorkSafeBC. Statistics 2018;2019:69. [cited 2020 Jun 7] Available from: https://www.worksafebc.com/en/resources/ about-us/annual-report-statistics/2018-stats?lang=en

2. Dersh J, Gatchel RJ, Polatin P, Mayer T. Prevalence of psychiatric disorders in patients with chronic work-related musculoskeletal pain disability. J Occup Environ Med 2002 May;44(5):459-68. https://doi.org/10.1097/00043764200205000-00014.

3. Dersh J, Gatchel RJ, Mayer T, Polatin P, Temple OR. Prevalence of psychiatric disorders in patients with chronic disabling occupational spinal disorders. Spine 2006 May;31(10):1156-62. https://doi.org/10.1097/01. brs.0000216441.83135.6f.

4. Dersh J, Mayer T, Theodore BR, Polatin P, Gatchel RJ. Do psychiatric disorders first appear preinjury or postinjury in chronic disabling occupational spinal disorders? Spine 2007 Apr;32(9):1045-51. https://doi.org/10.1097/01. brs.0000261027.28779.52.

5. Han C, Pae CU. Pain and depression: a neurobiological perspective of their relationship. Psychiatry Investig 2015 Jan;12(1):1-8. https://doi.org/10.4306/pi.2015.12.1.1.
6. Theunissen M, Peters ML, Bruce J, Gramke HF, Marcus MA. Preoperative anxiety and catastrophizing: a systematic review and meta-analysis of the association with chronic postsurgical pain. Clin J Pain 2012 Nov-Dec;28(9):819-41. https://doi.org/10.1097/AJP.0b013e31824549d6.
7. Slepian P, Bernier E, Scott W, Niederstrasser NG, Wideman T, Sullivan M. Changes in pain catastrophizing following physical therapy for musculoskeletal injury: the influence of depressive and post-traumatic stress symptoms. J Occup Rehabil 2014 Mar;24(1):22-31. https://doi.org/10.1007/ s10926-013-9432-2.
8. Sullivan MJ, Simmonds M, Velly A. Pain, depression, disability and rehabilitation outcomes. Revised version. Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST). 2011. Available from: https://www.irsst. qc.ca/media/documents/PubIRSST/R-675.pdf. [Accessed 7 Jun 2020].
9. Petrie KJ, Weinman J, Sharpe N, Buckley J. Role of patients' view of their illness in predicting RTW and functioning after myocardial infarction: longitudinal study. BMJ 1996 May;312(7040):1191-4. https://doi.org/10.1136/ bmj.312.7040.1191
10. Sullivan MJ, Scott W, Trost Z. Perceived injustice: a risk factor for problematic pain outcomes. Clin J Pain 2012 Jul;28(6):484-8. https://doi.org/10.1097/ AJP.0b013e3182527d13
11. Stuart H. Mental illness and employment discrimination. Curr Opin Psychiatry 2006 Sep;19(5):522-6. https://doi. org/10.1097/01.yco.0000238482.27270.5d.
12. Iles RA, Davidson M, Taylor NF. Psychosocial predictors of failure to RTW in non-chronic non-specific low back pain: a systematic review. Occup Environ Med 2008 Aug;65(8):507-17. https://doi.org/10.1136/ oem.2007.036046.
13. Shaw WS, Pransky G, Fitzgerald TE. Early prognosis for low back disability: intervention strategies for health care providers. Disabil Rehabil 2001 Dec;23(18):815-28. https:// doi.org/10.1080/09638280110066280.
14. Steenstra IA, Verbeek JH, Heymans MW, Bongers PM. Prognostic factors for duration of sick leave in patients sick listed with acute low back pain: a systematic review of the literature. Occup Environ Med 2005 Dec;62(12):851-60. https://doi.org/10.1136/oem.2004.015842.
15. Kuijer W, Groothoff JW, Brouwer S, Geertzen JH, Dijkstra PU. Prediction of sickness absence in patients with chronic low back pain: a systematic review. J Occup Rehabil 2006 Sep;16(3):439-67. https://doi.org/10.1007/s10926-0069021-8.
16. Kent PM, Keating JL. Can we predict poor recovery from recent-onset nonspecific low back pain? A systematic review. Man Ther 2008 Feb;13(1):12-28. https://doi. org/10.1016/j.math.2007.05.009.
17. Clay FJ, Newstead SV, McClure RJ. A systematic review of early prognostic factors for RTW following acute orthopaedic trauma. Injury 2010 Aug;41(8):787-803. https://doi.org/10.1016/j.injury.2010.04.005.
18. Carnide N, Franche RL, Hogg-Johnson S, Côté P, Breslin FC, Severin CN et al. Course of depressive symptoms following a workplace injury: a 12-month follow-up update. J Occup Rehabil 2016 Jun;26(2):204-15. https://doi. org/10.1007/s10926-015-9604-3.
19. Laisné F, Lecomte C, Corbière M. Biopsychosocial determinants of work outcomes of workers with occupational injuries receiving compensation: a prospective study. Work 2013;44(2):117-32. https://doi.org/10.3233/WOR-20121378.
20. Scott KM. Sex differences in the disability associated with mental disorders. Curr Opin Psychiatry 2011 Jul;24(4):3315. https://doi.org/10.1097/YCO.0b013e3283477ad5.
21. Moyser M, Burlock A. Time use: total work burden, unpaid work, and leisure. Statistics Canada. 2018. Available from: https://www150.statcan.gc.ca/n1/pub/89-503-x/2015001/ article/54931/c-g/c-g01-eng.htm. [Accessed 1 Aug 2019].
22. WorkSafeBC [creator] (2016). WorkSafeBC claims and firm level files. Population Data BC [publisher]. Data extract. WorkSafeBC (2016). Available from: http://www.popdata. bc.ca/data.
23. BC Ministry of Health [creator] (2017). PharmaNet. BC Ministry of Health [publisher]. Data extract. Data Stewardship Committee (2016). [Available from: http:// www.popdata.bc.ca/data].

24. BC Ministry of Health [creator] (2017). Medical services plan (MSP) payment information file. Population Data BC [publisher]. Data dxtract. MOH (2016). Available from http://www. popdata.bc.ca/data.
25. BC Ministry of Health [creator] (2017). Consolidation file (MSP registration &premium billing). Population Data BC [publisher]. Data extract. MOH (2016). Available from: http://www. popdata.bc.ca/data
26. Canadian Institute for Health Information [creator] (2017). Discharge abstract database (hospital separations). Population Data BC [publisher]. Data extract. MOH (2016). Available from: http://www.popdata.bc.ca/data.
27. Association of Workers' Compensation Boards of Canada. Detailed key statistical measures report 2009 to 2013 [database online]. 2018. Available from: http://awcbc. org/?page_id=9755. [Accessed 7 Jun 2020].
28. World Health Organization. International classification of diseases: [pth]f ninth revision, basic tabulation list with alphabetic index. 1978. Available from: https://apps.who. int/iris/handle/10665/39473. [Accessed 21 Mar 2020].
29. Katzman MA, Bleau P, Blier P, Chokka P, Kjernisted K, Van Ameringen M et al.; Canadian Anxiety Guidelines Initiative Group on behalf of the Anxiety Disorders Association of Canada/Association Canadienne des troubles anxieux and McGill University. Canadian clinical practice guidelines for the management of anxiety, posttraumatic stress and obsessive-compulsive disorders. BMC Psychiatry 2014;14 Suppl 1:S1. https://doi.org/10.1186/1471-244X-14-S1-S1.
30. Lam RW, McIntosh D, Wang J, Enns MW, Kolivakis T, Michalak EE et al.; CANMAT Depression Work Group. Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 clinical guidelines for the management of adults with major depressive disorder: section 1. Disease burden and principles of care. Can J Psychiatry 2016 Sep;61(9):510-23. https://doi. org/10.1177/0706743716659416.
31. World Health Organization. Anatomical Therapeutic Chemical (ATC) Classification. WHO Collaborating Centre for Drug Statistics Methodology. 2011. Available from: https://www.whocc.no/atc/structure_and_principles/. [Accessed 9 Jan 2018].
32. Cameron CM, Purdie DM, Kliewer EV, McClure RJ. Differences in prevalence of pre-existing morbidity between injured and non-injured populations. Bull World Health Organ 2005 May;83(5):345-52.
33. Cox DR. Regression models and life-tables. J R Stat Soc [Ser A] 1972;34(2):187-220. https://doi. org/10.1111/j.2517-6161.1972.tb00899.x.
34. Zhang X, Loberiza FR, Klein JP, Zhang MJ. A SAS macro for estimation of direct adjusted survival curves based on a stratified Cox regression model. Comput Methods Programs Biomed 2007 Nov;88(2):95-101. https://doi.org/10.1016/j. cmpb.2007.07.010.
35. Knol MJ, VanderWeele TJ. Recommendations for presenting analyses of effect modification and interaction. Int J Epidemiol 2012 Apr;41(2):514-20. https://doi. org/10.1093/ije/dyr218.
36. Li R, Chambless L. Test for additive interaction in proportional hazards models. Ann Epidemiol 2007 Mar;17(3):227-36. https://doi.org/10.1016/j.annepidem.2006.10.009.
37. Zieger M, Luppa M, Meisel HJ, Günther L, Winkler D, Toussaint R et al. The impact of psychiatric comorbidity on the RTW in patients undergoing herniated disc surgery. J Occup Rehabil 2011 Mar;21(1):54-65. https://doi. org/10.1007/s10926-010-9257-1.
38. Lavoie KL, Favreau H, Paine NJ, Lemiere C, Joseph M, Gagnon-Chauvin A et al. Prospective impact of psychiatric disorders on employment status and health care use in patients investigated for occupational asthma. J Occup Environ Med 2016 Dec;58(12):1196-201. https://doi. org/10.1097/JOM.0000000000000886.
39. Stein MB, Cox BJ, Afifi TO, Belik SL, Sareen J. Does comorbid depressive illness magnify the impact of chronic physical illness? A population-based perspective. Psychol Med 2006 May;36(5):587-96. https://doi.org/10.1017/ S0033291706007239.
40. Stein MB, Roy-Byrne PP, Craske MG, Bystritsky A, Sullivan G, Pyne JM et al. Functional impact and health utility of anxiety disorders in primary care outpatients. Med Care 2005 Dec;43(12):1164-70. https://doi.org/10.1097/01. mlr.0000185750.18119.fd.
41. Lim D, Sanderson K, Andrews G. Lost productivity among full-time workers with mental disorders. J Ment Health Policy Econ 2000 Sep;3(3):139-46. https://doi.org/10.1002/ mhp.93.

42. Jefferis BJ, Nazareth I, Marston L, Moreno-Kustner B, Bellón JÁ, Svab I et al. Associations between unemployment and major depressive disorder: evidence from an international, prospective study (the predict cohort). Soc Sci Med 2011 Dec;73(11):1627-34. https://doi. org/10.1016/j.socscimed.2011.09.029.
43. Waghorn G, Chant D, White P, Whiteford H. Disability, employment and work performance among people with ICD-10 anxiety disorders. Aust N Z J Psychiatry 2005 Jan-Feb;39(1-2):55-66. https://doi.org/10.1080/j.14401614.2005.01510.x.
44. American Psyhiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington, VA: American Psychiatric Publishing; 2013.
45. Dewa CS, Goering P, Lin E, Paterson M. Depressionrelated short-term disability in an employed population. J Occup Environ Med 2002 Jul;44(7):628-33. https://doi. org/10.1097/00043764-200207000-00007.
46. Maas ET, Koehoorn M, McLeod CB. Descriptive epidemiology of gradual RTW for workers with a workacquired musculoskeletal disorder in British Columbia, Canada. J Occup Environ Med 2020 Feb;62(2):113-23. https://doi.org/10.1097/JOM.0000000000001768.
47. Roberge P, Fournier L, Duhoux A, Nguyen CT, Smolders M. Mental health service use and treatment adequacy for anxiety disorders in Canada. Soc Psychiatry Psychiatr Epidemiol 2011 Apr;46(4):321-30. https://doi.org/10.1007/s00127-010-0186-2.
48. Gagné S, Vasiliadis HM, Préville M. Gender differences in general and specialty outpatient mental health service use for depression. BMC Psychiatry 2014 May;14(135). https:// doi.org/10.1186/1471-244X-14-135.
49. Smith KL, Matheson FI, Moineddin R, Dunn JR, Lu H, Cairney J et al. Gender differences in mental health service utilization among respondents reporting depression in a national health survey. Health (Irvine Calif) 2013;5(10):1561-71. https://doi.org/10.4236/ health.2013.510212.
50.O'Donnell S, Syoufi M, Jones W, Bennett K, Pelletier L. Use of medication and psychological counselling among Canadians with mood and/or anxiety disorders. Health Promot Chronic Dis Prev Can 2017 May;37(5):160-71. https://doi.org/10.24095/hpcdp.37.5.04.
Received for publication: 5 August 2021

DETAILS

Subject:	Mental depression; Gender; Mental disorders; Health hazards; Spine; Workers compensation; Statistical analysis; Disability management; Anxiety; Men; Confidence intervals; Health care; Workers' compensation; Disorders; Public health; Probability; Anxiety disorders; Mental health; Women; Statistical models; Cohort analysis
Business indexing term:	Subject: Workers compensation Disability management
Location:	Canada; British Columbia Canada
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	296-305
Publication year:	2021
Publication date:	2021

Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3951
ProQuest document ID:	2530521858
Document URL:	https://www.proquest.com/scholarly-journals/impact-anxiety-depression-disorders-on-sustained/docview/2530521858/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2023-04-27
Database:	Public Health Database

Document 8 of 9

Developing a cost-estimation model for work-related stress: An absence-based estimation using data from two Italian case studies

Russo, Simone, PhD [1] ; Ronchetti, Matteo, MSc [1] ; Di Tecco, Cristina, PhD [1] ; Valenti, Antonio, PhD [1] ; Jain, Aditya, PhD [2] ; Mennini, Francesco Saverio, PhD; Leka, Stavroula, PhD; Iavicoli, Sergio, MD, PhD [1] Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, Italian Workers' Compensation Authority (INAIL), Rome, Italy [2] Nottingham University Business School, Jubilee Campus, Nottingham, UK.

