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Working from home: mismatch between access and need in relation to work–home interference and fatigue

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ABSTRACT (ENGLISH)

Objectives Working from home (WfH) is a promising practice that may enable employees to successfully and sustainably combine work and private life. Yet, not every employer facilitates WfH and not every employee has similar needs concerning the practice. The current study aims to examine the association of a WfH mismatch with work-home interference (WHI) and fatigue. Methods Data on WfH, WHI, and fatigue of a quasi-representative sample of 2374 Dutch employees in 2012/13 and a follow-up measurement one year later were used. Cross-sectional and longitudinal regression analyses were conducted to investigate the cross-sectional and temporal associations between WfH mismatch on the one hand and (changes in) time-based and strain-based WHI and fatigue on the other hand. Results In the cross-sectional analyses, WfH mismatch was significantly associated with higher time-based WHI (B=0.13), strain-based WHI (B=0.17) and more fatigue (B=0.32). WfH mismatch was not associated with changes in these outcomes after one year of follow-up. Conclusions A tailored WfH organizational policy, in which employees' need for working from home is taken into account, may be a fruitful approach to utilize WfH as a way for employees to successfully and sustainably combine work and private life to its full potential.

FULL TEXT

Headnote

Objectives Working from home (WfH) is a promising practice that may enable employees to successfully and sustainably combine work and private life. Yet, not every employer facilitates WfH and not every employee has similar needs concerning the practice. The current study aims to examine the association of a WfH mismatch with work-home interference (WHI) and fatigue.

Methods Data on WfH, WHI, and fatigue of a quasi-representative sample of 2374 Dutch employees in 2012/13 and a follow-up measurement one year later were used. Cross-sectional and longitudinal regression analyses were conducted to investigate the cross-sectional and temporal associations between WfH mismatch on the one hand and (changes in) time-based and strain-based WHI and fatigue on the other hand.

Results In the cross-sectional analyses, WfH mismatch was significantly associated with higher time-based WHI (B=0.13), strain-based WHI (B=0.17) and more fatigue (B=0.32). WfH mismatch was not associated with changes in these outcomes after one year of follow-up.

Conclusions A tailored WfH organizational policy, in which employees' need for working from home is taken into account, may be a fruitful approach to utilize WfH as a way for employees to successfully and sustainably combine

work and private life to its full potential.

Key terms remote work; well-being; work location flexibility; worktime control.

Three parallel societal and labor market developments have greatly challenged European workers in recent years. First, in most European countries, the workforce is ageing (1). To keep the pension system affordable, many governments have implemented measures to encourage prolonged working, eg, by raising the statutory retirement age. A second development is the rise in the number of double-income families: in Europe female employment increased from 58.1 to 68.2% in the period 2002-2019 (2). Although increased labor participation among women has important benefits, a taxing sideeffect is that workers have to combine paid work with household and care responsibilities more often. A third development is the increasing demand governments place on people, including working people, to (also) provide informal care for relatives (3).

These three developments, both in the workforce and society as a whole, challenge an appropriate balance between effort and recovery and between working life and private life. A lasting situation of expending high effort and having too little time and opportunities for recovery is a serious risk factor for ill-health and reduced quality of life (4). Combining high work demands with high responsibilities in private life poses a risk for negative work-home interference (WHI), ie, "when work demands absorb time and/or create strain that makes adequate functioning in the family domain more difficult" (5). In the long term, these two related types of imbalance can result in stress-related health problems, such as burnout, depression and substance abuse (6). As such, the three societal and labor market developments make healthy working conditions, which enable people to work sustainably, increasingly important.

The possibility to work (partly) from home, in the literature - also referred to as work location flexibility, remote work or spatial flexibility - may be a promising way to enable employees to successfully and sustainably combine working and private life, while keeping an appropriate balance between effort and recovery. Working from home (WfH) may, for example, enable employees to bring their children to school in the morning. Flexibility in work location may also be attractive for employees to reduce commuting time, leaving more time for actual work or meeting private life responsibilities. These factors may (partly) explain why working remotely has gained in popularity. In fact, in Europe the proportion of workers who sometimes or usually work from home increased from 12.4% in 2008 to 16.1% in 2019 (7). In The Netherlands, this proportion is even higher, with an increase in prevalence from 27.3% in 2010 (8) to 36.9% in 2019 (9). The current COVID-19 pandemic, especially the social distancing measures that governments have been forced to take, have further catalyzed this development and will continue to do so after the COVID-19 pandemic has passed (10).

The prevalence of WfH is not equally distributed across sectors, with logically sectors that require a fixed workplace (with on-site work responsibilities, such as in the healthcare and hospitality sector) showing a lower prevalence than those with work tasks that can be performed remotely (11). In The Netherlands, working from home is most common in financial services (72.6%), information and communication technology (72.0%) and education (67.9%) (9). During the COVID-19 pandemic, many organizations had to facilitate working from home out of necessity. Although the long-term impact of the COVID-19 pandemic on the organization of work remains to be seen, working from home rates are likely to increase (10).

WfH can be theorized to have favorable effects on WHI and health through two mechanisms that relate to worktime control, ie, "an employee's perception of his/her possibilities to control the duration, position, and distribution of his/her working times" (12). First, employees who work from home or on another preferred location may be better able to regulate time demands. As such, work location flexibility can function as a time-regulation mechanism. It enables employees to adapt working times to responsibilities in private life. This time-regulating function of WfH may protect employees from time-based WHI (ie, having difficulty fulfilling demands at home due to time devoted to work) (13). Two meta-analyses indeed showed a statistically significant (albeit weak) relationship between WfH and lower work-home conflict (14, 15). A second mechanism is that WfH enables the employee to adjust working and resting times to momentaneous recovery needs, ie, a recovery-regulation mechanism. The recoveryregulating function of WfH may protect employees for work-related fatigue and strain-based WHI (ie, having difficulty fulfilling demands at

home due to strain built up at work) (13).
Despite these two general mechanisms regarding the overall favorable effects of WfH on WHI and fatigue, it is relevant to consider that not every employee will have a similar need for or access to WfH. Also, need for and access to WfH may not always match, resulting in a WfH mismatch. Individual differences in need for WfH may be caused by individual differences in integration and segmentation preferences [eg, (16)]. Employees with a segmentation preference want to separate the work and home domains as much as possible, whereas employees with an integration preference desire to integrate these domains (16). As such, the second group is likely to experience a higher need for WfH than the first. Also, not every employer permits and facilitates their employees to work from home, resulting in differences between employees' access to WfH. Based on the theoretical notion of person-environment fit that individual well-being is optimized when individual preferences and needs fit contextual factors, it can be assumed that well-being outcomes among employees are optimal when their need for WfH (individual characteristic) on the one hand and their access to WfH (contextual factor) on the other hand are well connected (17).
Previous research on the health effects of WfH did not appropriately distinguish between workers' need for and access to WfH and thus, cannot appropriately study the implications of a WfH mismatch for workers' health and wellbeing. A previous study of Nijp et al (18) was the first to follow this reasoning for the related concept of worktime control. The study showed that over 40% of day workers experienced a mismatch between need for and access to worktime control, and that such a mismatch was associated with a higher level of WHI and fatigue. To date, no studies have focused on the association between WfH need versus access mismatch on the one hand and WHI and fatigue on the other.
To address this knowledge gap, the current study aims to examine the relationship of an unfavorable mismatch between need for and access to WfH [ie, need for WfH >access to WfH (ie, WfH mismatch)] with time-based and strain-based WHI and fatigue. Based on the time- and recovery-regulation mechanisms described above and in line with the theoretical notions of individual differences and person-environment fit, we hypothesize a WfH mismatch to be associated with higher levels of time- and strain-based WHI and workrelated fatigue.
Methods
To study the association of WfH mismatch with WHI and fatigue, the current study builds on Nijp et al's previous study (18), which investigated the association of a work time control mismatch with WHI and fatigue. To allow comparison, the methods of the present study were matched with those of this previous study as much as possible with the exception that the previous study included only cross-sectional data, whereas the current study also includes data from a one-year follow-up questionnaire.
Dataset and study sample
For the current study, we used data that were collected among a sample of the participants of The Netherlands Working Conditions Survey (NWCS) in 2010 (N=23 788) (19). NWCS is a periodical survey among employees with a broad range of occupational backgrounds and aims to monitor quality of work and employment in The Netherlands. All followed procedures concerning NWCS are in accordance with the Helsinki Declaration as revised in 2008. Potential respondents of NWCS were informed about the study in a letter accompanying the questionnaire. Participation in the questionnaire was considered informed consent. All data was pseudonymized before access was provided to the researchers.
Respondents who participated in NWCS 2010 and who had given permission to be approached again, were invited for participation in a new questionnaire in autumn 2012 (N=5504). The response rate was 48% (2012; N=2633). After one year, 53% of this population also participated in a second follow-up questionnaire (2012 and 2013; N=1393). Another 7% only participated in this follow-up questionnaire (only 2013; N=405).
To examine the relationship of WfH mismatch with time- and strain-based WHI and fatigue, we used a crosssectional sample including participants who participated in either the 2012 or 2013 measurement or both. Having a paid job was an inclusion criterion. Participants who reported that their work did not lend itself for WfH were excluded. Furthermore, workers who had <24 or >48 contractual hours/week were excluded. We considered working

24 hours/week as a minimum: sufficient exposure in terms of work hours/week is important in a study on WHI and work-related fatigue. Working 48 hours/week was considered the upper limit: this is the legal maximum work hours/week (on average in a 16-week period) in The Netherlands (20). These inclusion and exclusion criteria resulted in a study sample of 2374 persons for the crosssectional analyses. To replicate cross-sectional findings also longitudinally, we additionally applied analyses on the sample of respondents who participated in the 2012 and the 2013 measurement (N=1168) (figure 1).

Measures

Information on WfH, time- and strain-based WHI, fatigue and control variables were derived from the NWCS follow-up questionnaires in 2012 and 2013.

WfH mismatch has been operationalized based on selfdeveloped items on WfH need and access. WfH need was assessed with the following question: "To what extent do you have the need to work from home one or more days per week?" WfH access was assessed with the following question: "To what extent do you have the possibility to work from home?". A 5-point Likert scale was used ranging from "almost not" (1) to "to a very strong degree" (5). WfH need and access were dichotomized. The answers "almost not" and "to a limited degree" were classified as low, and the answers "to a reasonable degree" until "to a very strong degree" were classified as high. A mismatch variable was created by subtracting respondents' need scores from their access scores. Respondents were categorized into a match group (including those with a positive mismatch), ie, access >~ need (values -1, 0, 1, 2, 3 or 4) or an unfavorable mismatch group, ie, access <need (values -4, -3 or -2).

WHI has been operationalized with six items derived from two sub-scales from the Nijmegen Work-Home Interaction Survey (21), ie, time-based WHI and strainbased WHI. An example item of time-based WHI is: "How often does it happen that your work schedule makes it difficult for you to fulfil your domestic obligations?" An example item of strain-based WHI is: "How often does it happen that your work obligations make it difficult for you to feel relaxed at home?" A 4-point Likert scale was used raging from "almost never" to "almost always". Mean scores were calculated for both sub-scales based on the individual items. Higher scores indicate higher levels of time-based WHI and strainbased WHI. Cronbach's alpha's were 0.77 and 0.79 for time-based and strain-based WHI, respectively.

