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# Physical and mental strain at work: Relationships with onset and persistent of multi-site pain in a four-year follow up

Subas Neupane [a, b, *], Clas-Håkan Nygård [a, b]

[a] School of Health Sciences, FI – 33014, University of Tampere, Tampere, Finland
[b] Gerontology Research Center, FI – 33014, University of Tampere, Finland

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ABSTRACT

This study evaluates the association of physical and mental strain with the onset and persistence of multi-site musculoskeletal pain among younger and older employees in four-year follow-up. A questionnaire survey was conducted twice in a food processing company, in 2005 and 2009, with responses from 734 employees (445 younger and 289 older; 65% female). Information on musculoskeletal pain during the preceding week and perceived mental and physical strain was obtained through a structured questionnaire. The association of onset and persistent of multi-site pain with mental and physical strain was estimated with log binomial regression analysis and stratified by age group. Risk ratios (RR) with their 95% confidence intervals (CIs) are reported for the estimates. More than 56% of the employees reported multi-site pain at baseline. Among those who reported multi-site pain at baseline 70% reported persistent multi-site pain and one-third reported new onset of multi-site pain at follow-up. Mental strain at baseline strongly predicted persistence of multi-site pain among both younger and older employees (RR from for younger employees = 1.68, 95% CI = 1.01–2.83 and RR for older employees = 2.25, 95% CI 0 1.27–3.98) but the association with physical strain was not statistically significant. Mental strain predicted the risk of persistence of multi-site pain among both younger and older employees in four-year follow-up but not onset of multi-site pain.

*Relevance to the industry:* The results of this study suggest that monitoring working conditions of all age workers can reduce physical and mental strain, thereby reducing the incidence of multi-site musculoskeletal pain and promoting workers' health.



## 1. Introduction

Musculoskeletal pain at multiple body sites is frequent in the working population (Neupane et al., 2013a; Haukka et al., 2013; Herin et al., 2014). A large body of research, however, has focused on a single body site. Recently, more studies have been focused on multi-site pain (Herin et al., 2014; Neupane et al., 2013b; Haukka et al., 2013). Associations between certain physical (physical workload, repetitive tasks, awkward postures) and psychosocial exposures (high job demands, low job control, co-workers' and supervisors' support) at work and painful conditions at particular anatomical sites has been studied extensively. The evidence shows that pain at multiple body sites is associated with decreased functioning and poorer prognosis when compared to having pain at only one site (Neupane et al., 2015; Haukka et al., 2013; Kamaleri et al., 2008; Miranda et al., 2010). However, the relationship of multi-site pain with some specific work exposures, such as mental and physical strain at work, is not well understood.

The concept of strain in this study is based on the stress-strain model where the stress on a worker depends on environmental factors (both physical and psychosocial) acting upon the person, whereas strain denotes the effects of stress, which differ across individuals for a certain stress factor (Rutenfrantz, 1981; Cox et al., 2000). The stress-strain concept is practical in studying the effect of physical workload on the cardiovascular system, which is directly related to the individual's physical work capacity (Rutenfrantz, 1981). The model also emphasizes the role of individual characteristics such as age, gender, health status and work ability as modifiers of the relationship between strain and musculoskeletal symptoms or pain.

Industrial workers are mostly exposed to job strain (Nicot,

* Corresponding author. School of Health Science, FI – 33014, University of Tampere, Finland.
*E-mail address:* subas.neupane@uta.fi (S. Neupane).

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2007). The job strain is mostly due to the physical work environment in industry. In a cross-sectional study among men and women employed in different occupations, job strain was associated with musculoskeletal symptoms (Johansson, 1995). Another study among health care employees found that mental strain was a risk factor for musculoskeletal symptoms in a three-year follow-up (Josephson et al., 1997). The authors also found that the risk was higher when combined with perceived heavy physical exertion. Some earlier cross-sectional studies have also highlighted the associations of workplace psychosocial strain (Sembajwe et al., 2013) and somatization (Solidaki et al., 2010) with multi-site musculoskeletal pain. Psychological or mental strain were not only associated with musculoskeletal pain but also found to be linked to early retirement (Laine et al., 2008) and mortality (Kivimäki et al., 2002). In a study with 28-year follow-up among municipal employees, job strain during midlife was found to be closely related to mortality (Von Bonsdorff et al., 2012) and stress symptoms to disability in old age (Kulmala et al., 2013).