ProQuest document link

ABSTRACT (ENGLISH)

Objectives This paper discusses the development of a cost-estimation model for work-related stress based on psychosocial risk exposure and absence from work. It presents findings from its implementation and evaluation in two organizations in Italy, using national-level tools developed by the Italian Workers' Compensation Authority (INAIL). It also provides recommendations for the development of similar cost-calculation methods in other countries. Methods The cost-estimation model was based on the human capital approach using an indirect cost indicator: loss of productivity due to days of absence attributable to work-related stress. Furthermore, the population attributable fraction (PAF) epidemiological measure was used to calculate the impact of exposure to work-related stress on the basis of data collected through validated tools developed by INAIL and salary cost data. Results The developed model was implemented and evaluated in two organizations, the first in healthcare (N=1014) and the second in public administration (N=534). In the first case, it was found that absence related to work-related stress cost the organization €445 000. In the second case, the cost was €360 000. Conclusions The proposed model provides an example of how organizations can incorporate well-established indicators associated with work-related stress (eg, various types of absence, psychosocial risk perception, loss of productivity on the basis of salary costs) in a practical way in cost estimations of work-related stress. Such cost estimation can be applied in other countries and organizations to establish the economic and business case of managing work-related stress.

FULL TEXT

Headnote

Objectives This paper discusses the development of a cost-estimation model for work-related stress based on psychosocial risk exposure and absence from work. It presents findings from its implementation and evaluation in two organizations in Italy, using national-level tools developed by the Italian Workers' Compensation Authority (INAIL). It also provides recommendations for the development of similar cost-calculation methods in other countries.

Methods The cost-estimation model was based on the human capital approach using an indirect cost indicator: loss of productivity due to days of absence attributable to work-related stress. Furthermore, the population attributable fraction (PAF) epidemiological measure was used to calculate the impact of exposure to work-related stress on the basis of data collected through validated tools developed by INAIL and salary cost data.

Results The developed model was implemented and evaluated in two organizations, the first in healthcare (N=1014) and the second in public administration (N=534). In the first case, it was found that absence related to work-related stress cost the organization €445 000. In the second case, the cost was €360 000.

Conclusions The proposed model provides an example of how organizations can incorporate well-established indicators associated with work-related stress (eg, various types of absence, psychosocial risk perception, loss of productivity on the basis of salary costs) in a practical way in cost estimations of work-related stress. Such cost estimation can be applied in other countries and organizations to establish the economic and business case of managing work-related stress.

Key terms cost-benefit; cost-effectiveness; economic evaluation; mental health; occupational health; psychosocial risk.

(ProQuest: ... denotes formulae omitted.)

The rapid development and use of information technology, new types of work contracts and work processes, and changes in the workforce composition have brought about many changes in work organization over the last years. A consequence of these developments is an increased prevalence of psychosocial risks, leading to negative consequences on workers' health, such as work-related stress. Work-related stress has a recognized impact on workers' health and organizational productivity (1). Several studies have investigated the link between work-related stress and workers' ill health such as cardiovascular disease (2), musculoskeletal disorders (3), and mental ill health (4, 5).

A number of studies have attempted to calculate the economic burden of psychosocial risks and work-related stress on the basis of direct (healthcare and social security related), and indirect (productivity/loss of earnings related) costs (6-8), which highlight substantial costs for organizations and society as a whole. A World Bank and World Health Organization report estimated that the lost economic output caused by untreated mental disorders globally - as a result of diminished productivity at work, reduced rates of labor participation, and increased welfare payments - amounts to more than 10 billion days of lost work annually, the equivalent of US$1 trillion per year (9). In Europe, the total cost of mental health disorders is €240 billion/per year, of which €136 billion is the cost of reduced productivity including absenteeism and €104 billion is the cost of direct costs such as medical treatment (7). A systematic review of cost-of-illness studies estimated that the cost of work-related stress ranged from US$221 million to upward of US$187 billion across identified studies from different regions of the world; with the projected cost per working person ranging from US$17.79 to upward of US$1211.84. Around 70-90% of these costs were attributed to loss of productivity while 10-30% were attributed to medical treatments. The review also highlighted that the assessment of indirect costs (eg, absence from work, presenteeism, day loss due to staff turnover) is more effective in calculating the cost of work-related stress, irrespective of the estimation approach used (8).

There is evidence that organizations do not necessarily identify costs related to psychosocial risks, as only a relatively small percentage of employers indicate they manage issues such as work-related stress due to a decline in productivity or high absence rates (10, 11). As a result of this, systematic, continuous and strategically aligned psychosocial risk management is scarcely applied in organizations (12). Awareness of the cost of work-related stress can be raised by providing organizations with methodologies that enable them to estimate the cost of work-related stress at the organizational or departmental level. This would act as a driver for organizations to deal with work-related stress in a sustainable manner (7, 10). However, it has been highlighted that attention needs to be paid to how costs and outcomes are measured and valued. For both costs and health-related work productivity outcomes, the measurement tools used for data collection should be clearly reported and the tools valid (13). While some tools/methodologies to help employers establish the costs of poor employee health to their organization and create a business case for taking action have been developed (eg, 14, 15), few can help estimate the cost of work-related stress or exposure to psychosocial risks.

This paper discusses the development of an easy-touse cost-estimation model for work-related stress (the foundation of a costing tool) based on different types of absence from work and exposure to psychosocial risks. The findings of its implementation and evaluation in two organizations in Italy are also presented.

Studies evaluating the cost of psychosocial risks and work-related stress use two main approaches: a deductive or inductive approach. The deductive approach first calculates the total cost of ill health, and then a percentage estimate of the cases linked to the working activity is applied to obtain the total cost of work-related ill health (8). On the other hand, the inductive approach identifies the different implied costs before calculating and adding them to obtain the total cost of ill health and of work-related ill health in particular (8, 16). The inductive approach generally uses loss of productivity as an indirect cost of ill health and can be used at the national or organizational level to calculate the cost of work-related ill health more accurately (16).

The most commonly used approaches for estimating loss of productivity due to ill health are the friction cost approach (FCA) and the human capital approach (HCA) (17). While both often use the salary as a proxy for calculating productivity costs by multiplying the salary to the hours (or days) lost (18), there is a significant difference in how they estimate costs. FCA counts the number of hours not worked due to ill health until the organization replaces the absent worker, while HCA calculates the lost gross income during the time of absence from work until the worker returns to work or exits the workforce for retirement (19, 20). Accurate estimation of productivity costs remains a highly debated topic, and while estimates of economic burden of chronic conditions are generally much lower when FCA is used, HCA remains the predominant method used to estimate productivity costs (17).

Most studies on the cost of work-related stress have focused on costs associated with absenteeism, presenteeism and turnover (21, 22). While the interplay across such outcomes of exposure to work-related stress should be recognized, it is unlikely that organizations record all cost indicators identified in the literature, and it is therefore important to identify and use those cost indicators that are appropriate, and easy to calculate. Previous studies have suggested that costs associated with absence fulfil these objectives (16).

Absenteeism is the failure to report for work as scheduled, due to involuntary or voluntary factors (22). Organizations have a vested interest in reducing absenteeism since it represents a cost and is directly associated with loss of productivity. Using absence as a cost indicator is also a sensible choice due to its wide use and direct link to loss of earnings that allows good comparability in different contexts. Furthermore, information necessary for cost estimation is often readily available in organizations. This includes the number of working days lost and wage information according to employee position and tenure. In instances where such data is not available within organizations, it is still possible to calculate costs by using estimates of the average hourly wage according to collective labor agreements, broken down by gender, occupational position, age and other occupational characteristics. Therefore, taking into account the difficulty in identifying and/or quantifying different kinds of existing costs related to work-related stress (8, 16) and the need to select cost indicators that can be easily collected by organizations, this study focuses on absence from work as an indirect cost of exposure to psychosocial risk and work-related stress.

Method

Procedure and measures

Risk assessment for work-related stress has been a legal obligation in Italy since 2008. It should be noted here that legal requirements specify that employers should assess 'work-related stress risk' to refer to psychosocial risk (23). In line with this, we will use the terms 'work-related stress risk' and 'work-related stress risk assessment' in this paper to refer to psychosocial risk and psychosocial risk assessment.

According to national legal requirements, as a first step in the risk assessment process, organizations must consider objective indicators and data records (such as injuries, sick leave, turnover rate) as potential signs of the impact of work-related stress. In addition, they need to identify psychosocial hazards that might be negatively affecting specific work groups or the working population in the organization. Findings from this preliminary assessment lead to the implementation of preliminary measures to manage the emerging psychosocial risk areas. If these measures do not improve the situation sufficiently, organizations must proceed to conduct a further in-depth work-related stress risk assessment based on employee perceptions.

The main methodological approach used for the assessment and management of work-related stress risk in Italy is a methodology developed by the Italian Workers' Compensation Authority (24), which uses two main tools. First, a checklist is used for the preliminary assessment, which includes objective indicators associated with work-related stress as evidenced in the literature such as work-related injuries, sick leave absence, other absence from work, left over vacation days, turnover, legal action/disciplinary sanctions, formal records of employees' complaints to the company or to the company's occupational physician (25). This information is collected from organizational records by a Steering Group that includes the employer or his/her representative, a health and safety professional working for the organization, the occupational physician and the employee representatives. In addition, the second part of the checklist is used to identify work-related stress risks on the basis of group discussions with workers at unit level (referring to homogenous groups1 of workers), that have specific work-related risk factors and organizational aspects in common (23).

Second, for the in-depth assessment of work-related stress risk, a validated questionnaire, the Management Standards Indicator Tool (MS-IT), an adapted version of the UK tool, is used (26, 27). This tool enables organizations to assess employee perceptions of psychosocial risk factors and is in line with good practice recommended by the European Framework for Psychosocial Risk Management (PRIMA-EF) (28). This multi-layered method of data collection offers important opportunities for the identification of costs associated with workrelated stress since it drives organizations to collect data that can also be used for cost estimation purposes.

Development of the cost-estimation model

We developed a cost-estimation model of work-related stress based on one of the most widely used indirect cost indicators - loss of productivity due to days of absence attributable to work-related stress using the HCA. One of the main challenges with using an inductive approach such as HCA is related to the weight assigned to the different implied cost components in order to identify the real economic burden of ill health (29). In the case of work-related stress, it is difficult to estimate the extent to which the days lost due to sickness absence are directly due to work-related stress. Several studies report figures based on the calculation of an "attributable fraction", ie, the part of a negative outcome (for example sick leave) calculated as attributable to the exposure to psychosocial risk and work-related stress, which is a measure of context. This method allows obtaining the costs related to work-related stress from the total financial burden associated with that negative outcome (eg, sick leave) (6). In light of this and following Bejean &SultanTaieb's recommendations (6), the following formula was developed for calculating the cost estimation of work-related stress (Cost w.r.s.t):

...

where dti are the number of days of absence from work due to injuries, sickness, and other reasons such as extended leave for personal reasons and unauthorized absence in the year t for the homogenous group i. The cti is the average cost of a working day for the year t in the homogenous group i. The f is the average fraction or percentage attributable to work-related stress risk.