Fatigue was measured using four items from the Fatigue Assessment Scale (eg, "I have enough energy for everyday life") (22) and one item from the Questionnaire for Experience and Assessment of Work (ie, "In general, I only start to feel relaxed on the second non-working day") (23). A 5-point Likert scale was used ranging from "almost never" to "almost always". One item was mirrored and, as such, had to be reverse coded. A mean score was calculated for fatigue based on the five individual items (including the reverse coded item). Higher scores indicate higher levels of fatigue. Cronbach's alpha was 0.82 for fatigue.

Age, sex and educational level were included as control variables. Educational level was measured using a question on the highest level of education completed with a diploma, and categorized into low (primary school, lower and intermediate secondary education or lower vocational training), intermediate (higher secondary education or intermediate vocational training), and high (higher vocational education or university).

Motives to (not) work from home were included to gain insight in why employees choose to use or not to use the possibility to work from home. Respondents who used the possibility to work from home were asked to indicate from a list of eight possible motives, which ones applied to them. Respondents who did not use the possibility to work from home could choose from a list of seven possible motives. These variables are not included in the main analyses but are used to provide insight in the most common reasons to use or not to use the possibility to work from home within the study population.

Analyses

Descriptive statistics, ie, means, standard deviations (SD), frequencies and percentages, were used to report on baseline characteristics and the three most-frequently selected reasons to use or not to use the possibility to work from home. Frequency analyses were conducted to examine the prevalence of WfH mismatch.

Regression analyses were conducted to investigate the association between WfH mismatch on the one hand, and time-based WHI, strain-based WHI and fatigue, on the other hand. All models were adjusted for age, sex and

educational level. Firstly, the analyses were conducted with cross-sectional data. To test whether there were differences between male and female, we included an interaction term between WfH mismatch and sex in these analyses. Thereafter, the analyses were conducted with a longitudinal design in which we examined the temporal association between WfH mismatch in 2012 and WHI and fatigue in 2013, controlling for the levels of WHI and fatigue in 2012. This implies that we investigated the relations between WfH mismatch in 2012 with changes in levels of WHI and fatigue in the following year.

Results

Table 1 shows descriptive statistics of control variables and main study variables of the sample used for crosssectional analyses for the total group as well as separately for the WfH match and mismatch groups. The average age of the study sample was 44.2 years. Most participants were male (62.7%), and had an intermediate (37.9%) or a high (52.7%) educational level. Respondents were mainly working in business services (18%), healthcare (15%), industry (14%), education (12%), public administration (12%) and trading (10%).Respondents reported, on average, a score of 2.5 for WfH need, and 46.1% of the participants were classified to have high WfH need (table 1). On average, respondents scored 2.1 for WfH access, and 32.1% could be classified as having high WfH access. With regard to WfH mismatch 21.1% of the participants were classified as having a WfH mismatch (access <need). Table 2 shows descriptive statistics of control variables and main study variables (at baseline and follow-up) of the sample used for the longitudinal analyses. WfH mismatch was stable over time, with 85% remaining either in the match group or in the mismatch group between baseline and follow-up, 9% changing from match to mismatch and 6% changing from mismatch to match (data not shown in table). Also, the outcomes timebased WHI, strain-based WHI and fatigue were stable over time. When applying a dichotomous operationalization, 14% changed from low to high time-based WHI and 10% from high to low, 16% changed from low to high strain-based WHI and 9% from high to low, and 12% changed from low to high fatigue and 12% from high to low (data not shown in table).

Motives to (not) work from home

Among the respondents who had access to work from home and additionally made use of this possibility, the three most-frequently selected motives were (i) to be more productive (62.9% of those who responded to this question), (ii) to facilitate a good balance between working life and private life (42.7%), and (iii) to reduce commuting time (37.1%). Among the respondents who had WfH access but did not make use of this possibility, the three most-frequently selected reasons were (i) to promote a proper separation between working life and private life (4.7%), (ii) to facilitate collaboration with colleagues (37.9%), and (iii) to have better (social) contact with colleagues (33.6%).

WfH mismatch in relation to time-based WHI

Table 3a shows adjusted models resulting from the linear regression analysis for WfH mismatch and timebased WHI using cross-sectional and longitudinal data. Using cross-sectional data, WfH mismatch was associated with a higher level of time-based WHI than a positive mismatch or a match (B 0.13). There was no significant interaction between WfH mismatch and sex (P=0.23) (data not shown in table). Explained variance (R2) of WfH mismatch was 0.009 beyond the explained variance of 0.007 attributed to the control variables only. Using the longitudinal data, WfH mismatch was not associated with a change in time-based WHI between 2012 and 2013.

WfH mismatch in relation to strain-based WHI

Table 3b shows adjusted models resulting from the linear regression analyses for WfH mismatch and strainbased WHI using cross-sectional and longitudinal data. Using cross-sectional data, WfH mismatch was asso- ciated with strain-based WHI with a higher level of strain-based WHI than a positive mismatch or a match (B=0.17). There was no significant interaction between WfH mismatch and sex (P=0.34) (data not shown in table). Explained variance of WfH mismatch was 0.016 beyond the explained variance of 0.020 attributed to the control variables only. Using the longitudinal data, WfH mismatch was not associated with a change in strainbased WHI between 2012 and 2013.

WfH mismatch in relation to fatigue

Table 3c shows adjusted models resulting from the linear regression analyses for WFH mismatch and fatigue using cross-sectional and longitudinal data. Using crosssectional data, WfH mismatch was associated with more fatigue than a positive mismatch or a match (B 0.32). There was no significant interaction between WfH mismatch and sex

(P=0.31) (data not shown in table). Explained variance of WfH mismatch was 0.027 beyond the explained variance of 0.008 attributed to the control variables only. Using the longitudinal data, WfH mismatch was not associated with a change in fatigue between 2012 and 2013.

Discussion

This study showed that an unfavorable WfH mismatch was associated with higher levels of time- and strainbased WHI and more fatigue in the cross-sectional analyses, but it was not associated with changes in these outcomes in the longitudinal analyses. This implies that a WfH mismatch is associated with higher WHI and more fatigue, but that it is not related to further worsening of WHI and increasing fatigue over time.

Previous research mainly examined WfH access in relation to employee wellbeing. Our findings showed that it is important to not merely consider WfH access, but to take on a richer conceptualization of WfH, including attention for employee preferences and the match between access to and need for WfH. These insights align with the study by Nijp et al (18), showing that a proper match between need for- and access to worktime control may help to prevent problems in work-life balance, fatigue and work motivation. It should, however, be noted that the associations between WfH mismatch on the one hand and time- and strain-based WHI and fatigue on the other hand were rather weak in the current study. Interestingly, our results on motives to work from home or not showed that a proper balance between working and private life appeared to be a reason to work from home for some respondents, but a reason to not work from home for others. Also, WfH use may be related to long working hours and working in evenings and weekends, which, in turn, may have consequences for WHI and fatigue. Future (qualitative) research may be a fruitful way to gain more insight in underlying mechanisms related to the role of motives to (not) work from home as well as long working hours and working at unfavorable times in relation to wellbeing outcomes.

These findings fit the theoretical notions of individual differences in integration and segmentation preferences (16) and person-environment fit, which poses that individual wellbeing is optimal when characteristics of the context match those of the individual (17). Application of this theoretical notion to the context of WfH implies that a proper match between access to and need for WfH is important for employees to successfully and sustainably combine working life and private life. Our finding that an unfavorable WfH mismatch is associated with higher time-based WHI supports the time-regulation mechanism (13), meaning that an unfavorable WfH mismatch hampers employees to adapt working times to responsibilities in their private life. Besides, our findings that an unfavorable WfH mismatch is associated with strain-based WHI and fatigue are support for the recovery-regulation mechanism (13), meaning that WfH enables employees to adjust their working and resting times to their recovery needs.

Methodological considerations

A strength of our study is that we used a large and heterogeneous sample of employees in The Netherlands. Nevertheless, two third of our population was male, which may be due to the fact that we excluded workers who had <24 contractual hours/week. The unequal male-female distribution may limit generalizability of the findings to some extent, but still our study sample included a group of 860 women. Also, post-hoc analyses showed no significant interactions between WfH mismatch and sex for all the outcomes, which indicates that findings of our study apply to men and women. Also, intermediate and high educational level were somewhat overrepresented. This may be a reflection of our choice to select participants who reported that their work lends itself to WfH, which is more common among people with higher compared to lower educational levels. Another strength is that that we used longitudinal data to replicate our cross-sectional findings, which allowed us to assess the temporal association between WfH mismatch and change in WHI and fatigue one year later. Nevertheless, the longitudinal analyses cannot provide clear evidence for causal links between WfH mismatch and WHI and fatigue. It is thus not clear whether a WfH mismatch causes WHI and fatigue or whether higher WHI and fatigue increase the need for WfH and as such a WfH mismatch. An analytical approach taking into account changes in WfH mismatch from baseline to follow-up would be better, but was not possible due to the high stability in WfH mismatch in our data, and, as a consequence, insufficient statistical power. Future research is recommended to gain more insight into causal links between WfH mismatch and wellbeing outcomes, including studies with a larger study sample with sufficient statistical power to study the effects of changes in WfH mismatch, as well as studies within settings in which changes in WfH mismatch

can be expected, such as after changes in WfH policies or other reasons for intensification of WfH (eg, due to COVID-19). Another limitation of this study is that WfH need and WFH access have been measured with only one item each, and thus, WfH mismatch was based on two items. As WfH need and WfH access are relatively simple constructs, this might, however, not be problematic. In addition, WfH mismatch was treated as a dichotomous construct and we did standard linear regression analyses to gain insight in the association between WfH mismatch and WHI and fatigue. To explore the association in more detail, future research is recommended treating WfH mismatch as a continuous construct and to do more advanced statistical analyses, for example including polynomial regression analyses.

Practical implications

Our results emphasize the need for tailored organizational WfH policies to reduce the risk of a personenvironment misfit. Individual preferences with regard to WfH need to be taken seriously by organizations to prevent reduced employee wellbeing and protect sustainable employability. Prior to the COVID-19 pandemic, employers were sometimes reluctant to introduce a lenient WfH-policy, as they feared reduced work performance and suboptimal remote collaboration. However, these fears are found to be mostly unfounded in case WfH is supported by modern technology and clear performance targets (11). A tailored approach to WfH-policies implies some level of freedom in WfH; employees can evaluate whether WfH >1days a week fits their preferences and aligns with their personal situation (eg, a proper place to work at home) and work tasks at hand. The employer (ie, managers or supervisors) plays an essential role in reducing WfH mismatch and in securing tailored and thus favorable and sustainable WfH-policies.

Working from home in the context of COVID-19

The COVID-19 pandemic catalyzed WfH, making this topic very relevant. However, WfH during our preCOVID-19 data collection is different from WfH during the COVID-19 pandemic, which is very specific for several reasons (24). First, the COVID-19 outbreak made it impossible for employees and employers to anticipate large-scale WfH, and they had to abruptly move to fully working from home without relevant WfH-policies to manage this transition. Second, WfH became the (obligatory) default instead of the (self-chosen) exception and many employees had to work fulltime from home, instead of the one WfH-day a week that they may have had prior to the COVID-19 pandemic. At the same time, it may have increased the challenge to combine work and care responsibilities for many workers due to (temporarily) school closures. Although the results from the current study may not apply to WfH practices during the COVID-19 pandemic, the experiences from the pandemic may change how employers and employ- ees perceive WfH. It is likely that WfH becomes an integral part of our future work society, maybe even in a more extensive form (ie, >1 day per week) than before the COVID-19 pandemic. Previously, employees may have had too little access to WfH in comparison to their need, whereas in future the opposite may be true with mandatory WfH even for those workers with a low need for WfH. Future research should address the effects of mandatory WfH on employees' wellbeing.