Workers with multi-site pain are reportedly at high risk of work disability (Miranda et al., 2010; Neupane et al., 2013a) in earlier studies, therefore for preventive purposes more information is needed on the workplace risk factors that predict the future course of multi-site pain. The risk factors of multi-site pain are known to differ by age. However, the association with strain in the age group is inconclusive. One earlier study has shown that older employees experience higher strain than younger employees (Nygård et al., 1997). On the other hand, Pailhe (2005) reported that younger cohorts are exposed to physical strain more frequently than older cohorts. In other studies, the prevalence of multi-site pain has been reported to increase with age (Sembajwe et al., 2013; Solidaki et al., 2010). However, we found in our earlier study that younger age was strongly associated with multi-site pain even after controlling for several possible confounders such as gender, occupational status, physical exercise, biomechanical and psychosocial exposures, work ability etc. (Neupane et al., 2011).

The aim of this prospective study in an industrial population was to investigate whether work-related physical and mental strain at baseline predict multi-site pain at follow-up, whether these factors differ between younger and older workers, and which factors contribute in particular to the persistence of multi-site pain over four years.

## 2. Methods

This study is based on questionnaire surveys conducted among all employees of one of the leading food industries of Finland in spring 2005 (N = 1201) and spring 2009 (N = 1398). The questionnaires were distributed at the workplaces to every employee and were completed during working hours. It was possible to reply anonymously or to sign the consent for individual follow-up of the surveys and for linking to the personnel registers of the company including information on age, gender, occupational status, workplace and duration of and interruptions in the job contract. The replies were placed in sealed envelopes, which were collected and forwarded to the researchers. As the questionnaires were not addressed to individual employees, no reminders could be sent. The ethics committee of Pirkanmaa Hospital District, Tampere, Finland, approved the study.

A total of 734 employees participated in both surveys with response rates of 60% at baseline and 72% at follow-up. Of these, 518 were blue-collar employees, the majority worked in food processing and maintenance, whereas 216 were white-collar employees, mainly working in management. The mean age of the employees was 41 years (SD = 9.9) ranging from 20 to 62 years at baseline.

### 2.1. Measurement of variables

#### 2.1.1. Multi-site musculoskeletal pain

A modification of the validated Nordic Musculoskeletal Questionnaire (Kuorinka et al., 1987) was used to assess musculoskeletal pain. It included a question regarding whether the employee had felt pain, aching or numbness in four anatomical areas (hands or upper extremities; neck or shoulders; lower back; and feet or lower extremities) during the preceding week, the response options ranging from 0 (not at all) to 10 (very much). The variables were dichotomised at the median (less than median: 0 = mild; more than median: 1 = severe). The median values for upper extremities, neck and shoulder, lower back and lower extremities were 4, 5, 2 and 2 respectively. The dichotomised variables were summed up into a variable expressing the number of areas with severe pain (from zero to four) (Neupane et al., 2013a, 2013b). The summed variable was further categorized into two, leaving zero and one as 'no multi-site pain' and 'multi-site pain' by combining two, three and four sites pain.

#### 2.1.2. Mental strain

Perceived mental strain was assessed by a modified version of the Occupational Stress Questionnaire (Elo et al., 1992), using a single question ("Stress means a situation in which a person feels excited, apprehensive/concerned, nervous or distressed or she/he cannot sleep because of the things on her/his mind. Do you feel this kind of stress nowadays?") (Elo et al., 1992), with the response scale from 0 (not at all) to10 (very much). For this analysis, mental strain was categorized into low (0–2), medium (3–6) and high (7–10) according to tertile values.

#### 2.1.3. Physical strain

Perceived physical strain was elicited with respondents' ratings of perceived exertion (RPE) with the question "How physically hard/exhausting do you feel your job is in a normal work day?" on a scale from 6 (not at all) to 20 (very much) (Borg, 1970). Physical strain in this study was categorized into three, low (6–11), medium (12–15) and high (16–20) according to the tertile values.

#### 2.1.4. Covariates

Work ability was assessed as a subjective assessment of current work ability compared with a person's self-identified lifetime best (i.e. with the question "Assume that your work ability at its best has a value of 10 points. What score would you give your current work ability?"). Work ability was categorized into excellent (score 10), good (score 9), moderate (score 8) and poor (scores 0–7) work ability in this study (Gould et al., 2008).

Body mass index (BMI) was calculated using workers' self-reported weight (kg) and height (cm). The level of physical exercise during the last month was elicited on a scale from 0 (not at all) to 7 (strenuous physical activity for more than 3 h a week).

### 2.2. Statistical analysis

Descriptive statistics of the study population were first presented in the form of frequencies and percentages in total stratified by age group (<45 years 'younger' and ≥45 'older') (WHO, 1993) to analyse the association separately among younger and older employees. Log binomial regression analysis was performed to examine whether baseline mental and physical strain were associated with multi-site musculoskeletal pain after four years of follow-up. Risk ratios (RR) with their 95% confidence intervals (CI) are presented. The analyses were conducted separately for those reporting multi-site pain at baseline ('persistence of multi-site pain') and those reporting no multi-site pain at baseline ('onset of