Days of absence from work. Days of absence from work was further sub-divided into:

1. Days of absence due to injury at work;
2. Days of absence due to sickness;
3. Days of absence due to other reasons, such as extended leave for personal reasons, unauthorized absence.

In the proposed formula, the days of absence are calculated at the homogenous group level. In order to assess the average cost of a working day (or the selected unit of time), it is possible to use different parameters. The best parameter identified is the worker's income per unit of time considered. However, in case such data is not available for each worker, it is possible to consider the average income by professional category within the company or at national level. Accordingly, since income per unit of time for the single workers was not available in the two case studies considered, we decided to apply to the workers the average salary relative to their professional categories that were identified by the two organizations. Then, the cost of total days of absence by homogenous group (A. cost1) was calculated by the following formula:

...

where wij is the number of workers with job j in the homogenous group i; wi is the number of workers in the homogenous group i; cwij is the estimated average cost of a working day for a worker with professional category j in the homogenous group i; ai is the total number of days of absence in the homogenous group i; ch' is the estimated average cost of a working day of the homogenous group i.

Work related stress attributable fraction. Absence from work has concurrent determinants, but, in this study, we were interested in calculating the potential impact of workrelated stress on the number of absence days from work for each homogenous group. According to the literature, this could be done using an attributable fraction, as an epidemiological measure generally used to calculate the contribution of a risk factor to a specific disease (30). The general formula used for calculating the population attributable fraction (PAF) (30) is reported as follows to show how we proceeded in adapting this to estimate the contribution of work-related stress to absence from work:

...

where Ip is the incidence in the population and Iu is the incidence in the unexposed population.

Starting from the general PAF formula, we proceeded in adapting this to develop a work-related stress attributable fraction formula (W.r.s.at.fract.1), by considering the incidence in the population as the number of days of absence (measured with the three indicators included in this study) for each homogenous group, and the work-related stress risk as the exposure factor:

...

where N' is the total number of absence days from work in the homogenous group i and NJ is the number of absence days from work for unexposed workers to work-related stress risk in the homogenous group i.

To apply the work-related stress attributable fraction formula to our data, we also needed to calculate the number of unexposed workers to work-related stress risk. To this aim, we used the scores obtained from workers by filling in the MS-IT, a work-related stress questionnaire of 35 items that measure seven psychosocial hazard dimensions (demands, control, management support, colleague support, role, relationships and change). Higher scores obtained by the questionnaire generally reflect better working conditions (ie, a more positive psychosocial work environment). In order to identify those workers that can be considered unexposed to the work-related stress risk, threshold values need to be considered and these are provided through the questionnaire for each of the seven dimensions, based on a large normative national sample. In our study, it was necessary to calculate a unique score for our estimation model as a general measure of work-related stress risk. Thus, we used national data from INAIL's web platform consisting of 66 118 questionnaires collected from different organizational settings and uploaded at the time of the study. Using a distributive criterion, we defined four risk groups (high <20%, medium-high <50%, mediumlow >50%, low >80% risk) measuring the threshold values and related quartiles from the general distribution of INAIL's national database. Those with higher scores than the ones observed in the first quartile were classified as unexposed workers to work-related stress risk, and accordingly those with lower scores were classified as exposed workers. Thus, we applied the threshold values calculated on the national dataset to our study to identify the unexposed workers in each homogenous group based on their scores on the MS-IT. Then, we verified the frequency of absence days from work of unexposed workers (NJ) with respect to the total number of absence days from work in the homogenous group (N). Finally, we applied the work-related stress attributable fraction formula (W.r.s. at.fractJ (PAF')), by subtracting the number of absence days from work reported by unexposed workers in a specific homogenous group (NJ) from the total number of absence days from work in the same homogenous group (N). In this way, we obtained a weighted measure of the impact of work-related stress risk on the number of days of absence from work for each homogenous group (i), namely the work-related stress risk attributable fraction (PAF').

The case studies

Two case studies were selected among the organizations using the INAIL methodology to test the proposed costestimation model of work-related stress risk. The selection criteria of the case studies were: (i) the availability of data through the application of both phases of INAIL's methodology (the checklist and the MS-IT); and (ii) being an organization in two high risk sectors for work-related stress in Italy: healthcare and public administration (31).

The first case study was a public hospital where data was collected on 14 homogenous groups of healthcare workers (N=1014). The second case study was a public administration department, where data was collected on 6 homogenous groups of workers (N=534). Objective indicators of days of absence from work were extracted in both of these organizations for each homogenous group using data records that were obtained through the use of the checklist for the preliminary assessment of work-related stress risk. All the workers belonging to the homogenous groups were also included in the in-depth assessment conducted through the use of the MS-IT. Responses were matched to the respective homogenous group, which enabled the identification of the number of exposed/unexposed workers to work-related stress risk for each homogenous group by applying the cut-off score extracted by the national sample.

Results

Case study 1

In the first case study, 14 homogenous groups of healthcare workers from a public hospital were included where preliminary and in-depth work-related stress risk assessments were conducted using the INAIL methodology in 2018. To estimate the cost associated with absence for each homogenous group, we were able to link absence to the job positions of workers in collaboration with the organization and calculated the average cost of a working day per position using data published on the hospital website (table 1). The average annual cost per single worker is the total yearly average cost per type of occupational position divided by the number of workers. The monthly average cost is the annual average cost per single worker divided by 142. Finally, the monthly average cost of a worker divided by the average number of working days in a month (working days in a year/months of a year) estimates the average cost of a working day per single worker (cti).

To provide an in-depth explanation of how costs were estimated for each group, table 2 presents an example of one homogenous group (Reconstructive plastic surgery). In this example, the number of workers per type of job position, the related percentage and the average cost of a working day are reported. The average cost of a working day in this group was calculated using the formula for calculating the average cost of total days of absence by homogenous group (€183). Then, the cost associated with work-related stress risk (Cost w.r.s.); €177 538) was calculated by applying the specific attributable fraction of the group (f; 64.8%) to the total cost of absence (€259 559). This cost was obtained from the product between the total number of absences (dti 1417) and the average cost of a working day (cț).

The calculation was applied to all the homogenous groups included in this study, as presented in table 3.

Overall, an estimated 10 000 days of absence were calculated, costing the organization about €1.8 million. Absence related to work-related stress risk cost the organization about €445 000 (24% of the absence cost). The weighted average (taking into account the different number of questionnaires per group) was found to be about €41 780, with a standard deviation of €33 900. Three homogenous groups (Insurance and Litigation and Deliberative Acts, Reconstructive Plastic Surgery, Hematology) reported an attributable fraction higher than 35%, while five groups reported an estimated attributable fraction of 30-35%, and six groups an estimated fraction value <20%. The Reconstructive Plastic Surgery group reported the highest cost (€123 000) due to workrelated stress risk, with an attributable fraction equal to 24.1% and 10 224 absences totally, corresponding to 1.6 times the estimate of the second group with the highest costs (Anatomy and Histopathology and Cytodiagnostics, with an estimated cost of about €74 000). Fifty-five percent of the total estimated cost associated with work-related stress risk corresponds to the first three homogenous groups (33% of the total questionnaires considered).

Case study 2

The second case study was carried out in a public administration unit and included six homogenous groups. The same data records related to absence from work (absence due to injuries, sick leave, and other absence from work) were taken into account (dt), to estimate the average cost linked to work-related stress risk for the groups considered (Cost w.rs.t). Data was extracted for each homogenous group from the preliminary and in-depth workrelated stress risk assessments. As in the first case study presented, we calculated the attributable fraction of the cost indicators for each homogenous group (f) using the cut-off identified in the national dataset of workers that responded to the MS-IT. Then, the formula for calculating the PAF for each group was applied. In line with case study 1, only those homogenous groups with a workers' response rate to MS-IT >75% were included.

However, in contrast to the previous case study, we could use the monthly salaries as the basis for estimating the average cost of a working day (c)). Findings reported in table 4 indicate that the estimated average value of the attributable fraction is far from the value observed in the previous case study (25.1%). Furthermore, the second case study reports lower internal variance (standard deviation of 6.5%) compared to the first case study (standard deviation of 17.1%). The six homogenous groups reported 26 564 absences (60% for sick leave), leading to a total cost of about €2 million; 16.2% of this (€360 000) was estimated to be the cost of absence generated by workers exposed to work-related stress risk, while the weighted average per homogenous group was about €220 400 (standard deviation of €151 100).

Discussion

Even though there are studies providing national and supranational estimations of the cost of work-related stress and psychosocial risks (8), there are a lack of tools and models that allow organizations to evaluate their economic burden in their own context. Current cost of illness studies on work-related stress and psychosocial risks use various methods to calculate costs and show limitations in terms of the high number of variables considered, costs that are hard to calculate, and lack of availability of information (13, 18).

In developing our cost-estimation model, we used the HCA (19, 20) and focused on an indirect cost of work-related stress, namely loss of productivity associated with absence from work. As seen in both case studies used in this research, absence data were easy to obtain and it was possible to aggregate them at the unit level (homogenous group). Moreover, absence from work data can easily be linked to an economic value by using the salary as a proxy of productivity (8).

Even though sickness absence emerged as the most commonly used indirect cost indicator in the literature, we also included different types of absence in our costestimation model to enable organizations to account for all costs associated with loss of productivity due to absenteeism. However, to account for uncertainty in relation to the absence from work that is related to work-related stress, we estimated the level of absence that might be attributable to work-related stress risk by developing an attributable fraction of each absence indicator to the specific exposure factor, using the MS-IT scores). This questionnaire is included in the INAIL methodology (24), which is the most widely used methodology in Italy for meeting legal requirements for assessing work-related stress risk. In other national/ regional contexts, other instruments, where available, can also be used to identify the attributable fraction by using the method discussed in this paper, as long as they cover the required parameters in the proposed model. It is, therefore, recommended that further research evaluates the model in low risk sectors and in other countries where it is possible to use similar tools and parameters. Furthermore, our study did not consider other aspects associated with loss of productivity such as turnover and presenteeism. Such measures could be included in cost-estimation models where available to improve their accuracy. On the other hand, even though the HPA approach used in this study is the predominant method used to estimate productivity costs, it is important to acknowledge that other methods, such as FCA, generally produce much lower estimates of economic burden of chronic conditions (17). Other issues to be considered in future research are the time frames used in cost estimates at national level such as adjusting for timing and uncertainty (eg, 32).

The introduction of new regulation on work-related stress risk assessment in Italy and the development of practical work-related stress risk assessment tools have had a positive impact both in terms of awareness and practice in Italian organizations (33). The INAIL methodology has been made publicly available to Italian organizations and the collection of data at national level through the INAIL platform allows the development of national benchmarks by using cut-off points and applying appropriate weighting (as described in this paper). The developed cost-estimation model is an additional tool publicly available to Italian organizations aiming to further engage them in implementing good practice.

Similar policy contexts to Italy are also found in several countries around the world, particularly in Europe (eg, Belgium, Czech Republic, Germany, the Netherlands, the UK) and other regions (e.g. Australia, Chile, Canada, and Mexico) (1). The cost model developed in this paper can inform the development of similar national benchmarking systems and costing models in countries where policies exist or where national level tools are available. For instance, in the US, a tool will soon be launched by NIOSH in relation to their total worker health (TWH) programme (34). The proposed cost-estimation model could be used to calculate the cost of work-related stress in organizations in conjunction with TWH national level data. While it is acknowledged that the development of such tools requires both strong commitment and investment of resources at country or sectoral level, it is possible to learn from good practice examples that are now available and adapt existing models in new national contexts (35).

Indeed, there is a need to develop further tools based on this method to improve awareness of the cost of work-related stress among employers since the business case and especially the cost of absence have consistently been identified in the literature as key drivers that engage organizations in psychosocial risk management (eg, 12, 13). Such cost estimation tools will supplement other economic evaluation approaches (ie, cost-benefit analysis, cost-effectiveness analysis or cost-utility analysis), which are already used at the organizational level to evaluate the return-on-investment of interventions (13, 36), and provide a direct assessment of their impact on the bottom line (37). The proposed model will also help answer calls for economic evaluation of interventions based on established guidelines and validated consistent measures of productivity costs as the main cost driver (38).