Concluding remarks

In conclusion, we found that an unfavorable mismatch between WfH access and need is associated with higher WHI and fatigue. A tailored WfH organizational policy, in which employees' need for working from home is taken into account, may be a fruitful approach to utilize WfH as a way for employees to successfully and sustainably combine work and private life in its full potential.

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Conflict of interest

The authors declare no conflicts of interest.

Sidebar

Working from home (WfH) is a promising practice that may enable employees to sustainably combine work and private life. However, employees may not have similar access to and need for WfH. As an unfavourable mismatch between WfH access and need is associated with work-home interference and fatigue, tailored WfH organizational

policies are essential to utilize WfH to its full potential.

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Associations of working conditions and chronic low-grade inflammation among employees: a systematic review and meta-analysis

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ABSTRACT (ENGLISH)

Objectives Chronic low-grade inflammation has been identified as a key pathway linking stress experience to human health. However, systematic evaluations on the relationship of work stress and immune function are scarce and predominantly based on cross-sectional studies. We performed a systematic review and meta-analysis of prospective studies on associations of working conditions and inflammatory biomarkers. Methods In line with our previously established study protocol and the PRISMA-guidelines, we systematically searched electronic databases for prospective studies on working conditions as well as workplace interventions and inflammatory markers in employees. We classified studies (by design, type of exposure/intervention, outcome) and performed rigorous risk-

of-bias assessments. Studies were summarized qualitatively, and a meta-analysis was conducted. Results We identified 23 eligible studies (N=16 432) with a broad scope of working conditions and inflammatory markers. For interventional designs, we differentiated between individual-directed/behavioral (including physical and mental) and organization-directed/structural interventions. Workplace physical exercise interventions were associated with a decrease in C-reactive protein (k=5; d=-0.61; P<0.001). For other workplace interventions, ie, mental and organizational/structural, results were inconclusive. Concerning observational studies, dimensions of the job demand-control(-support) model were most frequently investigated, and results showed weak - if any - associations with inflammatory markers. Conclusions The research base was heterogeneous and high-level evidence was limited. More prospective studies are needed with broader consideration of work stressors and inflammatory markers. For practical occupational health management, exercise interventions are effective measures to reduce chronic low-grade inflammation.

FULL TEXT

Headnote

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Methods In line with our previously established study protocol and the PRISMA-guidelines, we systematically searched electronic databases for prospective studies on working conditions as well as workplace interventions and inflammatory markers in employees. We classified studies (by design, type of exposure/intervention, outcome) and performed rigorous risk-of-bias assessments. Studies were summarized qualitatively, and a meta-analysis was conducted.

Results We identified 23 eligible studies (N=16 432) with a broad scope of working conditions and inflammatory markers. For interventional designs, we differentiated between individual-directed/behavioral (including physical and mental) and organization-directed/structural interventions. Workplace physical exercise interventions were associated with a decrease in C-reactive protein (k=5; d=-0.61; P<0.001). For other workplace interventions, ie, mental and organizational/structural, results were inconclusive. Concerning observational studies, dimensions of the job demand-control(-support) model were most frequently investigated, and results showed weak - if any - associations with inflammatory markers.

Conclusions The research base was heterogeneous and high-level evidence was limited. More prospective studies are needed with broader consideration of work stressors and inflammatory markers. For practical occupational health management, exercise interventions are effective measures to reduce chronic low-grade inflammation.

Key terms health; immune system; inflammatory biomarker; information and communication technology; job; occupational stress; work.

Given the profound transformation of work in the age of digitalization, investigations into ramifications for employee health are of crucial importance. There is substantial evidence for associations between exposure to workplace-related stressors and risk of physical as well as mental morbidity, including cardiovascular diseases (CVD), metabolic conditions, depression, etc, and mortality (1-9). Over the past years, research on work stress has expanded the focus on job task characteristics [such as described in Karasek's job strain model (10)] to organizational factors (such as working hours or organizational justice) and also broader labor market conditions (such as job insecurity) and their effects on employee health (11-14). Work stress is typically classified as chronic stress, ie, prolonged or repeated stress exposure, although there is no clear time point to dif- ferentiate between chronic and acute stressors (15-17).

In general, the human stress response involves - besides the engagement of the main stress systems [ie, autonomic

nervous system (ANS) and hypothalamic-pituitary-adrenocortical (HPA) axis] - complex effects on the immune system most importantly with up-regulation of inflammatory pathways and downregulation of cellular immunity (18-21). While in the short term these adaptations serve protective functions (22, 23), sustained and systemic low-grade inflammation implies a dysregulation of the immune system and has been suggested as a mediator in the pathogenesis of chronic diseases (20, 24-27). Particularly, inflammatory biomarkers, such as C-reactive protein (CRP), interleukin-6 (IL-6), but also leukocytes, are involved in the atherosclerotic process (28, 29).

Reviews and meta-analyses in the field of psychoneuroimmunology demonstrate a large body of evidence that psychosocial distress affects immunological and inflammatory activity (17, 30-32). Specifically for work stress, studies reported associations between adverse working conditions and chronic low-grade inflammation in employees, as for instance effort-reward imbalance (ERI) (33), long working hours (34), job strain and poor social support (35, 36). However, two pivotal limitations arise from the current literature base.

First, conclusive and systematic syntheses of the current knowledge base as well as quantitative aggregation of effects of work-related stress on employees' chronic low-grade inflammation are scarce. Previous reviews and meta-analyses have focused on associations of psychosocial job stress (37, 38) and herein particularly ERI (39) with immune and inflammatory markers. Those reviews have the limitation of including a significant number of cross-sectional studies, what limits inferences concerning cause-effect relationships.

Secondly, collated evidence is lacking with regard to effects of other work exposures - besides the commonly studied psychosocial work factors - on employees' immune function. With the ubiquitous and ever-increasing use of information and communication technologies (ICT) in the workplace, associated risks of professionals' stress experience have become a phenomenon of growing scholarly interest. Human interaction with ICT at work is suggested as a potential source of negative psychological and biological sequelae for health and well-being (40, 41). Yet, as far as we are aware, knowledge gaps exist with respect to how working conditions related to the omnipresence and use of ICT and concomitant new demands, but also resources for employees (42) have effects on physiological stress responses in terms of low-grade inflammation.

A review based on prospective studies allows for conclusions on a higher level of evidence and for inferences concerning temporal order and direction of effects in the interplay of workplace stressors and inflammatory reactivity as a risk factor to serious long-term diseases (43). Beyond temporal sequence, ie, the exposure precedes the outcome, one important indicator of causation is reversibility, ie, mitigation of work stress reduces the health risk (13, 44). The consideration of interventional studies with high-quality designs [ie, randomized trials (45)] in addition to observational prospective studies, may therefore not only provide a more complete summary of the evidence, but also deeper insights into potential cause-effect relationships between work stressors and inflammatory markers.

We conducted a systematic review and meta-analysis to determine the present evidence base on prospective associations between various working conditions and chronic low-grade inflammation in employees. More specifically, we aimed to (i) systematically summarize the current research base and establish quantitative estimations of associations. Furthermore, we sought to (ii) detect studies on ICT use at work and inflammatory markers. Lastly, we aimed to (iii) identify and evaluate workplacerelated interventions to decrease inflammation.

Methods

Protocol and registration

First, a systematic review protocol was developed and published (46). The review was registered in the PROSPERO-database (registration ID: CRD42020166887). It adheres to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (47; PRISMA-checklist upon request). No major deviances from the original protocol were undertaken. Minor adaptations related to the use of software, waiver of graphical synthesis, and use of AMSTAR-2 instead of GRADE (for details, please see below).

Eligibility criteria

We searched for studies on associations between working conditions and inflammation fulfilling the following PECOS/PICOS-criteria: Participants (P): adult employees/workers/professionals. Clinical samples with particular diagnoses as well as specific professional groups, like military personnel, athletes, artists, and students were

excluded. Exposures/interventions (E/I): all kinds of working conditions and workplacerelated interventions, including psychosocial, mental, and physical. There were no a-priori restrictions by type of workplace intervention, meaning all measures aiming at occupational health promotion or well-being on the job, conducted on or off site as well as during or outside working hours, were considered. Studies on environmental hazards, ie, chemical or biological agents and extreme heat, as well as nutritional, pharmaceutical, or nutraceutical interventions were not eligible. Furthermore, we excluded studies on shiftwork and exclusive shiftwork samples (48, for a review) as well as studies on socioeconomic status as exposure. A particular objective of our review were effects of work-related use of digital technologies and media, defined as all electronic devices (hardware), applications (software), and means of communication, such as computers, mobile phones, messaging systems, autonomous systems, etc. Comparators (C): workers not or exposed to a lower extent to working conditions/workplace interventions of interest. Outcomes: pre-defined biomarkers of inflammation within three main categories (cells, plasma molecules, intracellular processes) measured in blood or saliva (see supplementary material, www.sjweh.fi/article/3982, table S1). Study design (S): prospective studies with at least one follow-up measure, ie, at least two consecutive measurements of the inflammation outcome. We included observational (eg, cohort) and interventional studies, ie, randomized controlled trials (RCT) and non-randomized studies of interventions (NRSI, eg, before-after studies). Laboratory or simulation studies were not eligible. We included original research articles in the languages English or German published in peerreviewed journals from 1982 until present. Conference proceedings, study protocols, and theses were excluded.

Information sources

As primary information source, we conducted a systematic search in five electronic databases, including PubMed/MEDLINE, Embase, PsycINFO, Web of Science, and Cochrane's CENTRAL. Our search was finalized in November 2020. In addition, we performed citation searching of included studies in Google Scholar (forward search) and hand-searching of reference lists of included studies and relevant reviews (backward search).

Search and study selection

We developed a four-tier search string comprising a broad spectrum of terms related to the specified PECOS/ PICOS elements (see also 46). The four blocks were linked with the Boolean operator "AND" and within the blocks the terms were combined by "OR". The screening procedure of retrieved records was conducted in Rayyan (49). Two reviewers independently performed systematic and stepwise assessment of eligibility (HK, MW). First, titles and abstracts were screened and then full-texts were assessed. The title and abstract screening were pre-tested, in order to ensure a joint understanding of the eligibility criteria. Discrepancies and uncertainties were resolved by discussion as well as consultation of other review members until consensus was reached.

Data collection process and data items

Two reviewers (HK, MW) extracted data of included studies in a pilot-tested Excel sheet (table S2) that was based on the Cochrane Consumers and Communication Group's template (50). In case of missing information, we contacted authors. We obtained additional data from four authors. For multiple publications of identical data, only one study with longer follow-up period was included. Information was extracted on (46): study characteristics (authors, year, design, location, followup, occupational setting); participants' professional characteristics, age, gender, ethnicity, health-related variables, sample size, recruitment method, relevant inclusion/exclusion criteria; E/I and C=type and description of working condition/workplace intervention and comparators, theoretical foundation, and assessment; O=type and assessment of outcomes; statistical analyses, results, and moderators/control of confounders. Where reported, we extracted data from adjusted models for baseline biomarker levels and/or important covariates such as age or sex. After data extraction, professional samples were grouped into occupational settings based on the ILO classification of industries and sectors (51).