Concluding remarks

This paper offers a cost-estimation model for workrelated stress based on absence and psychosocial risk exposure. The proposed model provides an example of how well-established indicators associated with workrelated stress (eg, various types of absence, psychosocial risk perception, loss of productivity on the basis of salary costs) can be incorporated in a practical way in cost estimations of work-related stress by organizations. A key driver for the protection and promotion of health and well-being at work is the business case which focuses on the notion of financial costs, as well as benefits for organizations. Since all organizations require workers in order to achieve their goals, there is a strong business case to be made for ensuring that workers are mentally healthy through occupational health and safety management (37). The cost-estimation model proposed in this paper provides the starting point for developing such a business case. However, it can also be useful towards developing a more holistic 'value case' that also accounts for intangible business benefits associated with mental health and well-being at work (39). The 'value case' can help organizations internalize the value of addressing issues such as psychosocial risks and work-related stress and incorporate them in all organizational strategies, systems, and behaviors, therefore moving towards sustainable good practice. The need for a holistic approach is particularly important as not only financial reasons, but also legal and moral reasons drive organizations to manage psychosocial risks and promote health and well-being at work (40). The cost-estimation model proposed in this paper provides the starting point for developing such a value case and sustainable good practice.

Conflict of interest

The authors declare no conflicts of interest.

Sidebar

Russo S, Ronchetti M, Di Tecco C, Valenti A, Jain A, Mennini FS, Leka S, Iavicoli S. Developing a cost-estimation model for work-related stress: An absence-based estimation using data from two Italian case studies. Scand J Work Environ Health. 2021;47(4):318-327. doi:10.5271/sjweh.3948

Correspondence to: Stavroula Leka, Department of Management and Marketing, Cork University Business School, University College Cork, Cork T12 K8AF, Ireland. [E-mail: stavroula.leka@ucc.ie]

Received for publication: 13 April 2020

Footnote

1 The focus of the assessment are the homogenous groups, namely groups of workers sharing common features related to both the job and the context (in terms of job design, goals, procedures, management and communication styles, resources, relationships, and support from colleagues and direct supervisors) that are the potentiala sources of stress.

2 în Italy 14 months per year are paid for each worker.

References

References

1. International Labour Organization. Workplace stress: A collective challenge. Geneva: International Labour Organization; 2016.

2. Kivimäki M, Kawachi I. Work stress as a risk factor for cardiovascular disease. Curr Cardiol Rep 2015 Sep;17(9):630. https://doi.org/10.m07/s11886-015-0630-8.

3. Kraatz S, Lang J, Kraus T, Münster E, Ochsmann E. The incremental effect of psychosocial workplace factors on the development of neck and shoulder disorders: a systematic review of longitudinal studies. Int Arch Occup Environ Health 2013 May;86(4):375-95. https://doi.org/10.1007/ s00420-013-0848-y.

4. Bonde JP. Psychosocial factors at work and risk of depression: a systematic review of the epidemiological evidence. Occup Environ Med 2008 Jul;65(7):438-45. https://doi.org/10.1136/oem.2007.038430.

5. Madsen IE, Nyberg ST, Magnusson Hanson LL, Ferrie JE, Ahola K, Alfredsson L et al.; IPD-Work Consortium. Job strain as a risk factor for clinical depression: systematic review and meta-analysis with additional individual participant data. Psychol Med 2017 Jun;47(8):1342-56. https://doi.org/10.1017/S003329171600355X.

6. Béjean S, Sultan-Tai'eb H. Modeling the economic burden of diseases imputable to stress at work. Eur J Health Econ 2005 Mar;6(1):16-23. https://doi.org/10.1007/s10198-0040251-4.

7. European Agency for Safety and Health at Work. Calculating the cost of work-related stress and psychosocial risks. Luxembourg: Publications Office of the European Union; 2014.

8. Hassard J, Teoh KR, Visockaite G, Dewe P, Cox T. The cost of work-related stress to society: A systematic review. J Occup Health Psychol 2018 Jan;23(1):1-17. https://doi. org/10.1037/ocp0000069.

9. Mnookin S; World Bank Group, World Health Organization. Out of the shadows: Making mental health a global development priority. Background paper [cited 2020 Apr 6]. Available from: https://www.who.int/mental_health/

advocacy/wb_background_paper.pdf.
10. European Agency for Safety and Health at Work. European Survey of Enterprises on New and Emerging Risks: Managing safety and health at work. European Risk Observatory Report. Luxembourg: Publications Office of the European Union; 2010.
11. European Agency for Safety and Health at Work. Second European Survey of Enterprises on New and Emerging Risks (ESENER-2). Overview Report: Managing Safety and Health at Work. European Risk Observatory Report. Luxembourg: Publications Office of the European Union; 2016.
12. Köper B, Möller K, Zwetsloot G. The occupational safety and health scorecard-a business case example for strategic management. Scand J Work Environ Health 2009 Dec;35(6):413-20. https://doi.org/10.5271/sjweh.1361.
13. Uegaki K, de Bruijne MC, Lambeek L, Anema JR, van der Beek AJ, van Mechelen W et al. Economic evaluations of occupational health interventions from a corporate perspective - a systematic review of methodological quality. Scand J Work Environ Health 2010 Jun;36(4):273-88. https://doi.org/10.5271/sjweh.3017.
14. Department for Work and Pensions [Internet]. Workplace Wellbeing Tool [cited 2020 Apr 6]. Available from: https://www.gov.uk/government/publications/workplacewellbeing-tool
15. World Health Organization. WHO guide to identifying the economic consequences of disease and injury. Geneva: World Health Organization; 2009.
16. European Agency for Safety and Health at Work. Estimating the costs of work-related accidents and illhealth: An analysis of European data sources. Luxembourg: Publications Office of the European Union; 2017.
17. Pike J, Grosse SD. Friction Cost Estimates of Productivity Costs in Cost-of-Illness Studies in Comparison with Human Capital Estimates: A Review. Appl Health Econ Health Policy 2018 Dec;16(6):765-78. https://doi.org/10.1007/ s40258-018-0416-4.
18. Kankaanpää E, Tulder MV, Aaltonen M, Greef MD. Economics for occupational safety and health. Scand J Work Environ Health Suppl. 2008 Jan;34(5):9-13.
19. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. 4th ed. Oxford (United Kingdom): Oxford University Press; 2015.
20. van den Hout WB. The value of productivity: human-capital versus friction-cost method. Ann Rheum Dis 2010 Jan;69 Suppl 1:i89-91. https://doi.org/10.1136/ard.2009.117150.
21. Cooper C, Dewe P. Well-being-absenteeism, presenteeism, costs and challenges. Occup Med (Lond) 2008 Dec;58(8):522-4. https://doi.org/10.1093/occmed/kqn124.
22. Johns G. Attendance dynamics at work: the antecedents and correlates of presenteeism, absenteeism, and productivity loss. J Occup Health Psychol 2011 Oct;16(4):483-500. https://doi.org/10.1037/a0025153.
23. Persechino B, Valenti A, Ronchetti M, Rondinone BM, Di Tecco C, Vitali S et al. Work-related stress risk assessment in Italy: a methodological proposal adapted to regulatory guidelines. Saf Health Work 2013 Jun;4(2):95-9. https://doi. org/10.1016/j.shaw.2013.05.002.
24. INAIL. The methodology for the assessment and management of work-related stress risk. Handbook for companies, in compliance with Legislative. Decree 81/2008 and subsequent integrations and modifications. Milan, Italy: Tipolitografia INAIL; 2018.
25. Barbaranelli C, Ghezzi V, Di Tecco C, Ronchetti M, Fida R, Ghelli M et al. Assessing Objective and Verifiable Indicators Associated With Work-Related Stress: Validation of a Structured Checklist for the Assessment and Management of Work-Related Stress. Front Psychol 2018 Dec;9:2424. https://doi.org/10.3389/fpsyg.2018.02424.
26. Ronchetti M, Di Tecco C, Russo S, Castaldi T, Vitali S, Autieri S et al. An integrated approach to the assessment of work-related stress risk: comparison of findings from two tools in an Italian methodology. Saf Sci 2015 Dec;80:310-6. https://doi.org/10.1016/j.ssci.2015.08.005.
27. Wood S, Ghezzi V, Barbaranelli C, Di Tecco C, Fida R, Farnese ML et al. Assessing the Risk of Stress in Organizations: Getting the Measure of Organizational-Level Stressors. Front Psychol 2019 Dec;10:2776. https://doi. org/10.3389/fpsyg.2019.02776.
28. World Health Organization. PRIMA-EF: Guidance on the European framework for psychosocial risk

management: A resource for employers and worker representatives. Geneva: World Health Organization; 2008.
29. Larg A, Moss JR. Cost-of-illness studies: a guide to critical evaluation. Pharmacoeconomics 2011 Aug;29(8):653-71. https://doi.org/10.2165/11588380-000000000-00000.
30. Mansournia MA, Altman DG. Population attributable fraction. BMJ 2018 Feb;360:k757. https://doi.org/10.1136/bmj.k757.
31. INAIL. Indagine nazionale sulla salute e sicurezza sul lavoro, lavoratori e datori di lavoro. Milan, Italy: Tipolitografia INAIL; 2014.
32. World Health Organization. Methodological approaches for cost-effectiveness and cost-utility analysis of injury prevention measures. Copenhagen: World Health Organization; 2011.
33. Di Tecco C, Jain A, Valenti A, Iavicoli S, Leka S. An evaluation of the impact of a policy-level intervention to address psychosocial risks on organisational action in Italy. Saf Sci 2017 Dec;100(1):103-9. https://doi.org/10.1016/j.ssci.2017.05.015.
34. Chari R, Chang CC, Sauter SL, Petrun Sayers EL, Cerully JL, Schulte P et al. Expanding the Paradigm of Occupational Safety and Health: A New Framework for Worker WellBeing. J Occup Environ Med 2018 Jul;60(7):589-93. https://doi.org/10.1097/JOM.0000000000001330.
35. Iavicoli S, Leka S, Jain A, Persechino B, Rondinone BM, Ronchetti M et al. Hard and soft law approaches to addressing psychosocial risks in Europe: lessons learned in the development of the Italian approach. J Risk Res 2014 Aug;17(7):855-69. https://doi.org/10.1080/13669877.2013 .822911.
36. Tompa E, Verbeek J, van Tulder M, de Boer A. Developing guidelines for good practice in the economic evaluation of occupational safety and health interventions. Scand J Work Environ Health 2010 Jun;36(4):313-8. https://doi. org/10.5271/sjweh.3009.
37. Verbeek J, Pulliainen M, Kankaanpää E. A systematic review of occupational safety and health business cases. Scand J Work Environ Health 2009 Dec;35(6):403-12. https://doi.org/10.5271/sjweh.1355.
38. Lutz N, Clarys P, Koenig I, Deliens T, Taeymans J, Verhaeghe N. Health economic evaluations of interventions to increase physical activity and decrease sedentary behavior at the workplace: a systematic review. Scand J Work Environ Health 2020 Mar;46(2):127-42. https://doi. org/10.5271/sjweh.3871.
39. Van Scheppingen A, Baken N, Zwetsloot G, Bos E, Berkers F. A value case methodology to enable a transition towards generative health management. J Hum Resour Cost Account. 2012 Oct;16(4):302-19. https://doi. org/10.1108/14013381211317266.
40. Jain A, Leka S, Zwetsloot G. Managing health, safety and wellbeing: Ethics, responsibility and sustainability. Dordrecht (Netherlands): Springer; 2018.

DETAILS

Subject:	Occupational stress; Epidemiology; Human capital; Organizations; Mental disorders; Productivity; Absenteeism; Employers; Exposure; Evaluation; Wages &salaries; Risk assessment; Workers; Public administration; Labor contracts; Costs; Workers' compensation; Risk perception; Tools; Occupational health; Mental health; Social interactions; Stress
Business indexing term:	Subject: Occupational stress Productivity Absenteeism Employers Wages &salaries Risk assessment Workers Labor contracts Costs Human capital
Location:	Italy; United States--US
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm

Volume:	47
Issue:	4
Pages:	318-327
Publication year:	2021
Publication date:	2021
Section:	Discussion paper
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Journal Article
DOI:	https://doi.org/10.5271/sjweh.3948
ProQuest document ID:	2530521279
Document URL:	https://www.proquest.com/scholarly-journals/developing-cost-estimation-model-work-related/docview/2530521279/se-2?accountid=211160
Copyright:	Copyright Scandinavian Journal of Work, Environment &Health 2021
Last updated:	2022-04-29
Database:	Public Health Database

Document 9 of 9

Effects of an active break and postural shift intervention on preventing neck and low-back pain among high-risk office workers: a 3-arm cluster-

randomized controlled trial

Waongenngarm, Pooriput, MSc [1] ; van der Beek, Allard J, PhD [2] ; Akkarakittichoke, Nipaporn, BSc [1] ; Janwantanakul, Prawit, PhD [1] [1] Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, Thailand [2] Amsterdam UMC, Vrije Universiteit Amsterdam, Department of Public and Occupational Health, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands

ProQuest document link

ABSTRACT (ENGLISH)

Objective This study evaluated the effects of the promotion of active breaks and postural shifts on new onset of neck and low-back pain during a 6-month follow-up among high-risk office workers. Methods A 3-arm cluster-randomized controlled trial with 6-month follow-up was conducted among healthy but high-risk office workers. Participants were recruited from six organizations in Bangkok, Thailand (N=193) and randomly assigned at cluster level into active break intervention (N=47), postural shift intervention (N=46), and control (N=100) groups. Participants in the intervention groups received a custom-designed apparatus to facilitate designated active breaks and postural shifts during work. Participants in the control group received a placebo seat pad. The primary outcome measure was new onset of neck and low-back pain during 6-month follow-up. Analyses were performed using Cox proportional hazard models. Results One-hundred and eighty-six (96%) predominantly female participants were successfully followed up over six months. New onset of neck pain during the 6-month follow-up occurred in 17%, 17%, and 44% of the participants in the active break, postural shift, and control groups, respectively. For new onset of low-back pain, these percentages were 9%, 7%, and 33%, respectively. Hazard rate (HR) ratios after adjusting for biopsychosocial factors indicated a protective effect of the active break and postural shift interventions for neck pain [HR_{adj} 0.45, 95% confidence interval (CI) 0.20-0.98 for active break and HR_{adj} 0.41, 95% CI 0.18-0.94 for postural shift] and low-back pain (HR_{adj} 0.34, 95% CI 0.12-0.98 for active break and HR_{adj} 0.19, 95% CI 0.06-0.66 for postural shift). Conclusion Interventions to increase either active breaks or postural shifts reduced new onset of neck and lowback pain among high-risk office workers.

FULL TEXT

Headnote

Objective This study evaluated the effects of the promotion of active breaks and postural shifts on new onset of neck and low-back pain during a 6-month follow-up among high-risk office workers.

Methods A 3-arm cluster-randomized controlled trial with 6-month follow-up was conducted among healthy but high-risk office workers. Participants were recruited from six organizations in Bangkok, Thailand (N=193) and randomly assigned at cluster level into active break intervention (N=47), postural shift intervention (N=46), and control (N=100) groups. Participants in the intervention groups received a custom-designed apparatus to facilitate designated active breaks and postural shifts during work. Participants in the control group received a placebo seat pad. The primary outcome measure was new onset of neck and low-back pain during 6-month follow-up. Analyses were performed using Cox proportional hazard models.

Results One-hundred and eighty-six (96%) predominantly female participants were successfully followed up over six months. New onset of neck pain during the 6-month follow-up occurred in 17%, 17%, and 44% of the participants in the active break, postural shift, and control groups, respectively. For new onset of low-back pain, these percentages were 9%, 7%, and 33%, respectively. Hazard rate (HR) ratios after adjusting for biopsychosocial factors indicated a protective effect of the active break and postural shift interventions for neck pain [HR_{adj} 0.45, 95% confidence interval (CI) 0.20-0.98 for active break and HR_{adj} 0.41, 95% CI 0.18-0.94 for postural shift] and low-back pain (HR_{adj}

0.34, 95% CI 0.12-0.98 for active break and HR_{adj} 0.19, 95% CI 0.06-0.66 for postural shift).

Conclusion Interventions to increase either active breaks or postural shifts reduced new onset of neck and lowback pain among high-risk office workers.

Key terms computer; musculoskeletal disorder; posture; RCT; sedentary worker.

Neck and low-back pain are major health problems for office workers. Neck pain is prevalent among office workers. For example, 46% of office workers in Iran reported neck pain in the past year (1) and 31% of office workers in Thailand developed a new episode of neck pain in the previous year (2). Low-back pain affected 51% of office workers in Nigeria annually (3), while 14% of office workers in Thailand reported new onset of low-back pain in the past year (4). Neck and low-back pain are often the cause of significant physical and psychological health impairments, which affect work performance and social responsibilities (5, 6). Consequently, neck low-back pain constitute a great socioeconomic burden on both individuals and society as a whole (6, 7).

Office work mainly involves computer use, participation in meetings, reading, and phoning. A typical workday for many office workers is characterized by desk-based work, which entails several hours of sitting. Individuals with prolonged sitting have been found to experience increased musculoskeletal discomfort over time, particularly in the neck and low back (8, 9). Evidence suggests that signs of bodily perceived discomfort, such as tension, fatigue, soreness, or tremors, are predictors of musculoskeletal disorders (10).

A number of interventions have been proposed to alleviate the adverse effects of prolonged sitting, including breaks (11-13), postural shifts (14, 15), and ergonomic intervention (16). A recent systematic review showed a positive effect of rest breaks with postural change or active breaks on pain and discomfort (11). Postural shifts while sitting, defined as body movements causing significant changes in the load on the left and right ischial tuberosities for the sagittal and frontal planes (15), are regarded as a natural coping response to diminish the perception of discomfort and relieve the perceived pressure of compressed body parts (17). Previous research has found similar trends linking increased motion with decreased discomfort in the low back during prolonged sitting (18, 19). Thus, promotion of rest breaks and postural shifts during sitting may be an effective intervention in the reduction of neck and low-back pain.

To the best of our knowledge, there has been no randomized trial investigating the efficacy of rest break and postural shift interventions in the prevention of neck and low-back pain among office workers. Therefore, the aim of this study was to evaluate the effect of the promotion of rest breaks and postural shifts on new onset of neck and low-back pain during 6-month follow-up among high-risk office workers. We hypothesized that participants in the intervention groups, with increases in either rest breaks or postural shifts, show reduced new onset of neck and low-back pain.

Methods

Participants

A 3-arm, parallel-group, cluster-randomized controlled trial with 6-month follow-up was conducted in a convenience sample of office workers recruited from six organizations in Bangkok, Thailand. The organizations participating in this study were the government excise, public relations, and public transportation departments, the Metropolitan Waterworks Authority, and two private companies importing medical equipment and products (such as drugs and diagnostic reagents). Individuals were included in the study if they: were aged 23-55 years, worked full-time, had a body mass index (BMI) of 18.5-25 kg/m2, had >5 years of experience in their current position, and were at risk of non-specific neck pain as evaluated by the Neck Pain Risk Score for Office Workers (NROW; score >2) (20) and non-specific lowback pain as evaluated by Back Pain Risk Score for Office Workers (BROW; score >53) (21). Participants were excluded if they had reported musculoskeletal symptoms in the neck or low back in the previous six months, reported pregnancy or had planned to become pregnant in the coming 12 months, had a history of trauma or accidents in the spinal region, or had either spinal, intra-abdominal or femoral surgery in the previous 12 months. Participants who had been diagnosed with congenital anomaly of the spine, rheumatoid arthritis, infections of the spine or discs, ankylosing spondylitis, spondylolisthesis, spondylosis, spinal tumor, systemic lupus erythymatosus, or osteoporosis were also excluded from the study.

Office workers were invited to participate in this study and those who expressed interest completed a short screening questionnaire, assessing aforementioned inclusion and exclusion criteria using the NROW and BROW. The NROW comprises three questions concerning lifetime history of neck pain, chair adjustability, and perceived muscular tension. The NROW has scores of 0-4. A cut-off score of >2 had a sensitivity of 82% and specificity of 48%. The positive and negative predictive values were 29% and 91%, respectively. The BROW consists of two questions concerning lifetime history of low-back pain and psychological demands. The BROW has scores of 12-69. With a cut-off score of 53, the sensitivity was 65% and the specificity was 68%. The positive and negative predictive values were 16% and 95%, respectively. If eligible, potential participants were informed about the objectives and details of the study and asked to provide informed consent to participate in the research.

At baseline, participants completed the self-administered questionnaire for exposure data, ie, confounders. Participants were assigned at cluster level into either the intervention A (active break), intervention B (postural shift), or control groups by a simple randomization method. A researcher with no other involvement in the trial prepared the designation of intervention by using computer-generated randomization. Both data collectors and the analyst were not involved in the group assignment process. Clusters of participants were located in the same workplace to avoid contamination of the intervention and enhance compliance within the intervention group (22). A total of six clusters (two clusters for the intervention group A, two clusters for the intervention group B, and two clusters for the control group) were identified and cluster size range was 15-51 participants. Participants then received a selfadministered diary to record any new onset of neck or low-back pain and, if occurring, its intensity and any resulting disability. The researcher collected the diaries from participants every month over a 6-month period. The University Human Ethics Committee approved the study, which was registered in the Thai Clinical Trials Registry (TCTR20190111002). No changes had been made to the methods after trial commencement until March 2020, when the COVID-19 outbreak occurred in Thailand. At the time, a majority of the participants (68%) in this study were forced to work from home and did not bring the custom-designed apparatus home. Furthermore, a previous study reported no relationship between the prevalence of neck and low-back symptoms and the seasons (23).

Baseline questionnaires

The Borg CR-10 scale was used to determine perceived discomfort (24). Participants were asked to indicate how much discomfort was felt in the past year in the neck and low back (on a 0-10 scale; 0 denotes no discomfort and 10 denotes extreme discomfort). Neck and low-back regions were defined according to a chart based on the modified Nordic questionnaire (25). In addition, the following biopsychosocial characteristics were obtained: individual, work-related (physical) factors and psychosocial work characteristics. Individual factors included gender, age, education level, frequency of regular exercise or sport, and smoking habits. Workrelated (physical) factors included current job position, number of working hours, years of work experience, frequency of using a computer, adopting working postures, performing various work activities, and rest breaks. The questionnaire also asked respondents to self-rate (yes or no) the ergonomics of their workstations (whether the desk height was suitable for them, they used a heightadjustable chair, and the top of the computer screen was positioned at a level horizontal with their eyes) and work environment conditions (the appropriateness of ambient temperature, noise level, light intensity, and air circulation). Psychosocial work characteristics were measured using the Thai version of the Job Content Questionnaire (26). The questionnaire comprises 54 items in the following six areas: psychological demands (12 items), decision latitude (11 items), social support (8 items), physical demands (6 items), job security (5 items), and hazards at work (12 items). Each item has four Likerttype response options ranging from 1: strongly disagree, to 4: strongly agree, that were summarized to obtain a sum score per area.

Description of intervention

Participants in the intervention A (active break) and intervention B (postural shift) groups received a customdesigned apparatus, which consisted of three components: (i) a seat pad (width x length x height = 40 cm x 50 cm x i cm), (ii) a processor, and (iii) a smartphone application. The seat pad was used to collect data regarding sitting behavior, including sitting and break duration as well as number of postural shifts. Data were stored in the processor, which were used to calculate recommended active breaks and postural shifts for each individual. Instructions to have active breaks were sent from the processor to the smartphone application via Bluetooth technology. Designated postural shifts were induced by the apparatus gradually pumping the air into various parts of the seat pad placed underneath a participant's buttocks. Commands to operate the seat pad were sent from the processor to the seat pad via a cord connected between them. The apparatus was installed by the researcher at participants' workplaces. The researcher explained and demonstrated how to use the apparatus and participants were asked to follow the instructions conveyed via the smartphone application, ie, having active breaks or postural shifts, as much as possible.

Each participant in the intervention A (active break) group was asked to have designated active breaks during the workday, and they were asked not to be seated in a chair when taking the breaks. The frequency and duration of breaks were based on the theoretical effects of rest breaks on the reduction of neck and low-back discomfort (11), ranging from 30 seconds to 15 minutes per break and 0-30 times per workday, depending on their occupational sitting behavior.

Each participant in the intervention B (postural shift) group was asked to make designated postural shifts during each workday. The frequency of postural shifts was based on the theoretical effects of postural shifts on the reduction of neck and low-back discomfort (15, 27), ranging from 20-60 times per hour, depending on their occupational sitting behavior. The occupational sitting behaviors of participants in both intervention groups during the trial were assessed using the aforementioned custom-designed apparatus and collected every month during follow-up.

Participants in the control group received a placebo seat pad made of polypropylene foam (width x length x height = 40 cm x 50 cm x 1 cm) to be placed on the seat pan of a chair. During the study, participants in all groups were asked to keep the level of their leisure time physical activity unchanged.

Follow-up outcome measure

The new onset of non-specific neck or low-back pain - with or without radiation and without any specific systematic disease being detected as the underlying cause of the complaints (28, 29) - during the 6-month follow-up period was collected using a diary. Participants answered the yes/no question "Have you experienced any neck or low-back pain lasting >24 hours during the past month?". If they answered "Yes", follow-up questions about pain intensity measured by a visual analogue scale and the presence of weakness or numbness in the upper limbs were asked. Those who answered "Yes" to the first question, reported pain intensity >30 mm on a 100-mm visual analogue scale and had no weakness or numbness in the upper or lower limbs were identified as cases. Participants who reported new onset neck and low-back pain were also asked about their disability level as measured using the neck disability index (NDI) (30) or Roland-Morris low-back disability questionnaire (RMDQ) (31), respectively. The NDI contains 10 items on a 5-point Likert scale and the total score ranges from 0-50, with higher scores indicating more severe disability. The RMDQ comprises 24 items and the total score is the sum of the ticked boxes, ranging from 0-24, with higher scores indicating more severe disability. Participants were followed until they completed the 6-month follow-up or withdrew from the study.