Risk of bias in individual studies

Two reviewers (HK, MW) performed standardized risk of bias (RoB) assessments, and systematic evaluations were established after consensus. For RCT, the updated version of the commonly used Cochrane risk-of-bias tool (RoB 2; 52), and for NRSI, ROBINS-I was applied (53). Observational studies were assessed with the Quality of Reporting of

Observational Longitudinal Research checklist (54). A summary score was calculated with higher scores indicating better quality (54).

Synthesis of results

Synthesis of results comprised three steps: First, we clustered studies by design, exposure/intervention, and outcome. Concerning exposures/interventions, we applied our pre-defined classification system: studies were categorized based on underlying theoretical models and specific exposure features: mental versus non-mental, acute versus chronic, investigation of digital technology use (for definitions, see above and 46). Second, we provided a qualitative summary of all included studies in narrative and tabular format. In addition, main results were visualized by means of arrows indicating direction of effects. Third, where possible, we performed quantitative syntheses of sufficiently similar studies. Otherwise, results were summarized narratively for at least two studies within one cluster. A random-effects meta-analysis was conducted utilizing Meta-Essentials (55). Heterogeneity was evaluated using Q statistic with p-value and I2 statistic. In case of low heterogeneity, additionally a fixed-effects model was applied. As the majority of studies were based on controlled designs with repeated measurements, we chose an effect size that accounts for pre-post changes in different groups. In particular, we calculated the recommended pretestposttest-control group effect size dppc2, according to the following formula (56, 57):
(ProQuest: ... denotes formula omitted.)
(7=treatment group; C=control group)
For the interpretation, the operational definition by Cohen (58) of d-values of 0.2, 0.5, and 0.8 representing small, medium, and large effect sizes was used. As a sensitivity analysis, we excluded studies attributed a high RoB.

Risk of bias across studies

In order to assess RoB across studies, we used funnel plots, tests for funnel plot asymmetry (59), and the Trimand-Fill procedure (60, 61). Furthermore, we applied the appraisal instrument AMSTAR-2 for evaluation of the quality of our review (62).

Results

Study selection

The database search yielded a total of N=28 623 records. After removal of duplicates, 24 062 records remained and were screened by title and abstract; 23 956 records were discarded. Besides, we identified 2285 additional records and 3 reviews relevant to our research question, which were screened for further eligible studies (38, 63, 64). In total, 106 full-texts were assessed in detail, of which 83 studies did not meet our inclusion criteria (list of excluded studies upon request). Eventually, 23 studies were included in the qualitative and 5 studies in an additional quantitative analysis. A PRISMA flow diagram depicts the study selection process (figure 1).

Study characteristics

The characteristics of all included studies are presented in table 1. There were two major clusters of study designs: 16 interventional studies, including 8 RCT (65-72) and 8 NRSI (73-80) as well as 7 observational studies (81-87). The majority of studies (k=13) (65-68, 70, 73, 75-77, 79, 80, 84, 86) came from Europe, 4 from Asia (71, 72, 83, 87), and 2 from the USA (69, 78) (location in 4 studies not specified). In sum, data from N=16 432 (including dropouts, see table S2) participants were included in our review. Samples were based on different occupational settings, most frequently public service (k=7) (68, 70, 73, 78, 82, 84, 86), followed by health services (k=5) (65, 67, 69, 77, 85). The majority of studies excluded employees with particular diseases, such as CVD, diabetes, inflammatory conditions, and/or use of specific medication (table S2, for more details). We found high heterogeneity in studied work-related exposures/interventions. According to our pre-defined scheme for model- and feature-based classification of working conditions (46), we retrieved 5 studies that were based on established job stress models, including job demands and resources like job control, decision latitude, and workplace social support (73, 82, 83, 86, 87). Other or modified job stress models were examined in 2 studies (84, 85). Concerning specific features, we categorized 15 studies as investigating psychosocial or mental working conditions/interventions (65, 66, 69, 72-74, 76, 78, 80, 82-87) and 8 studies as assessing physical work-related exposures/interventions (67, 68, 70, 71, 75, 77, 79, 81). Furthermore, 3 studies (72, 74, 81) examined predominantly acute effects. Remarkably, we did not retrieve prospective studies on

work-related ICT use, apart from one study reporting effects of a web-based workplace intervention (66). Concerning inflammatory outcomes, included studies covered all pre-defined categories (table S1). Most frequently surveyed were plasma molecules including CRP (67, 68, 70, 71, 73, 75, 77-80, 82-84, 86, 87) and cytokines (66, 67, 71, 73, 74, 79-82, 84-86). Inflammation-related processes on cell level, ie, leukocyte counts, were investigated in 3 studies (72, 85, 87). Intracellular processes, including gene expression (65, 72) and transcription factors (69), were also assessed in 3 studies (see tables 1 and S2).

Risk of bias within studies

The results of the RoB assessments (per domain and overall) for RCT and NRSI as well as of the quality of reporting assessment for observational studies are shown in table S3. All RCT were appraised to have "some concerns" regarding their overall RoB. Evaluations for NRSI are presented separately for controlled and uncontrolled studies and ranged from "serious" to "critical" overall RoB. For observational studies, on average 20 of the 33 checklist criteria were reported, leading to a mean summary score of 0.62 (range 0.41-0.70).

Results of individual studies

In the following, results are described first for interventional and second for observational studies. For interventional designs, we further distinguished between individual/behavioral (ie, physical and mental) and organizational/structural interventions.

Interventional studies

Individual/Behavioral Interventions

Physical Interventions. We found seven studies assessing effects of workplace physical activity/exercise interventions on inflammatory biomarkers, including five controlled (four RCT) and two uncontrolled studies. With regard to RCT, two studies examined effects of worksite aerobic exercise interventions in laboratory (67) and cleaning personnel (68). Murphy et al (70) investigated the influence of a walking program in civil servants. Respective control groups (CG) received either no training (67, 70) or lectures (68). In a further RCT, effects of a workplace-based yoga intervention were assessed in industry employees against a wait-list CG (71). A controlled study (ie, comparison to passive CG) investigated a cycling to work intervention in professionals of a health insurance company (75). Two uncontrolled NRSI were identified: a leisure time physical activity program in a road maintenance company initiated by the employer (79) and a promotional campaign for stair use in a hospital (77). All studies explored plasma molecules, most frequently CRP. Results per marker are presented in table 2.

A meta-analysis was performed for CRP based on the five controlled studies (see figure 2). Results showed a combined effect size of Cohen's d=-0.61 (range -1.04- -0.18) that was significantly different from zero [z(242)=-3.47, P<0.001, 95% confidence interval (CI) -1.09- -0.12]. This effect was medium-to-large in size and indicated that the physical interventions resulted in a significant reduction of workers' CRP levels. The studies included in this pooled effect size showed no significant heterogeneity (Q=5.64, P =0.228, I2=29.1%). An additional fixed-effects meta-analysis revealed similar results. Exclusion of one study appraised with "serious" RoB (75) resulted in an attenuated, yet still significant negative effect (d=-0.48, 95% CI -1.04-0.08, P=0.003).

With regard to other inflammatory markers, three studies examined pro-inflammatory cytokines and two found reductions in IL-6 (71, 79) and TNF-a (67, 71), respectively.

Mental Interventions. We identified five studies on mental interventions, including four RCT (65, 66, 69, 72) and one uncontrolled study (78). Two RCT scrutinized meditation- and/or mindfulness-based trainings, one among emergency department professionals (65) and one in medical residents (69). Similarly, a resilience training was examined in an uncontrolled study among law-enforcement officers (78). Hasson et al (66) evaluated a web-based health promotion tool in IT and media workers, which in the intervention group (IG) additionally included classical stress management exercises (eg, time-management, relaxation) and a chat. A cross-over study assessed recreational music-making, ie, group drumming, in male corporate employees (72). All results are presented in table S4. Concerning gene expression, findings were mixed with two significant intervention effects, ie, an upregulation of TNF-a mRNA (65) and a downregulation of IL-10 mRNA (72), and non-significant effects for other cytokine mRNA levels.

Organizational/Structural Interventions

We found four NRSI on organizational/structural interventions. Two studies assessed effects of work reorganization. One investigated changes in physiological markers following a major reorganization of non-state public offices (73), and another measured physiological effects of outsourcing among bus drivers (76). Wultsch et al (80) examined inflammatory effects of extended daily working times in office workers and carpenters. In addition, we included one study among university professors that investigated acute inflammatory reactions in saliva after lecturing to students (74). All results are depicted in table S5. Due to "serious" and "critical" RoB appraisals, reported findings need to be interpreted with caution. The two studies that measured employees' CRP found significant increases after the intervention (73), yet one just in younger participants (80). For fibrinogen, no studies showed significant changes (73, 76). Regarding cytokines, for IL-6 one (73) out of two studies (80) reported significant upregulations. For other cytokines, increases were observed in response to an acute work stressor, ie, lecturing (except for IL-10) (74).

Observational studies

Overall, seven observational studies were retrieved (table 3). Four studies (82, 83, 86, 87) applied Karasek's job demand-control(-support) JDC(-S) model (10, 88): Job strain (82, 86, 87) and workplace social support (86, 87) were not prospectively related to CRP. Meanwhile, when the source of social support was specified, high supervisor support (in contrast to coworker support) was associated with lower CRP among women but not men (83). Job demands were not related to fibrinogen and leukocyte count (87) as well as IL-6 (82, 86). However, there were indications for small protective effects of job control regarding fibrinogen (87) and IL-6 (86) among women and leukocyte counts among men (87). For social support, Shirom et al (87) found no effects, but notably Magnusson Hanson et al (86) showed that poor workplace support - albeit weakly - was linked to higher IL-6 levels, which partially mediated the association with diabetes. Lee et al (85) investigated job stress in hospital nurses based on criteria related to the JDC(-S) model by comparing measures of objective (eg, data on staffing patterns) and subjective (ie, self-report data) stress: they identified significantly lower numbers of white blood cells in the group with high objective stress, but found no effects of subjective stress and for cytokines (85). Moreover, organizational justice and inflammation were surveyed in a large cohort study (84): Among men, but not women, low self-reported justice was associated with increased CRP and IL-6 in the long-term. Besides these model-based studies, we found one small exploratory study that compared acute effects of occupational physical demands in two groups with high (eg, construction workers) and low (ie, sedentary work) risk of work-related musculoskeletal disorders (81): IL-6 levels were greater in the high-risk group yet showed opposed temporal patterns in the two groups (table 3).

Risk of bias across studies

Concerning the meta-analysis, the funnel plot indicated symmetry in the distribution of individual effect estimates suggesting absence of bias and heterogeneity (89). As less than ten studies were included, tests for asymmetry were not used (90). Based on the Trim-and-Fill method, no studies were missing to the right of the mean, so the combined effect size did not have to be adjusted for publication bias (see figure S1). Our self-rating of the overall confidence in the results per AMSTAR-2 (62) was "high", indicating that the review provides an accurate and comprehensive summary of available studies addressing our research question (AMSTAR-2 evaluation sheet available upon request).

Discussion

Sustained systemic low-grade inflammation has been identified as one of the major pathophysiological pathways linking exposure to chronic stress and development of severe long-term diseases. A thorough and evidencebased understanding of the role of work stress exposure for inflammatory pathways is thus imperative to develop effective prevention and mitigation measures in occupational stress research. To the best of our knowledge, this is the first systematic review and meta-analysis on associations of working conditions and chronic lowgrade inflammation merely based on prospective studies. By building on a higher quality of evidence, this review advances our knowledge on effects of work stressors on chronic low-grade inflammation in employees.