Statistical analysis

Comparisons of the baseline characteristics of participants between the intervention A (active break), intervention B (postural shift), and control groups were conducted using one-way ANOVA for continuous data and x2 test for nominal and ordinal data. All analyses followed an intention-to-treat approach. Missing data were handled using the "hot-deck imputation" procedure. A respondent was selected at random from the total sample of the study, and the value for that person was assigned to the case for which information was missing. This procedure was conducted repeatedly for each missing value, until the dataset was complete. The 6-month incidence rate of neck and low-back pain was calculated for each group as the proportion of new cases reporting neck or low-back pain during the 6-month follow-up. Further follow-up data of those initially identified as cases were not used any further.

Survival analysis was used to determine KaplanMeier survival curves for the intervention A (active break), intervention B (postural shift), and control groups. Survival time was taken as the time (in months) from the start to the incident symptoms becoming manifested. Those participants who left the study without manifesting symptoms were no longer recorded at the time they left. The two survival curves generated by the Kaplan-Meier method were compared using the log rank test.

Hazard ratios (HR) with respect to incident cases for neck and low-back pain were calculated using the Cox proportional hazards model. Gender, age, and psychological scores were forced into all models to reduce confounding due to these factors. The other 40 possible covariates were each examined in multivariate models. If the tested covariate changed the HR of the intervention variable by >0.05 then it was also included in the final, adjusted model.

To determine the effects of intervention A (active break) and intervention B (postural shift) on neck and low-back discomfort scores during the 6-month followup period, the Borg CR-10 scores were analyzed using a two-way analysis of covariance (ANCOVA), using the Borg CR-10 score at baseline as covariate, with one within-subjects factor (time) and one between-subjects factor (group). When a significant interaction between time and group was detected, the effects of each variable was examined separately using one-way ANCOVA. The Bonferroni correction procedure was applied to determine where statistical significance occurred.

Health outcomes, ie, pain intensity and disability for those reporting neck and low-back pain, were compared between the intervention A (active break), intervention B (postural shift), and control groups using one-way ANOVA. All statistical analyses were performed using SPSS for Windows Version 23.0 (IBM, Armonk, NY, USA). Statistical significance was set at the 5% level.

Results

The trial ran from June 2019 to April 2020. Of the total 1600 workers who received the invitation, 654 responded (response rate: 40%). In total, 217 were eligible, 193 of whom agreed to participate in the study. Of those, 186 were successfully followed for six months and 7 (4%) were lost during the follow-up period because they left the organisations (figure 1). The sample population comprised mainly females (76%) (table 1). Their average age was 33.8 (6.3) years. Most of the participants (95%) had graduated with at least a bachelor's degree. There were no significant differences in any of the characteristics of the participants among the three groups, except for age, BMI, education level, duration of employment, psychological job demand, and social support. All occupational sitting behaviors from participants in both intervention groups are presented in table 2.

In March 2020, the COVID-19 outbreak occurred in Thailand, which forced a majority of the participants in the present study (68%) to work from home. At the time, we had completed the 6-month follow-up for the participants in the control and intervention A (active break) groups. However, the participants in the intervention B (postural shift) group were followed up for only the first 4 months. Thus, it should be noted that data from the 5th and 6th months of participants in the intervention B (postural shift) group were collected while they were working from home (during March to April 2020), and these months were used for statistical analyses in this study, following the intention-to-treat principle. All participants reported that they did not bring the customdesigned apparatus for use at home.

To investigate the effect of working from home in the intervention B (postural shift) group, we compared the 6-month follow-up results to those of 4-month followup (ie, excluding the last 2 months). No alteration of the findings was found between the two sets of data (results not shown). The 6-month follow-up results are given below.

New onset of neck and low-back pain

Over the 6-month follow-up, 17% (8/47) of participants in the intervention A (active break), 17% (8/46) of those in the intervention B (postural shift), and 44% (44/100) of those in the control group reported onset of neck pain. For low-back pain, 9% (4/47) of participants in intervention A (active break), 7% (3/46) of those in intervention B (postural shift), and 33% (33/100) of those in the control group reported onset of low-back pain. No harmful or unintended effects were reported among the participants in the three groups.

The Kaplan-Meier survival curves for the neck and low-back cohort illustrated a significant difference in time to neck and low-back pain between the intervention A (active break) and control group (log rank test probability = 0.002), and the intervention B (postural shift) and control group (log rank test probability = 0.001) (figures 2 and 3). Participants in the control group had greater risk of neck and low-back pain than those in the intervention A (active break) and intervention B (postural shift) groups.

Using the Cox proportional hazard model, after adjustment for age, gender, education level, duration of employment, seat height, and psychosocial work characteristics, the protective effects of intervention A (active break) and intervention B (postural shift) were found for neck and low-back pain. Intervention A (active break) significantly reduced the risk of incident neck pain [HRadj 0.45, 95% confidence interval (CI) 0.20-0.98, P=0.047] and lowback pain (HRadj 0.34, 95% CI 0.12-0.98, P=0.047). Intervention B (postural shift) significantly reduced the risk of incident neck pain (HRadj 0.41, 95% CI 0.18-0.94, P=0.035) and low-back pain (HRadj 0.19, 95% CI 0.060.66, P=0.009) (table 3). Comparisons of pain intensity and disability level among the intervention A (active break), intervention B (postural shift), and control groups indicated no statistically significant difference (table 4).

A two-way ANCOVA, with Borg CR-10 score at baseline as covariate, indicated significant effects for time ($F_{5,825}$=2.769, P=0.017), group ($F_{2,165}$=2.319, P=0.102), and their interaction ($F_{10,825}$=0.902, P=0.531) on neck discomfort score (figure 4). Also, there were significant effects of time ($F_{5,825}$=3.59 1 , P=0.003), group ($F_{2,165}$=3.589, P=0.030) and their interaction ($F_{10,825}$=1.0 1 2, P=0.431) on low-back discomfort score (figure 5). Thus, further analyses were performed.

The post-hoc Bonferroni test showed that neck and low-back discomfort scores after 3 and 2 months of all groups were significantly lower than those at baseline (P<0.05), respectively. Only a significant difference in low-back discomfort scores was found between the intervention A (active break) and control groups during 6-month follow-up (P<0.05). There was no significant difference in neck and low-back discomfort scores between the intervention B (postural shift) and control groups during 6-month follow-up (P>0.05).

Discussion

This randomized controlled trial showed that the rest break and postural shift intervention delivered by the custom-designed apparatus reduced the new onset of neck and low-back pain during 6-month follow-up among high-risk office workers. The 6-month onset of neck and low-back pain was reduced by 55-81% by the interventions. However, neither the rest break nor the postural shift intervention reduced pain intensity or disability level in those experiencing neck and low-back pain.

In this study, the 6-month onset of neck and lowback pain in office workers of the control group were 44% and 33%, respectively. These findings are in line with a previous study by Sitthipornvorakul et al (32), showing the 6-month incidence of neck pain among office workers to be 34%. However, Lapointe et al (33) reported the 6-month onset of neck and lowback pain among office workers to be 18% and 14%, respectively. The discrepancy between our study and that of Lapointe et al (33) may be due to the difference in the inclusion criteria. Lapointe et al (33) did not require participants to be at risk of neck or low-back pain. However, in our study office workers at risk of neck and low-back pain, assessed by the NROW and BROW, were included. Consequently, it is plausible that a greater number of participants experienced neck and low-back pain over the course of our study. The high-risk study population also puts the present study's relatively large effect sizes in perspective; it should be kept in mind that the majority of office workers (ie, those not at risk of neck and low-back pain as well as those who reported neck or low-back symptoms in the previous 6 months) were not included in the present study. Prevention targeted at a high-risk group is different from preventive efforts aimed at all employed office workers (34).

Sitthipornvorakul et al (32) has reported that a walking intervention can largely reduce the 6-month incidence rate of neck pain (adjusted odds ratio of 0.22) among high-risk healthy office workers, for which the same inclusion criteria as those in the present study were used. Danquah et al (35) also found a reduction in the prevalence of neck pain after their 3-month intervention among office workers, who received the Take a Stand! intervention aimed to reduce sitting time (adjusted odds ratio of 0.52). They found, however, no change in lowback pain. A systematic review and meta-analysis indicated that only exercise intervention was effective for reducing the occurrence of low-back pain (pooled risk ratio of 0.65) (36). However, other systematic reviews reported that rest breaks were an effective intervention to reduce pain and discomfort in various body regions (particularly in the low back), which is secondary prevention for musculoskeletal disorders (11, 37).

The present study found that active breaks can reduce new onset of neck and low-back pain by 55% and 66%, respectively. Our results showed that the average break duration of participants in the active break group was 3.1

minutes. Previous studies have found frequent active breaks with postural change, with break durations ranging from 20 seconds to 5 minutes, to be beneficial in reducing pain, discomfort, and fatigue in the neck and low back (12, 13, 38). The number of active breaks in the active break group of the present study was 32.5 times per workday and was higher than that reported by Renaud et al (39), who showed 28.3 sitstand transitions per workday. The discrepancy between our and previous studies may be partly attributed to the use of the intervention apparatus. Scheduled rest breaks have been recommended to decrease musculoskeletal discomfort and pain during computer tasks (13, 40) and active breaks with postural change were found to be effective in reducing pain and discomfort (11). Active breaks with postural change require participants to change their posture during breaks, which may lead to improvement in blood circulation in the lumbar region, change in spinal curvature, delay in the onset of any specific musculoskeletal discomfort, and increase in the flow of synovial fluid to lubricate and nourish the intervertebral disc (41, 42). Changing posture when adopting prolonged, sustained, and awkward sitting postures may prevent a reduction in the length of soft tissues and range of motion in joints, which may reduce the risk of injury (43). Therefore, frequent active breaks of short duration may be sufficient to prevent the onset of neck and low-back pain among high-risk office workers. Future studies should evaluate the impact of frequent and short breaks on work productivity to determine the feasibility of implementing our break program in a real working life setting.

Our results indicated that the postural shifts intervention can prevent the onset of neck and low-back pain by 59% and 81%, respectively. The number of total postural shifts found in the postural shift group of the present study was 27.3 times per hour, which was much higher than those reported in previous studies (8-10 times per hour in a normal work situation) (15, 27). Again, the discrepancy in number of postural shifts between our and previous studies may be partly attributed to the use of the apparatus. Previous studies indicated that increased motion during prolonged sitting has been found to decrease discomfort in the neck and low back (44, 45). Postural shift has been shown to increase subcutaneous oxygen saturation on average by 2.2% with each posture adjustment, indicating the positive effects of posture shifts on tissue viability (15). Static neck posture is a possible risk factor in neck pain (46). A previous study found that individuals with low-back pain had less frequent postural shifts than their healthy counterparts (47). Changing sitting postures has been found to result in different levels of cervicothoracic muscle activity (48). Hence, changing sitting postures may impose alternating activity between different parts of the neck and shoulder muscles resulting in alleviated postural discomfort during prolonged sitting. Increased postural movement whilst sitting has been associated with less spinal load and reduced loss of disc height (14, 49). Thus, our results suggest that frequency of postural shifts may partly be related to the occurrence of neck and low-back pain in those required to sit for long periods and at increased risk of neck and low-back pain.

Our results showed that neck and low-back discomfort scores in all three groups significantly decreased within the first 2-3 months. One plausible explanation of such a finding relates to participant expectations, which has been established as a key process behind the placebo effect (50). A previous study showed that placebo appears to be effective with subjective outcomes (51). Neck and low-back discomfort scores in the intervention groups were lower than those in the control group during 6-month follow-up, although the differences did not reach statistical significance. It should be noted that neck and low-back discomfort scores of participants in the intervention B (postural shift) group increased moderately at the 5th and 6th months of follow-up. At the time, the COVID-19 outbreak occurred in Thailand and the participants in the intervention B (postural shift) group were forced to work from home and did not bring the custom-designed apparatus for use at home. The results support the notion that reduced new onset of neck and low-back pain among those receiving either active break or postural shift may emanate from a decrease in discomfort in the neck and low back.