Overall, 23 studies met our inclusion criteria. The extant study base was fragmented with high heterogeneity in assessed exposures and interventions. We identified four clusters of study types, ie, individualdirected/behavioral

(including physical and mental) and organization-directed/structural interventions as well as observational studies.
For workplace physical interventions (k=7), the majority of studies reported reductions in inflammationrelated plasma molecules. These interventions primarily aimed at changing individual behavior by adding physical exercises or activity into employees' work routine (both on- and off-the-job) and were conducted among both sedentary and manual workers. The qualitative finding was corroborated in our meta-analysis demonstrating a medium to strong negative effect of physical exercise interventions (aerobic exercise, walking, yoga, cycling to work) on employees' CRP levels (d= -0.61; k=5). This resonates well with a previous meta-analysis on studies in non-occupational settings showing that exercise training was associated with a decrease in CRP (91). Our results suggest that exercise interventions are an effective measure to reduce low-grade inflammation in employees.
Concerning mental interventions in the workplace (eg, stress reduction programs, music making), the study base (k=5) was limited and inconclusive. However, there were indications for changes of inflammation-related processes on intra-cellular level, ie, gene expression (65, 72) and transcription factors (69). These interventions were also individual-oriented, ie, they aimed at influencing mental processes by providing employees opportunities and skills for increasing their well-being, alleviating stress, facilitating relaxation, strengthening resilience etc. Reviews outside work settings have shown associations of psychosocial interventions, especially cognitive behavior therapy and combined psychotherapeutic interventions, with enhanced immune system function (92). In addition, salutogenic effects of mindfulness meditation and yoga practices in combination with mindfulness-based stress reduction regarding specific inflammatory markers have been suggested (93, 94). Yet, these studies included heterogeneous populations, also clinical samples, which can lead to spurious estimates of effects. Our synthesis suggests that in occupational settings, individual/behavioral interventions appear to be viable measures to ameliorate dysregulated inflammatory processes, however extended research into workplace mental interventions is warranted.
The study base on organizational/structural interventions was confined, with high RoB (k=4). Despite indications of responsiveness of CRP and cytokines to organizational changes (73, 80), definite conclusions would be premature. Given the high variety of organizational-level workplace interventions and differentiated effects on employee health, further investigations into particular types of organizational interventions, such as work reorganization or work time-related conditions, and their effects on inflammatory markers are necessary (95).
The majority of observational studies (k=7) was based on the JDC(-S) model. Results showed predominately null and/or weak associations. However, there were some indications for beneficial functions of job control and workplace social support as well as for sex-related effects. Conclusions of previous reviews are somewhat conflicting: Whereas Nakata (37) suggested that inflammatory markers might be less sensitive to job strain, Wright et al (38) inferred that workplace stress is positively associated with CRP, especially when measured with the JDC model. Despite the evidence for a close link between personal relationships, including social support amongst others, and immune function (96), we found only three studies on workplace social support and inflammatory outcomes. Consistent with previous reviews we deem future research into resources and potentially beneficial effects of workplace support of particular interest (37).
We also sought to detect studies examining stress reactions in terms of inflammation evoked by workrelated ICT use. Ultimately, we identified just one study showing that the application of a web-based health promotion tool modulated TNF-a (66). The extent to which working conditions associated with ICT use or respective workplace interventions affect inflammatory processes needs thus to be further investigated.
Work stress and inflammation: methodological and conceptual considerations
For the interpretation of the collected evidence, some pivotal aspects potentially influencing associations of working conditions and inflammation warrant attention. First, included studies differed tremendously in time lags of follow-ups, spanning a few hours to 14 years, and in numbers, ranging from one to eight follow-up assessments. In longitudinal research the magnitude of effects might vary with the span of the follow-up, ie, whether it corresponds with the true underlying time lag of the outcome under study (43). Multi-wave designs increase the likelihood of detecting effects compared to two-wave designs, and response latencies of respective outcomes may depend on type, intensity, and duration of exposures as well as context factors (43, 97). Thus, differences in follow-up

measurements of inflammatory markers may help to explain the disparity in findings of the present studies. Moreover, although longitudinal designs are suggested to overcome the problems of cross-sectional designs in examining causality, reversed or reciprocal causation and third variables constitute critical issues in longitudinal research (98). As for the question of reverse effects, we are aware of only two of the included observational studies that also tested for associations in the opposite direction in full panel designs, ie, inflammatory markers on subsequent appraisal of working conditions (86, 87). Concerning influences of third variables, many studies controlled for variables critical in stress physiology, such as sex, age, health behaviors (eg, physical activity, smoking), body mass index, (hormone) medication, and baseline levels of respective markers. However, studies differed in the selection and number of included covariates, entailing varying degrees of threats to internal validity (see also tables S2 and S3). For the investigation of cause-effect relationships between intervention and outcome, RCT are considered the gold standard; yet this design is often not feasible in occupational settings (99). Notwithstanding, half of the identified interventions were RCT, so we were able to draw our meta-analysis upon a high level of evidence, yet confined study base.

Furthermore, inflammation should not be assessed in isolation with regard to stress but in the light of potential disruptions of interactions and feedback loops with other stress axes. Inflammation is affected by the two major stress systems HPA axis and ANS through complex neuroendocrine-immune cascades and interactions, indicating that the effects of stress system mediators on the inflammatory system are not linear (100). There is consistent evidence that chronic stress is related to alterations in the sensitivity of target tissue to stress signals, most importantly glucocorticoid resistance, which is associated with increases in circulating inflammatory mechanisms (100). Examples of these complex multisystem interdependences are the - at first glance surprising - results of Dunne et al (65), where TNF-a mRNA increased in the IG, and Hasson et al (66), where TNF-a decreased in the CG. Both authors provided post-hoc explanations concerning potentially impaired negative feedback loops with the HPA axis in chronic stress, and Dunne et al proposed that the observed increase could be due to decreases in cortisol following stress reduction in the IG. Anti-inflammatory effects of cortisol have been well-described (100).

Lastly, we focused on working conditions, as they are more modifiable to workplace interventions than personal factors. Nonetheless, we acknowledge that employees' intrinsic characteristics, such as personal resources, affective-cognitive states, and coping styles, play a significant role in (work) stress perception and regulation (101-103). For instance, higher work engagement was found to be associated with lower subsequent high-sensitivity CRP (104), whereas over-commitment was associated with reduced immunity (39).

Limitations and strengths

Our findings should be interpreted in the light of some limitations. By defining the PECOS/PICOS components, we might have excluded relevant aspects. For example, shiftwork is an important risk factor for inflammation, and in our search, we found sound interventional studies in shift worker samples (eg, 105). However, as it is difficult to disentangle effects of working conditions from the effects of circadian misalignment per se on inflammatory markers (106), we decided a priori to exclude these studies. Moreover, for greater external validity, we only considered investigations in real-world occupational settings. Notwithstanding, we are aware of high-quality laboratory studies on stress responsiveness in chronic work stress (107, 108) and simulation studies in high-risk professions, such as firefighting (109). The generalizability of our findings is restricted to the working population, yet we included a broad range of different professional and occupational groups. A main limitation of our review is the limited study base with great heterogeneity regarding intervention contents and modes of implementation, work exposures, and occupational sectors. By clustering studies following an inductive logic we attempted to build more homogenous subgroups of studies. However, the disparity of clusters in combination with the scarcity of data currently limits the possibility and adequacy of deriving overall conclusions. We acknowledge, that some employer-instigated health promotion approaches were not limited to the workplace and included components to be performed off site/ off duty or on the way to work (eg, cycling to work). This may have introduced heterogeneity within our clusters and impeded a clear differentiation concerning the nature and implementation of included interventions as well as ensuing inferences concerning effectiveness. An important strength of our investigation is that we developed and determined

our methodology prior to the start in a peer-reviewed protocol, limiting the risk of reporting bias and ensuring higher quality. Further strengths pertain to our pre-defined classification system, which enabled us to draw conclusions per cluster given the high heterogeneity of identified studies, and the consideration of a comprehensive set of inflammatory biomarkers. Furthermore, we applied rigorous and thorough RoB assessments in and across studies, allowing for a critical evaluation of the presented evidence.

Implications for occupational health management and future research

For occupational health management, a holistic approach integrating both individual/behavioral and organizational/structural measures may generate greater benefits for employee health (110). The reported physical interventions primarily aimed at modifying employees' behaviors, ie, increasing their physical activity to counteract predominantly sedentary work or high aerobic workload (eg, cleaning). Yet, rather than merely reducing symptoms of work-related strain, preventive measures on an organizational level that target the sources of strain are crucial (111). Primary preventive interventions address stressors through changes in the psychosocial working conditions, physical work environment, or organization and include for instance enhancement of social support or autonomy, and job redesign (110, 112, 113). Although we did not find intervention studies directly aiming at modifying psychosocial work stressors, pooled results of the observational studies suggesting protective effects of job control and social support to employees' inflammation indicate that these factors could be important leverage points to future intervention studies. Furthermore, all retrieved interventions referred to unidimensional approaches, what points to the need for evaluation of complementary, multi-component interventions consisting of individual and organizational measures regarding effects on physiological stress parameters (eg, 114.).

In the light of our findings and further considerations, we suggest the following avenues for future research: First and foremost, more prospective studies are needed. For workplace interventions, RCT or at least controlled studies on mental, physical, and organizational interventions are necessary. In observational research, deployment of full cross-lagged panel designs provides reliable insights into the direction of effects. Second, future research should investigate combinations of work exposures, eg, both psychosocial work factors and occupational physical activity. Investigations into potential additive and interactive effects on psychophysical health might better reflect real-world occupational situations. Moreover, we advocate a clear conceptual and methodological differentiation between objective work exposures on the one hand and subjective reactions of the individual workers on the other. For research on psychosocial work stress however, this is often not feasible, as per definition, psychosocial factors at work concern interactions between both work environment, job content, organizational conditions and individual factors of the workers, such as capacities, needs etc., which may influence health and well-being (115). Third, future research should examine effects of work-related ICT use on inflammation in occupational settings with high-quality designs. With the dynamic advancement of digitalization and technologization of humans' workplaces, research into the concept of technostress (116-118) has been rapidly increasing. However, physiological effects associated with technostress are under-researched (40), and assessment of inflammatory markers might reveal valuable insights into potential detrimental health effects. Forth, while CRP and cytokines were surveyed most frequently, future research should consider further biomarkers of inflammatory processes (such as cellular and intracellular) and interactions with other stress systems. This will contribute to a deeper understanding of pathophysiological pathways from work stress exposure to disease.

Concluding remarks

This systematic review and meta-analysis on associations of working conditions and chronic low-grade inflammation showed that the current base of prospective studies is limited and diverse in methodology, exposures, and inflammatory outcomes. Meta-analytic evidence was established for workplace physical exercise interventions, which were found to significantly reduce employees' CRP level. Complementary to previous reviews mainly based on cross-sectional studies, our review revealed a more differentiated picture of potential associations, suggesting that at this stage, definite conclusions are premature. The review identified important research gaps and derived recommendations for future high-quality studies to advance knowledge in this field. Concerning occupational health management practice, we conclude that physical activity interventions for employees are effective counter-measures

to chronic low-grade inflammation.

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Sidebar

This is the first systematic review and meta-analysis on associations of working conditions and chronic low-grade inflammation solely based on prospective studies. It finds that workplace physical activity interventions were effective in reducing employees' inflammation. However, the current research base is limited and heterogeneous, highlighting the need for prospective studies to advance knowledge regarding pathways from work stress to ill-health.

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Additional material

Please note that there is additional material available belonging to this article on the Scandinavian Journal of Work, Environment &Health -website.

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DETAILS

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Sickness absence and return to work among employees with knee osteoarthritis with and without total knee arthroplasty: a prospective register linkage study among Finnish public sector employees

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ABSTRACT (ENGLISH)

Objective This study aimed to examine duration of sickness absence due to knee osteoarthritis (OA) and sustained return to work (RTW) among municipal employees who had at least one compensated sickness absence period due to knee OA. The contribution of sociodemographic characteristics, diabetes and previous sickness absence were assessed. We differentiated between participants with and without total knee arthroplasty (TKA). Methods Data from 123 506 employees in the Finnish Public Sector Study were linked with national health and mortality register information. There were 3 231 sickness absence periods (2372 participants) due to knee OA in 2005-2011. Kaplan-Meier curves for sustained RTW were obtained and median time with inter-quartile range (IQR) calculated for those with and without TKA. Cox regression analyses were carried out in multivariable analyses. Results The median time to RTW from the beginning of sickness absence was 21-28 days when TKA was not related to sickness absence and 92-145 days when it was. Among participants with no TKA, age 60-64, non-sedentary work, diabetes, and previous sickness absences predicted longer time to RTW, while pain medication predicted a shorter time. Among participants with TKA, non-sedentary work and previous sickness absences predicted a longer time to RTW. Conclusions The clinical relevance of the difference in time to RTW between employees with or without TKA was substantial. Employees with knee OA working in physically demanding jobs need work modifications after TKA, and this calls for a dialog between occupational health care professionals and workplaces.

FULL TEXT

Headnote

Kaila-Kangas L, Leino-Arjas P, Koskinen A, Takala E-P, Oksanen T, Ervasti J, Kausto J. Sickness absence and return to work among employees with knee osteoarthritis with and without total knee arthroplasty: a prospective

register linkage study among Finnish public sector employees. Scand J Work Environ Health. 2021;47(8):600-608. doi:10.5271/sjweh.3989
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Results The median time to RTW from the beginning of sickness absence was 21-28 days when TKA was not related to sickness absence and 92-145 days when it was. Among participants with no TKA, age 60-64, non-sedentary work, diabetes, and previous sickness absences predicted longer time to RTW, while pain medication predicted a shorter time. Among participants with TKA, non-sedentary work and previous sickness absences predicted a longer time to RTW.
Conclusions The clinical relevance of the difference in time to RTW between employees with or without TKA was substantial. Employees with knee OA working in physically demanding jobs need work modifications after TKA, and this calls for a dialog between occupational health care professionals and workplaces.
Key terms arthritis, cohort study, employment, Finland; musculoskeletal disease, sick leave, work.
Knee osteoarthritis (OA) is a common chronic disorder that causes pain and functional limitations with difficulties in walking, stair climbing and other lower-extremity tasks. It reduces quality of life (1), work ability, and work participation (2, 3). The etiology of knee OA is not fully understood, but genetic factors, older age, female sex, obesity, injuries, and repetitive loading of the knee joint, eg, frequent squatting, kneeling, and heavy lifting may play a role (4, 5). OA is a complex condition that involves the entire joint, with progressive loss of articular cartilage, synovitis, and changes in the subchondral bone (6). There is often a discrepancy between the severity of symptoms and the severity of knee OA as assessed by radiography, related to individual experience of pain, and the discrepancy can be to either direction (7).
According to a systematic review (8), the prevalence estimates of knee OA have varied considerably depending on the definition. In European studies, the self-reported prevalence has varied between 7.1% and 15.0%. Among Finns aged >30 years, the prevalence of clinically assessed knee OA was 6% and 8% among men and women respectively in 2000 (9). The incidence of knee OA is higher among women than men, and it increases with age and increasing relative weight of the population (8). Thus, the occurrence of knee OA is likely to rise due to population aging and the obesity epidemic (10).
The management of knee OA is primarily conservative emphasizing the role of exercise, balance training and weight control (7) in diminishing pain and improving functional capacity (11, 12). Arthroscopic surgery with debridement or partial meniscectomy may not bring long-lasting benefits in pain or physical function (13, 14). In severe cases, total knee arthroplasty (TKA) has been regarded as the best method to reduce pain and disability and maintain physical activity in the long term (15, 16).
According to a review (17), there is limited evidence for a specific symptom threshold that justifies TKA, but the minimum requirements for it are significant, prolonged symptoms with supporting clinical and radiological signs. Obesity, diabetes and smoking, and comorbidities particularly among older patients increase the risk of complications following TKA. On average 15-20% of patients are dissatisfied with their outcome after surgery, usually because of ongoing pain and poor physical functioning (18). Also, low preoperative functioning, comorbidities (diabetes mellitus, pulmonary disease and back pain), psychological distress, or desire to return to high-impact activities and unrealistic expectations have been associated with dissatisfaction following TKA (19).
Most employees return to work after TKA (20-22), but long periods of sickness absence are common (23), and only a minority of patients aged >60 years ever return to work (24). A systematic review (25) identified several individual-

related factors that were associated with return to work (RTW) after TKA. These included sex, age, educational level, obesity, motivation to return, and physical and mental functioning, as well as workrelated factors like physical demands, workplace characteristics, employment status, pre-operative sickness absence and workers' compensation.

Timely RTW is the primary goal after recovery among working-aged TKA patients, and the recent steep increase in the incidence of TKA (18, 26) has raised concern regarding the consequences of the procedure for RTW and employability (27). In several countries, the current number of TKA patients <65 years is already high, and the figures are expected substantially to rise at least in United States and Europe (27). It is suggested that also the number of revised TKA is rising in those countries (28). According to a meta-analysis (29), the expectable revision rate in ten years has been <5% in general, but 7% among patients aged <60 years.

Ability to work is not defined by only health or health impairment, but also in relation to one's work demands, and the onset of illness or handicap may not necessarily lead to work disability (30). Because of a lack of research, it is not known whether conservative treatment of knee OA is associated with a shorter or longer time to RTW as compared with TKA. Therefore, we examined time to sustained RTW among Finnish municipal sector employees with sickness absence due to knee OA, using comprehensive register data. We stratified the analyses by treatment modality (TKA or no TKA) and assessed the contribution of morbidity related factors, sociodemographic characteristics, and occupation.

Methods

Participants

The study cohort consisted of participants of the Finnish Public Sector study working in ten municipalities and six hospital districts representing about 20% of public sector employees in Finland (31). In the current analyses, we focused on those employees who were working in the target organizations at the start of the follow-up on 1 January 2005 (N=123 506) and had at least one compensated (ie, lasting >10 work days) sickness absence period due to knee OA before the end of follow-up on 31 December 2011. There were 169 330 compensated sickness absence periods (from 65 985 participants) due to any disorder during the follow-up. Of these periods, 3 231 (1.9%) were due to knee OA (among 2372 participants). Data on hospitalization due to TKA in 1996-2004 were explored, and those who had undergone TKA before the study period were excluded from the analyses.

Data sources

Employers' registers provided information on sociodemographic factors of the participants. Data on medically certified sickness absence periods were drawn from the national register of the Social Insurance Institution of Finland. The register covers the compensated periods that lasted for >10 workdays including the day when the disability started. Information on hospitalization periods and the surgical procedures targeting knee OA, also on TKA, (recorded according to the Nordic Classification of Surgical Procedures) was received from the Hospital Discharge Register provided by the National Institute for Health and Welfare. Data on reimbursed medication purchases with codes from the Anatomical Therapeutic Chemical (ATC) classification system were retrieved from the Register of Special Reimbursement for Medication Purchases from the Social Insurance Institution of Finland. We obtained data on pensions from the national registers of the Finnish Centre for Pensions, and data on deaths were retrieved from Statistics Finland. Register data were combined by each participant's personal identification number that is assigned to each citizen of Finland at birth or when receiving a residence permit.

The Ethics Committee of the Hospital District of Helsinki and Uusimaa in Finland approved the study protocol.

The Finnish work disability compensation scheme

In Finland, all non-retired residents aged 16-67 are eligible for a compensation of incapacity to work due to disorders after the employer period of payment (a minimum of ten days), and thereafter the Social Insurance Institution of Finland compensates sickness absence >10 days. The maximum length of sickness absence compensation is 300 working days per disease in two years. In case of longer-term work disability, a disability pension can be granted either temporarily or permanently.

Sustained return to work (RTW)

RTW was defined as sustained when it was indicated by the end of sickness absence period that was not followed by a recurrent sickness absence period due to the same diagnosis within 30 days. This was based on the regulations of the Social Insurance Institution of Finland, according to which two consecutive sickness absence periods with the same diagnosis are regarded as one if the working period in between the two absence periods lasted <30 calendar days.

Sickness absence data consisted of the starting and ending dates and diagnostic codes (ICD-10) (32) for all medically certified and compensated sickness absence periods. For the analysis, the duration of each sickness absence period was calculated starting from the initial day of work absence until the end of the compensation period. Sickness absence periods that lasted <10 days, and thus were not compensated, were not available in the data. We did not differentiate between partial and full sickness absence days in the analyses.

Covariates

Covariates were sex, age at the time of sickness absence, and occupation [categorized according to the International Classification of Occupations (ISCO) as follows: managers and professionals (ISCO 1-2), associate professionals and clerks (ISCO 3-4), service and care workers (ISCO 5) and manual workers (ISCO 6-9)]. Region was categorized according to the geographical location of the participant's work organization, to adjust for possible regional differences in sickness absence practices (data not shown). Health-related covariates were (i) sickness absence lasting >10 days during the previous year due to musculoskeletal disorders (no/ yes), and separately due to other disorders (no/yes), respectively (ii), purchased medication for musculoskeletal pain (no/yes) using ATC classification system codes M01 (anti-inflammatory and anti-rheumatic products) and N02 (analgesics) (iii), diabetes (based on entitlement to special reimbursements (no/yes), and (iv) hospitalization periods related to knee OA. Medication purchases and hospitalization periods were recorded for the preceding 30 days and during the following 7 days after the sickness absence period. To adjust for the severity of knee OA related to sickness absence periods with no TKA, we added information on hospitalizations (no/yes) due to knee OA.

Statistical analyses

The observational unit was a medically certified and compensated sickness absence period (>10 workdays) due to knee OA. We analyzed separately those periods that were associated with TKA and those that were not. The participants could belong only to one of these categories. We excluded sickness absence associated with partial TKA (36 periods).

The Cox proportional hazards model with a cluster option was applied to estimate the time from the beginning of the sickness absence period to RTW. The cluster option considered the intra-individual correlation of sickness absence periods by using the robust sandwich variance estimates in calculating standard errors. In case of hospitalization for TKA, the time to RTW was estimated from the beginning of sickness absence period due to knee OA or from the beginning of the hospitalization period (when there was no previous sickness absence from work due to knee OA). Hazard ratios (HR) and 95% confidence intervals (CI) were calculated for the time from the beginning of sickness absence to RTW. Observations were right censored in case of disability pension, old age pension, death, or end of the follow-up, whichever came first. Cox proportional hazards models were adjusted for age, sex, occupational group, region, sickness absence during previous year for musculoskeletal disorders, and for other disorders, reimbursed purchase of pain medication, and diabetes. The time until RTW was visually presented by Kaplan Maier curves, separately for those who had undergone TKA and for those who had not. All analyses were performed using SAS software package (version 9.4; SAS Institute, Inc, Cary, NC, USA).