In the present study, no significant differences were found in pain intensity or disability between the groups. These results support the notion that effective interventions to prevent neck and low-back pain, at least among office workers, may differ from those to alleviate pain intensity and disability level among those with neck and low-back pain. Disability levels due to neck or low-back pain among the present study population, ie, those who reported pain, were relatively low. Consequently, we may have encountered a floor effect, ie, participants scored at or near the possible lower limit (52). Further research should examine the effects of active break and postural shift intervention in office workers with moderate to high pain intensity or disability to validate the findings of the present study.

A major strength of this study is its randomized design and the inclusion of a broad range of psychosocial factors for their confounding effect on neck and low-back pain. Moreover, use of the placebo seat pad in the control group may have reduced the placebo or Hawthorne effect on the outcomes of this study. Four methodological limitations should be taken into consideration when interpreting the results of this study. First, the present study was conducted among healthy office workers with specific characteristics, including being 23-55 years of age, having >5 years of experience in the current position, having high risk of neck and low-back pain, and not presenting any of several medical conditions. Thus, extrapolation of these results to other populations should be made with caution. Further research on the effects of active break and postural shift intervention on the onset of neck and low-back pain in normal office worker populations or other occupations is suggested. Second, assessments of biopsychosocial factors as well as the diagnosis of neck and low-back pain were subjective, which poses the risk of bias in the estimation of exposure or health outcome. Researchers should consider the inclusion of objective information from physical examination to increase data accuracy in future studies. Third, the population in this study comprised mainly females and some baseline characteristics showed differences among the three study groups. Following the use of cluster randomization, participants were randomized as intact groups rather than as individuals. A small number of clusters (N=6) were randomized in this study, which had the risk of baseline imbalance between the randomized groups. Thus, further research should use stratified or pair-matched randomization of clusters (53). Last, we did not assess participants' sitting behavior at baseline. Therefore, we did not know whether the designated active breaks and postural shifts suggested by the apparatus for individuals in the intervention A and B groups were higher or lower than their habitual daily occupational sitting behavior. Due to the limitation of the custom-designed apparatus, we did not assess the compliance of participants in the intervention groups during the follow-up period. It is plausible that, for example, participants may not have had active breaks as instructed. In addition, we did not monitor the daily occupational sitting behavior of participants in the control group, who received a placebo seat pad made of polypropylene foam to sit on. Thus, a comparison of occupational sitting behaviors between the intervention and control groups is not possible. These limitations may affect the internal validity of the present study. Future study should examine the efficacy of active breaks and postural shifts to prevent neck and low-back pain in those with poor habitual sitting behavior relative to the designated active breaks and postural shifts suggested by the apparatus to validate the present findings.

Concluding remarks

A 3-arm, cluster-randomized controlled trial was conducted in a convenience sample of healthy office workers drawn from six organisations located in Bangkok, Thailand, comprising mainly middle-aged females with >5 years working experience and high risk of neck and low-back pain. Our results suggest that the active break and postural shift interventions delivered by the custom-designed apparatus can effectively reduce new onset of neck and low-back pain in these office workers. However, neither the active break nor postural shift intervention decreased pain intensity and disability in those experiencing neck and low-back pain.

Competing interests

The authors declare no conflicts of interest.

Acknowledgements

This work was supported by the Thailand Research Fund through the Royal Golden Jubilee Ph.D. Program (PHD/0180/2558 and PHD/0120/2559) and Industry Division (RDG6050058). Srithai Auto Seats Industry Company Limited partially provided financial support with no interference in the methodology, data collection, and data analysis of the study.

Sidebar

Waongenngarm P, van der Beek AJ, Akkarakittichoke N, Janwantanakul P. Effects of an active break and postural shift intervention on preventing neck and low-back pain among high-risk office workers: a 3-arm cluster-randomized controlled trial. Scand J Work Environ Health. 2021;47(4):306-317. doi:10.5271/sjweh.3949

Correspondence to: Prawit Janwantanakul, Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, 10330, Thailand. [E-mail: prawitj@chula.ac.th]
Received for publication: 4 October 2020

References

References

1. Ehsani F, Mosallanezhad Z, Vahedi G. The prevalence, risk factors and consequences of neck pain in office employees. Middle East J Rehabil Health 2017;4(2):e42031. https://doi. org/10.5812/mejrh.42031.
2. Areerak K, van der Beek AJ, Janwantanakul P. A health behavior screening tool for non-specific neck pain in office workers: a 1-year prospective cohort study. J Occup Health 2018 Sep;60(5):4l0-8. https://doi.org/l0.l539/joh.20l80001-FS.
3. Ayanniyi O, Ukpai BO, Adeniyi AF. Differences in prevalence of self-reported musculoskeletal symptoms among computer and non-computer users in a Nigerian population: a cross-sectional study. BMC Musculoskelet Disord 2010 Aug;ll(l):177. https://doi.org/l0.ll86/l47l2474-11-177.
4. Sitthipornvorakul E, Janwantanakul P, Lohsoonthorn V. Sitthipornvorakul E, Janwantanakul P, Lohsoonthorn V. The effect of daily walking steps on preventing neck and low back pain in sedentary workers: a 1-year prospective cohort study. Eur Spine J 2015 Mar;24(3):4l7-24.
5. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F et al. A systematic review of the global prevalence of low back pain. Arthritis Rheum 2012 Jun;64(6):2028-37. https://doi. org/10.1002/art.34347.
6. Côte P, van der Velde G, Cassidy JD, Carroll LJ, HoggJohnson S, Holm LW et al. 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. J Manipulative Physiol Ther 2009 Feb;32(2 Suppl):S70-86. https://doi.Org/10.1016/j.jmpt.2008.ll.012.
7. Manchikanti L. Epidemiology of low back pain. Pain Physician 2000 Apr;3(2):l67-92.
8. Søndergaard KH, Olesen CG, Søndergaard EK, de Zee M, Madeleine P. The variability and complexity of sitting postural control are associated with discomfort. J Biomech 2010 Jul;43(l0):l997-2001. https://doi.0rg/lO.lOl6/j. jbiomech.2010.03.009.
9. Waongenngarm P, van der Beek AJ, Akkarakittichoke N, Janwantanakul P. Perceived musculoskeletal discomfort and its association with postural shifts during 4-h prolonged sitting in office workers. Appl Ergon 2020 Nov;89:l03225. https://doi.Org/l0.l0l6/j.apergo.2020.l03225.
10. Hamberg-van Reenen HH, van der Beek AJ, Blatter BM, van der Grinten MP, van Mechelen W, Bongers PM. Does musculoskeletal discomfort at work predict future musculoskeletal pain? Ergonomics 2008 May;5l(5):63748. https://doi.org/l0.l080/00l40l3070l743433.
11. Waongenngarm P, Areerak K, Janwantanakul P. The effects of breaks on low back pain, discomfort, and work productivity in office workers: A systematic review of randomized and non-randomized controlled trials. Appl Ergon 2018 Apr;68:230-9. https://d0i.0rg/lO.lOl6/j. apergo.2017.12.003.
12. Mclean L, Tingley M, Scott RN, Rickards J. Computer terminal work and the benefit of microbreaks. Appl Ergon 2001 Jun;32(3):225-37. https://doi.org/l0.l0l6/S00036870(00)00071-5.
13. Sheahan PJ, Diesbourg TL, Fischer SL. The effect of rest break schedule on acute low back pain development in pain and non-pain developers during seated work. Appl Ergon 2016;53 Pt A:64-70.
14. Zenk R, Franz M, Bubb H, Vink P. Technical note: spine loading in automotive seating. Appl Ergon 2012 Mar;43(2):290-5. https://d0i.0rg/lO.lOl6/j. apergo.2011.06.004.
15. Reenalda J, Van Geffen P, Nederhand M, Jannink M, IJzerman M, Rietman H. Analysis of healthy sitting behavior: interface pressure distribution and subcutaneous tissue oxygenation. J Rehabil Res Dev 2009;46(5):577-86. https://doi.org/l0.l682/JRRD.2008.l2.0l64.
16. Pillastrini P, Mugnai R, Bertozzi L, Costi S, Curti S, Guccione A et al. Effectiveness of an ergonomic intervention on work-related posture and low back pain in video display terminal operators: a 3 year cross-over trial. Appl Ergon 2010 May;4l(3):436-43. https://d0i.0rg/lO.lOl6/j. apergo.2009.09.008.

17. Vergara M, Page A. Relationship between comfort and back posture and mobility in sitting-posture. Appl Ergon 2002 Jan;33(l): 1-8. https://doi.org/l0.l0l6/S00036870(01)00056-4.
18. Maradei F, Quintana L, Castellanos J. Influence of seat tilt motion on discomfort perception during a simulated driving activity. Work 2017;56(1):99-110. https://doi.org/l0.3233/ WOR-162464.
19. O'Keeffe M, Dankaerts W, O'Sullivan P, O'Sullivan L, O'Sullivan K. Specific flexion-related low back pain and sitting: comparison of seated discomfort on two different chairs. Ergonomics 2013;56(4):650-8. https://doi.Org/10.I 080/00140139.2012.762462.
20. Paksaichol A, Janwantanakul P, Lawsirirat C. Development of a neck pain risk score for predicting nonspecific neck pain with disability in office workers: a 1-year prospective cohort study. J Manipulative Physiol Ther 2014 Sep;37(7):468-75. https://doi.Org/10.1016/j.jmpt.2014.07.004.
21. Janwantanakul P, Sihawong R, Sitthipornvorakul E, Paksaichol A. A screening tool for non-specific low back pain with disability in office workers: a 1-year prospective cohort study. BMC Musculoskelet Disord 2015 Oct;16:298. https://doi.org/10.1186/s12891-015-0768-y.
22. Andersen LL, Jørgensen MB, Blangsted AK, Pedersen MT, Hansen EA, Sjøgaard G. A randomized controlled intervention trial to relieve and prevent neck/shoulder pain. Med Sei Sports Exerc 2008 Jun;40(6):983-90. https://doi. org/10.1249/MSS.0b013e3181676640.
23. Hildebrandt VH, Bongers PM, van Dijk FJ, Kemper HC, Dul J. The influence of climatic factors on non-specific back and neck-shoulder disease. Ergonomics 2002 Jan;45(1):3248. https://doi.org/10.1080/00140130110110629
24. Borg G. Psychophysical scaling with applications in physical work and the perception of exertion. Scand J Work Environ Health 1990;16 Suppl 1:55-8. https://doi. org/10.5271/sjweh.1815.
25. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, BieringSørensen F, Andersson G et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987 Sep;18(3):233-7. https://doi. org/10.1016/0003-6870(87)90010-X.
26. Phakthongsuk P. Construct validity of the Thai version of the job content questionnaire in a large population of heterogeneous occupations. J Med Assoc Thai 2009 Apr;92(4):564-72.
27. Akkarakittichoke N, Janwantanakul P. Seat Pressure Distribution Characteristics During 1 Hour Sitting in Office Workers With and Without Chronic Low Back Pain. Saf Health Work 2017 Jun;8(2):212-9. https://doi.Org/10.1016/j. shaw.2016.10.005.
28. Borghouts JA, Koes BW, Bouter LM. The clinical course and prognostic factors of non-specific neck pain: a systematic review. Pain 1998 Jul;77(1):1-13. https://doi. org/10.1016/S0304-3959(98)00058-X.
29. Krismer M, van Tulder M; Low Back Pain Group of the Bone and Joint Health Strategies for Europe Project. Strategies for prevention and management of musculoskeletal conditions. Low back pain (non-specific). Best Pract Res Clin Rheumatol 2007 Feb;21(1):77-91. https://doi.Org/10.1016/j. berh.2006.08.004.
30. Uthaikhup S, Paungmali A, Pirunsan U. Validation of Thai versions of the Neck Disability Index and Neck Pain and Disability Scale in patients with neck pain. Spine 2011 Oct;36(21):E1415-21. https://doi.org/10.1097/ BRS.0b013e31820e68ac.
31. Pensri P, Baxter GD, McDonough SM. Reliability and internal consistency of the Thai version of Roland-Morris disability questionnaire and Waddell disability Index for back pain patients. Chula Med J 2005;49(6):333-49.
32. Sitthipornvorakul E, Sihawong R, Waongenngarm P, Janwantanakul P. The effects of walking intervention on preventing neck pain in office workers: A randomized controlled trial. J Occup Health 2020 Jan;62(1):e12106. https://doi.org/10.1002/1348-9585.12106.
33. Lapointe J, Dionne CE, Brisson C, Montreuil S. Interaction between postural risk factors and job strain on self-reported musculoskeletal symptoms among users of video display units: a three-year prospective study. Scand J Work Environ Health 2009 Mar;35(2):134-44. https://doi.org/10.5271/ sjweh.1312.
34. van der Beek AJ, Dennerlein JT, Huysmans MA, Mathiassen SE, Burdorf A, van Mechelen W et al. A research framework for the development and implementation of interventions preventing work-related musculoskeletal disorders. Scand J Work Environ Health 2017 Nov;43(6):526-39. https://doi. org/10.5271/sjweh.3671.