Results

In this sample of municipal workers, knee OA-related sickness absence periods (N=3 231) comprised 1.9% of all compensated (>10 days) sickness absence periods (N=169 330) and 6.2% of sickness absence periods due to musculoskeletal disorders (N=51 469) between 2005 and 2011. Of the participants with sickness absence due to knee OA, 17.6% (N=416) had undergone TKA.

Characteristics of participants with sickness absence due to knee osteoarthritis (OA)

Among participants with sickness absence due to OA, the proportion of women was 77.4%, and among those with

TKA, 80.1% (table 1). The mean age at the time of the first sickness absence due to knee OA among those with no TKA (N=1956), was 52.8 years (SD 7.2) and with TKA 56.5 years (SD 5.2) at the time of surgery. Seventy-one per cent of those with TKA belonged to the age group of 55 to 64 at the time of surgery. The proportion of participants aged 60-64 was 19.5% among those without TKA and 31.0% among those with TKA. The corresponding figures among manual workers were 33.2% and 21.9%.

Return to work (RTW)

Table 2 presents the adjusted associations between baseline characteristics and RTW when sickness absence due to knee OA was not related to TKA. The median time until RTW was 21-28 days. Sex or hospitalization related to sickness absence due to knee OA were not associated with RTW. Participants aged 60-64 had a lower probability of RTW compared to those aged 26-49 (HR 0.78, 95% CI 0.68-0.88). With managers and professionals as reference, associate professionals and clerks (0.85, 95% CI 0.75-0.97), service and care workers (HR 0.76, 95% CI 0.67-0.86) and manual workers (HR 0.74, 95% CI 0.65-0.85) had a lower probability of RTW. Similarly, sickness absence due to musculoskeletal disorders overall (HR 0.90, 95% CI 0.83-0.98) or due to other disorders (HR 0.87, 95% CI 0.79-0.95) during the previous year, as well as diabetes (HR 0.65, 95% CI 0.53-0.80), decreased the probability of RTW, while purchase of pain medication (yes versus no) shortened it (HR 1.09, 95% CI 1.01-1.18).

Table 3 presents the adjusted associations between baseline characteristics and RTW when sickness absence was related to TKA. The median time until RTW was 92-145 days. Sex had no association, but occupation was strongly associated with time to RTW: while the median time to RTW was 92 days among managers and professionals, the corresponding figures were 108 among associate professionals and clerks (HR 0.51, 95% CI 0.38-0.68 with managers and professionals as reference), 130 among service and care workers (HR 0.34, 95% CI 0.26-0.46), and 145 among manual workers (HR 0.28, 95% CI 0.20-0.39). The occurrence of sickness absence due to musculoskeletal disorders (HR 0.79, 95% CI 0.64-0.97) or other disorders (HR 0.71, 95% CI 0.53-0.94) during the previous year was associated with a longer time to RTW.

Kaplan-Meier curves (figure 1) demonstrate that 92% of the compensated sickness absence periods due to knee OA without TKA ended with RTW within six months, while the corresponding figure among those with TKA was 72%. Within a year, 96% and 89% of the periods, respectively, had ended with RTW.

Discussion

In this register based, prospective study, we analyzed the time to RTW from the beginning of sickness absence due to knee OA in a cohort of municipal employees who had at least one compensated sickness absence period due to knee OA during the 7-year follow-up. Sustained RTW was defined as the end of the sickness benefit period that was not followed by recurrent sickness absence period for the same diagnosis within 30 days (33). It was assumed that a person was recovered from an acute disorder when she/he had been working 30 days after sickness absence. Analyses were carried out separately for sickness absence periods (and participants) not related to TKA and for those thus related. At the time of the first sickness absence due to knee OA not related to TKA, the participants were on average 4 years younger than those with TKA, whose mean age was 56 years at the time of surgery.

The median time until sustained RTW was 21-28 and 92-145 days among those without and those with TKA, respectively, when adjusting for sociodemographic characteristics, diabetes and previous sickness absence. Among participants with no TKA, the age of 60-64 years, non-sedentary work, diabetes, and previous sickness absence due to musculoskeletal or other disorders, predicted longer time to RTW, while pain medication predicted a shorter time. Among those with TKA, non-sedentary work and previous sickness absence due to musculoskeletal or other disorders predicted longer time to RTW. A prolonged sickness absence was especially common in service, care and manual work.

The primary strength of our study was the prospective study design and access to comprehensive and valid national register data on sickness absence and hospitalization (34). We could also adjust for many important factors that may have an impact on the time until RTW, including health conditions based on register data on all causes of sickness absence and reimbursed purchases of medication. A cohort of mostly female municipal employees representing hundreds of occupations was followed up. Although municipal occupations involve a large variety of tasks, the

results may not be directly generalizable to other branches of industry. Public sector employees are mostly women. Even though the proportion of women was much higher than that of men, the number of men was high enough for comparison. Moreover, the previous studies have shown contradictory sex related results on the time to RTW among TKA patients (20, 35).

There are some limitations in this study. First, we did not have information on short sickness absences. Consequently, the length of sickness absence until RTW may be slightly overestimated. The sickness absence periods related with knee OA comprised 1.9% of all sickness absence periods in our data, in line with a Swedish population-based study that assessed that 2% of all sick days were attributable to knee OA (36). Another limitation is a lack of information on body weight of the participants. There is evidence on obese patients having more difficulties with knee OA and less improvement in TKA outcomes (37). However, diabetes was associated with slower RTW only among sickness absence not related to TKA. This result may be due to healthrelated selection of individuals to TKA, while diabetes increases the risk of complications following TKA (17). Selection of older patients to surgery or postponement of it due to work-related hindrances can also explain the overrepresentation of those aged 60-64 and the underrepresentation of manual workers among TKA patients.

Most of the previous studies on time to RTW after TKA have based on self-reported retrospective data, and the authors have calculated the full or partial return to work based on the working hours before and after TKA (35). We considered only full return to work. We also measured the time to RTW from the first day of sickness absence and this may have resulted in a longer median time to RTW than in previous studies. In a register-based study, about half of the patients started their sick leave even before the surgery (23).

Lastly, there may have been changes in the care path for OA in Finland after 2005-2011 when the data were gathered. For example, a new law, called the '30-60-90-day rule', was introduced in 2012. This law requires that, after 30 days of sickness absence, the employer needs to inform their occupational healthcare services about the situation of the employee. After 60 days of sickness absence, the occupational healthcare physician needs to assess the need for rehabilitation. And after 90 days of sickness absence, the occupational healthcare physician needs to assess the possibilities of RTW. A register-based study (38) of municipal workers showed, that the effect of the new legislation was most pronounced after about 12 weeks of sickness absence, but the annual gain in work participation was modest.

There is a lack of research on RTW when knee OA is not related to TKA. In a study (39) among Swedish working-age population, the length of the age- and sexadjusted mean period of sickness absence for knee OA was 81 days. A population-based register study on work ability and work participation of Finnish employees with knee OA (40) found that the median time to RTW was 31 days. However, neither of these studies reported whether sickness absence was related with TKA or not. In a previous study that was based on the same data as the study at hand, the median time to RTW for intervertebral disc disorders (ICD-10: M51) was 32 days among men and 37 among women, and for back pain (ICD-10: M54) 21 and 22 days, respectively (33).

In this study, 92% of the participants with knee OA who did not go through TKA returned to work within six months and about 96% within a year. Half of the sickness absence periods ended with RTW in 21 days. Thus, the median time to RTW was comparable to sickness absence related to back pain in the same population (33). When sickness absence was related to TKA return to work took several months.

According to a descriptive review, the greatest functional improvements occur during the first year after the TKA (41). We found that 72% of sickness absence periods compensated for TKA were associated with RTW within six months, and 89% in one year. The adjusted median time to RTW was 3.1 months among managers and professionals, 3.6 months among associate professionals and clerks, 4.3 months among service and care workers, and 4.8 months in manual work. A systematic review (20) of studies (altogether 649 patients) on RTW after TKA showed that 71-83% of patients were back at work within 3-6 months. In the study of Sankar et al (22), 77% returned to work in 6 months after TKA. Early return to work (within one month) was associated with male sex, university education, working in business, finance or administration, and low physical demands at work. In a prospective study of working patients aged <65 years undergoing TKA for OA, 89% had returned to work one year postoperatively

(42). In line with our results, a recent review found that most important factors associated with a slower return to work were a physical nature of employment and preoperative absence from work (35).
We used occupational group as a proxy for physical workload. However, the loads imposed on the knee can vary even within the same job due to individual variation of tasks. It was found (43) that the risk of sickness absence and disability pension due to knee OA was higher in female-dominated job sectors such as health care, childcare and cleaning, which are common among municipal occupations. A large Finnish nationally representative study suggested that 50% of disability retirement due to knee OA among individuals in most manual occupations could be attributed to physical workload factors (44).
A qualitative study (45) reported, that the rehabilitation goals of TKA patients are mainly focused on knee mobility and range of motion, but there is also a need to integrate work into the individually tailored rehabilitation process. However, this requires a dialog between healthcare professionals and employers on appropriate work adjustments (46). Especially occupational health care professionals have knowledge on the work, workplace and potential work adjustments. Obviously, more knowledge is needed on how rehabilitation combined with workplace adjustments can ease RTW and possibly postpone TKA among knee OA patients.
To conclude, our findings showed that 50% of employees on sickness absence due to knee OA returned to work in three weeks when TKA was not needed, and in three months when it was. RTW was especially slow in non-sedentary jobs, and among those with previous sickness absences. Given the burden of knee OA in working age population, the clinical relevance of the difference in time to RTW between employees with or without TKA was substantial, and especially among manual workers. Employees with knee OA working in physically demanding jobs need work modifications after TKA, and this calls for a dialog between occupational healthcare professionals and workplaces.

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Sidebar

It is not known whether conservative treatment of knee osteoarthritis (OA) is associated with shorter or longer return to work as compared with total knee arthroplasty (TKA). We examined the duration of sickness absence due to OA and return to work among public sector employees. We differentiated between employees with and without TKA.

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DETAILS

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Job dissatisfaction as a predictor of poor health among middle-aged workers: a 14-wave mixed model analysis in Japan

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ABSTRACT (ENGLISH)

Objective This study aimed to examine the association between job dissatisfaction (JD) and health outcomes among middle-aged workers. Methods This study used longitudinal data comprising 156 823 observations of 24 056 workers (13 177 men and 10 879 women) collected from a 14-wave nationwide population-based survey in Japan that began in 2005, involving individuals aged 50-59 years. Mixed models were estimated to examine the association between JD and the risk of psychological distress (PD), poor self-rated health (SRH), and health-related resignation (HRR). Results Across all waves, 20.9-32.5% of participants were dissatisfied with their jobs for at least one year before each wave. Mixed model results showed that this JD experience was associated with higher risks of

PD, poor SRH, and HRR, with odds ratios (OR) of 1.96 [95% confidence interval (CI) 1.75-2.20], 1.33 (95% CI 1.26 - 1.40), and 1.57 (95% CI 1.40 -1.75), respectively. A longer JD duration was associated with a higher risk of poor health. No substantial differences between genders were found regarding the association between JD and health outcomes. A separate analysis showed reverse causation from poor health to JD; poor health was significant in predicting later JD even when it was controlled for. Conclusions The results confirm that JD was predictive of poor health among middle-aged workers. Therefore, policymakers and managers should monitor the JD of their employees and improve their work environments to enhance their occupational health.