35. Danquah IH, Kloster S, Holtermann A, Aadahl M, Tolstrup JS. Effects on musculoskeletal pain from "Take a Stand!" - a cluster-randomized controlled trial reducing sitting time among office workers. Scand J Work Environ Health 2017 Jul;43(4):350-7. https://doi.org/10.5271/sjweh.3639.
36. Steffens D, Maher CG, Pereira LS, Stevens ML, Oliveira VC, Chappie M et al. Prevention of Low Back Pain: A Systematic Review and Meta-analysis. JAMA Intern Med 2016 Feb;176(2):199-208. https://doi.org/10.1001/ jamainternmed.2015.7431.
37. Stock SR, Nicolakakis N, Vėžina N, Vėžina M, Gilbert L, Turcot A et al. Are work organization interventions effective in preventing or reducing work-related musculoskeletal disorders? A systematic review of the literature. Scand J Work Environ Health 2018 Mar;44(2):113-33.
38. Galinsky T, Swanson N, Sauter S, Dunkin R, Hurrell J, Schleifer L. Supplementary breaks and stretching exercises for data entry operators: a follow-up field study. Am J Ind Med 2007 Jul;50(7):519-27. https://doi.org/10.1002/ ajim.20472.
39. Renaud LR, Jelsma JG, Huysmans MA, van Nassau F, Lakerveld J, Speklé EM et al. Effectiveness of the multi-component dynamic work intervention to reduce sitting time in office workers - Results from a pragmatic cluster randomised controlled trial. Appl Ergon 2020 Apr;84:103027. https://doi.0rg/lO.lOl6/j. apergo.2019.103027.
40. Barredo RD, Mahon K. The Effects of Exercise and Rest Breaks on Musculoskeletal Discomfort during Computer Tasks: An Evidence-Based Perspective. J Phys Ther Sei 2007;19(2):151-63. https://doi.org/10.1589/jpts.19.151.
41. Marras WS, Lavender SA, Leurgans SE, Fathallah FA, Ferguson SA, Allread WG et al. Biomechanical risk factors for occupationally related low back disorders. Ergonomics 1995 Feb;38(2):377-410. https://doi. org/10.1080/00140139508925111.
42. Thorp AA, Kingwell BA, Owen N, Dunstan DW. Breaking up workplace sitting time with intermittent standing bouts improves fatigue and musculoskeletal discomfort in overweight/obese office workers. Occup Environ Med 2014 Nov;71(ll):765-71. https://doi.org/10.1136/ oemed-2014-102348.
43. Main C, Sullivan M, Watson P. Pain management: practical applications of the biopsychosocial perspective in clinical and occupational setting. 2nd ed ed: Churchill livingstone; 2008.
44. O'Keeffe M, Dankaerts W, O'Sullivan P, O'Sullivan L, O'Sullivan K. Specific flexion-related low back pain and sitting: comparison of seated discomfort on two different chairs. Ergonomics 2013;56(4):650-8. https://doi.Org/10.I 080/00140139.2012.762462.
45. van Deursen LL, Patijn J, Durinck JR, Brouwer R, van Erven-Sommers JR, Vortman BJ. Sitting and low back pain: the positive effect of rotary dynamic stimuli during prolonged sitting. Eur Spine J l999;8(3):l87-93. https://doi. org/l0.l007/s005860050l55.
46. Szeto GP, Straker LM, O'Sullivan PB. Neck-shoulder muscle activity in general and task-specific resting postures of symptomatic computer users with chronic neck pain. Man Ther 2009 Jun;l4(3):338-45. https://doi.0rg/lO.lOl6/j. math.2008.05.001.
47. Dunk NM, Callaghan JP. Gender-based differences in postural responses to seated exposures. Clin Biomech (Bristol, Avon) 2005 Dec;20(l0):ll0l-10. https://doi. org/l0.l0l6/j.clinbiomech.2005.07.004.
48. Caneiro JP, O'Sullivan P, Burnett A, Barach A, O'Neil D, Tveit O et al. The influence of different sitting postures on head/neck posture and muscle activity. Man Ther 2010 Feb;l5(l):54-60. https://d0i.0rg/lO.lOl6/j. math.2009.06.002.
49. van Dieen JH, de Looze MP, Hermans V. Effects of dynamic office chairs on trunk kinematics, trunk extensor EMG and spinal shrinkage. Ergonomics 2001 Jun;44(7):739-50. https://doi.org/l0.l080/00l40l30l20297.
50. Vase L, Riley JL 3rd, Price DD. A comparison of placebo effects in clinical analgesic trials versus studies of placebo analgesia. Pain 2002 Oct;99(3):443-52. https://doi. org/l0.l0l6/S0304-3959(02)00205-l.
51. Hróbjartsson A, Gøtzsche PC. Is the placebo powerless? An analysis of clinical trials comparing placebo with no treatment. N Engl J Med 2001 May;344(2l):l594-602. https://doi.org/l0.l056/NEJM200l05243442l06.
52. Everitt B. The Cambridge dictionary of statistics / B.S. Everitt. Cambridge, U.K.; New York: Cambridge University

Press; 2002.
53. Ivers NM, Halperin IJ, Barnsley J, Grimshaw JM, Shah BR, Tu K et al. Allocation techniques for balance at baseline in cluster randomized trials: a methodological review. Trials 2012 Aug;l3:l20. https://doi.org/l0.ll86/l745-62l5-l3120.

DETAILS

Subject:	Back pain; Workers; Neck; Posture; Confidence intervals; Intervention; Low back pain; Questionnaires; Clinical trials; Neck pain; Clusters; Pain; Statistical models; Risk; Placebos
Business indexing term:	Subject: Workers
Location:	Thailand; Bangkok Thailand
Publication title:	Scandinavian Journal of Work, Environment &Health; Stockholm
Volume:	47
Issue:	4
Pages:	306-317
Publication year:	2021
Publication date:	2021
Section:	Original article
Publisher:	Scandinavian Journal of Work, Environment &Health
Place of publication:	Stockholm
Country of publication:	Finland, Stockholm
Publication subject:	Occupational Health And Safety
ISSN:	03553140
e-ISSN:	1795990X
Source type:	Scholarly Journal
Language of publication:	English
Document type:	Evidence Based Healthcare, Journal Article
DOI:	https://doi.org/10.5271/sjweh.3949
ProQuest document ID:	2530520682

Bibliography

Citation style: APA 6th - Annotated with Abstracts - American Psychological Association, 6th Edition

The COVID-19 pandemic: One year later - an occupational perspective. (2021). Scandinavian Journal of Work, Environment & Health, 47(4), 245-247. doi:https://doi.org/10.5271/sjweh.3956

The COVID-19 pandemic is discussed. This report points to the importance of occupation as a risk factor but also to the availability and use of appropriate personal protection to mitigate the risk of becoming infected. In addition, well-established socioeconomic factors of health inequalities intermingled with occupations at risk, demonstrated by the fact that most taxi drivers belonged to the same ethnic group and that taxi drivers had higher mortality rates when residing in London. These findings are mirrored in a recent preprint publication from the US state of California, reporting that relative excess mortality was particularly high among food/agriculture, transportation/logistics, facilities, and manufacturing workers.

Shiri, Rahman,M.D., PhD., Hakola, T., M.Sc, Härmä, Mikko, MD, PhD, & Ropponen, A., PhD. (2021). The associations of working hour characteristics with short sickness absence among part- and full-time retail workers. Scandinavian Journal of Work, Environment & Health, 47(4), 268-276. doi:https://doi.org/10.5271/sjweh.3952

Objective This study aimed to determine the associations of working hour characteristics with short (1-3 days) sickness absence (SA) among retail workers. Methods As part of "RetailHours-project", 4046 employees of 338 Finnish retail stores were included. Registry-based data on working hour characteristics and short SA were utilized. A case-crossover design was used and the odds ratios (OR) were controlled for the clustering effect and working hour characteristics. Results There were strong dose-response relationships between percent of short (25% of work times. Weekly working hours >40 hours were associated with SA among part-time workers odds ratio (OR) 2.22, CI 1.65-2.98], women (OR 1.62, CI 1.27-2.07) and among workers <30 years of age (OR 1.68, CI 1.20-2.35) as well as among workers aged ≥30 years (OR 1.43, CI 1.07-1.92). Furthermore, working mainly night shifts was associated with SA among full-time workers (OR 2.41, 95% CI 0.99-5.86) and women (OR 1.72, CI 1.02-2.89). Conclusions A short shift interval is an important risk factor for short SA. Improving intervals between shifts and shortening long weekly working hours could reduce the risk of short SA among retail workers.

Bovenzi, M., M.D., & Schust, M., PhD. (2021). A prospective cohort study of low-back outcomes and alternative measures of cumulative external and internal vibration load on the lumbar spine of professional drivers. Scandinavian Journal of Work, Environment & Health, 47(4), 277-286. doi:https://doi.org/10.5271/sjweh.3947

Objective The aim of this study was to compare the performance of alternative measures of cumulative lifetime vibration dose to predict the occurrence of low-back pain (LBP) outcomes in a cohort of 537 professional drivers investigated at baseline and over a two-year follow up period. Methods The exposure data obtained in the EU VIBRISKS project were used to calculate alternative measures of either acceleration- (external) or force- (internal) based lifetime vibration doses. Vibration was measured in representative samples of machines and vehicles used by the drivers. Internal lumbar forces were calculated by means of anatomy-, posture-, and anthropometry-based finite element models. The relations of LBP outcomes to alternative measures of lifetime vibration doses were assessed by the generalized estimating equations method. Results Metrics of cumulative vibration exposure constructed with either acceleration- or force-based methods were significantly associated with the occurrence of LBP outcomes. A measure of model fitting suggested that force-based doses were better predictors of LBP outcomes than acceleration-based doses. Models with force root-mean-square doses provided a better fit to LBP outcomes than those with force-peak doses. Conclusions Measures of internal lumbar forces were better predictors of LBP outcomes than measures of external vibration acceleration although the exposure metrics constructed with the acceleration-based method have the advantage of greater simplicity compared to the force-based method. The differences between the models with force-based doses suggest that the cumulative health effects on the lumbar spine might depend on the integrated resulting total force over the entire exposure time rather than primarily on the force peaks.

Li, W., M.D., Yi, G., M.S., Chen, Z., M.S., Dai, X., M.D., Wu, J., M.S., Peng, Y., M.S., . . . Wang, D., M.D. (2021). Is job strain associated with a higher risk of type 2 diabetes mellitus? A systematic review and meta-analysis of prospective cohort studies. Scandinavian Journal of Work, Environment & Health, 47(4), 249-257. doi:https://doi.org/10.5271/sjweh.3938

Objectives Epidemiological studies have explored the relationship between work-related stress and the risk of type 2 diabetes mellitus (T2DM), but it remains unclear on whether work-related stress could increase the risk of T2DM. We aimed to evaluate the association between job strain and the risk of T2DM. Methods We searched PubMed and Web of Science up to April 2019. Summary risk estimates were calculated by random-effect models. And the analysis was also conducted stratifying by gender, study location, smoking, drinking, body mass index, physical activity, family history of T2DM, education and T2DM ascertainment. Studies with binary job strain and quadrants based on the job strain model were analyzed separately. Results A total of nine studies with 210 939 participants free of T2DM were included in this analysis. High job strain (high job demands and low control) was associated with the overall risk of T2DM compared with no job strain (all other combinations) relative risk (RR) 1.16, 95% confidence interval (CI) 1.03-1.31], and the association was more evident in women (RR 1.48, 95% CI 1.02-2.14). A statistically significant association was also observed when using high strain as a category (job strain quadrants) rather than binary variable (RR 1.62, 95% CI 1.04-2.55) in women but not men. Conclusions Our study suggests that job strain is an important risk factor for T2DM, especially among women. Appropriate preventive interventions in populations with high job strain would contribute to a reduction in T2DM risk.

Andersen, L. L., PhD., Vinstrup, J., PhD., Sundstrup, E., PhD., Skovlund, S. V., M.Sc, Villadsen, E., B.Sc, & Thorsen, S. V., PhD. (2021). Combined ergonomic exposures and development of musculoskeletal pain in the general working population: A prospective cohort study. Scandinavian Journal of Work, Environment & Health, 47(4), 287-295. doi:https://doi.org/10.5271/sjweh.3954