FULL TEXT

Headnote

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Objective This study aimed to examine the association between job dissatisfaction (JD) and health outcomes among middle-aged workers.

Methods This study used longitudinal data comprising 156 823 observations of 24 056 workers (13 177 men and 10 879 women) collected from a 14-wave nationwide population-based survey in Japan that began in 2005, involving individuals aged 50-59 years. Mixed models were estimated to examine the association between JD and the risk of psychological distress (PD), poor self-rated health (SRH), and health-related resignation (HRR).

Results Across all waves, 20.9-32.5% of participants were dissatisfied with their jobs for at least one year before each wave. Mixed model results showed that this JD experience was associated with higher risks of PD, poor SRH, and HRR, with odds ratios (OR) of 1.96 [95% confidence interval (CI) 1.75-2.20], 1.33 (95% CI 1.26 -1.40), and 1.57 (95% CI 1.40 -1.75), respectively. A longer JD duration was associated with a higher risk of poor health. No substantial differences between genders were found regarding the association between JD and health outcomes. A separate analysis showed reverse causation from poor health to JD; poor health was significant in predicting later JD even when it was controlled for.

Conclusions The results confirm that JD was predictive of poor health among middle-aged workers. Therefore, policymakers and managers should monitor the JD of their employees and improve their work environments to enhance their occupational health.

Key terms job satisfaction; psychological distress; self-rated health.

Job dissatisfaction (JD) is widely known to have a negative association with workers' health and productivity (1-3). Many studies have observed that JD contributes to mental health problems, including anxiety, burnout, and depression (4-7), as well as poor self-rated health (SRH) (8-10), which represent more general health conditions. Studies have also provided evidence of a correlation between JD and more objective negative outcomes in the workplace, such as sickness absence (11-13), health-related job loss (14), and disability pension (15, 16), all of which signify a loss of effective workforce participation. JD can be interpreted as a key mediator of the association between psychosocial factors in the workplace and workers' health outcomes (6, 7) because it reflects a worker's subjective assessment of various aspects of the work environment.

However, the observed association between JD and health outcomes is most likely confounded by personality traits (17, 18) and other inherent individual attributes that are likely to vary from participant to participant. For instance, workers with higher neuroticism - that is, those who tend to respond to threats, frustration, or loss with negative emotions - are more likely to be dissatisfied with their jobs and suffer from psychological distress (PD) (17). If this is the case, the observed association between JD and health outcomes may be overstated. Many previous studies that relied on cross-sectional analysis were not fully free from this type of bias.

Another issue to be addressed is simultaneity bias. Health outcomes are affected by JD; however, JD is also likely to be affected by health outcomes, possibly resulting in an overestimated impact of JD on health, as observed in the cross-sectional data (19, 20). Prospective cohort studies are generally expected to alleviate these biases, but follow-up for just a few years after the baseline cannot fully control for the correlations between repeated measurements

within each participant.
Lastly, the reverse causation from health outcomes to JD has been largely understudied. Although many studies have investigated the determinants of JD (21-26), health outcomes have usually been treated as a result rather than a cause of JD.
In this study, we examined the association between JD and health among middle-aged workers using longitudinal data obtained from a 14-wave nationwide population-based survey. Unlike most preceding studies, we employed a mixed model analysis (27) to take full advantage of repeated measures for each participant over time. Mixed models can capture both fixed effects (which are assumed to remain the same across participants) and random effects (which are assumed to vary randomly from participant to participant). These models are expected to control for participant-specific factors, which may confound the association between JD and health outcomes by explicitly accounting for the correlations between repeated measurements within each participant (27).
We also focused on the association between health outcomes in the concerned wave and JD experience before it; that is, we considered how health outcomes in wave t were associated with JD experience until wave t-1. This approach, which evaluates the presence of JD before health outcomes, is expected to mitigate simultaneity biases, which tend to overestimate the association between JD and health outcomes due to their reciprocal relationship (19, 20). Further, we examined the reverse causation from health outcomes to JD by estimating the association between health outcomes and JD one year later in the framework of mixed model analysis.
We considered three aspects of JD, evaluating it in terms of ability utilization (21, 22), workplace relationships (23, 24), and working conditions (25, 26), all of which are key determinants of JD, and combined them into a single-item measure. Regarding health outcomes, we focused on PD, poor SRH, and health-related resignation (HRR). PD measured by Kessler 6 (K6) scores (28, 29), represents mental health, SRH serves as a global measure of health status (30, 31), and HRR is a proxy for objective negative outcomes in the workplace. Given the observations in previous studies, we hypothesized that JD would be predictive of poor health outcomes in workers.
In summary, this study attempted to examine the association between JD and health outcomes and their reverse causation by applying mixed model analysis, which is expected to control for participant-specific factors that may confound the association between JD and health outcomes. The findings of this study are expected to provide new insights into the relevance of JD in occupational health to the existing literature, which consists mainly of cross-sectional or short-term prospective cohort studies.

Methods

Study sample

In this study, we used data obtained from a nationwide 14-wave panel survey, "The Longitudinal Survey of Middle-Aged and Older Adults," conducted by the Japanese Ministry of Health, Labor, and Welfare (MHLW) each year from 2005 to 2018. Japan's Statistics Law required the survey to be reviewed from statistical, legal, ethical, and other viewpoints. We obtained the survey data with the official permission of the MHLW; therefore, the current study did not require ethical approval.
The survey started with the cohort aged 50-59 years (born 1946-1955) in the first wave. A total of 34 240 individuals responded (response rate: 83.8%). The 2nd to 14th waves of the survey were conducted annually from 2006 to 2018; 20 677 individuals remained in the 14th wave. In wave t, we focused on the health outcomes of participants who reported their job satisfaction in wave t-1. Since the questions on JD were asked of employed workers, we removed participants who had not been employed (that is, who had been unemployed, self-employed, or other) before each concerned wave. After further excluding participants with missing key health variables (PD, SRH, and HRR) in each wave, we obtained 156 823 observations of 24 056 participants (13 177 men and 10 879 women), which were used for descriptive analysis.
For regression analysis, we further removed participants who were already psychologically distressed or whose health was assessed as poor or very poor (see below for definition) one year before each concerned wave because they may have been psychologically distressed or unhealthy due to reasons other than job dissatisfaction. Consequently, we used longitudinal data from 147 830 observations of 23 498 participants (12 901 men and 10 597

women) for the regression analysis.

Measures

Job dissatisfaction. The survey asked the participants to answer the question, "How do you feel about your job in terms of the following: (i) ability utilization, (ii) workplace relationships, and (iii) working conditions?" - all of which have been the key correlates of JD in preceding studies (21-26), on a five-point scale (satisfied, 2=somewhat satisfied, 3=average, 4=somewhat dissatisfied, and 5=dissatisfied). We calculated the sum of these scores (range: 3-15); Cronbach's alpha varied 0.724-0.780 for each wave. We defined JD as a higher degree of overall dissatisfaction with the three job aspects; specifically, we defined it as a total score of >10, which accounted for 31.7% of the total respondents and roughly corresponded to the highest tertile of the total score. We then focused on how long the individuals had been continuously dissatisfied with their jobs before the concerned wave. We constructed four binary variables for JD duration: (i) >1 (ii) 1, (iii) 2, and (iv) >3 years, where (i) is a comprehensive definition of JD, including (ii)-(iv).

Health outcomes. We considered three health outcomes: PD, poor SRH, and HRR. We constructed K6 scores to measure the PD (28, 29). The reliability and validity of K6 has been demonstrated in a Japanese sample (32, 33). The participants were asked to answer a six-item questionnaire that included items such as "During the past 30 days, how often did you feel (a) nervous, (b) hopeless, (c) restless or fidgety, (d) so depressed that nothing could cheer you up, (e) that everything was an effort, or (f) worthless?" The questions were rated on a five-point scale (0=never to 4=all of the time). We then calculated the sum of the reported scores (range: 0-24) and defined it as the K6 score, whose Cronbach's alpha varied 0.876-0.883 for each wave. Higher K6 scores reflect higher PD levels, and K6 scores >13 indicate serious mental illness in a Japanese sample, as validated by previous studies (29, 31). We constructed a binary variable for PD by assigning a value of 1 to those with K6 scores >13 and 0 to the others. We did not include data from respondents who did not report all six items.

Regarding SRH, the participants were asked to rate their current health condition as follows: 1 (very good), 2 (good), 3 (somewhat good), 4 (somewhat poor), 5 (poor), or 6 (very poor). SRH is correlated with morbidity and is predictive of changes in functional ability (31, 32). We constructed a binary variable for poor SRH by allocating 1 to those who chose 4-6 and 0 to the others.

We further constructed a binary variable for HRR by allocating 1 to those who answered that they stopped working for health reasons in the concerned wave and 0 to the others. This definition corresponded to a temporary leave from the workplace in most cases because the survey provided other reasons for leaving a job, such as being fired and mandatory retirement, and 95.3% of those who had resigned for health reasons resumed working in later years, allowing us to compare the results regarding sickness absence (11-13).

Covariates

We considered a set of participant-level covariates evaluated for each wave. Specifically, we constructed binary variables for gender (female=1; male=0) and marital status (having a spouse =1; otherwise=0). For age at baseline, we constructed binary variables for each age (for instance, 1=age 50 years, 0=otherwise). Occupational status was divided into six categories (managers, regular employees, non-regular employees [such as part-time, temporary, and contract worker], other, and unemployed) and constructed binary variables for each category (for instance, 1=managers, 0=otherwise). Similarly, we constructed binary variables for each category of educational qualification (junior high school, high school, junior college, college or above, other, and unanswered) and health behavior (currently smoking, heavy alcohol consumption, and no physical activity). We also considered household spending as a proxy for household income and adjusted it for household size by dividing it by the square root of the number of household members (34). We categorized them into quartiles and constructed binary variables for each quartile. For respondents who did not answer questions about household spending, we allocated a binary variable to unanswered questions. We also included binary variables for each wave to control for wave-specific effects. We did not use occupational status in wave t as a covariate when estimating HRR in wave t, because current occupational status (especially, no job and self-employed) may be a result of HRR in many cases.

Statistical analysis

For descriptive analysis, we compared the prevalence of each health outcome between those who were satisfied with their jobs and those who were not, and examined the extent to which the prevalence of each health outcome was correlated with JD duration.

For regression analysis, we estimated two logistic mixed models, Models 1 and 2, to predict the probability of each health outcome by JD, according to the choice of JD variables. For participant i in wave t, Model 1 is given by

$$\ln[Pr(Hit = 1)/(l - Pr(Hir = 1))] = ß10 + ß11JDTit\text{-}1 + (covariates) + ε1i + u1it$$

where H is a binary variable for each health (PD, poor SRH, or HRR), JDT is a binary variable for JD duration of one year or longer, ej represents participantspecific factors, and u is an error term. Meanwhile, Model 2 is given by

$$\ln[Pr(H_{it} = 1)/(l - Pr(H_{it} = 1))] = ß20 + ß21\text{-}JD1it\text{-}1 + ß22jD2it\text{-}1 + ß23jD3it\text{-}1 + (covariates) + εi + uit$$

where JD 1, JD2, and JD3 are binary variables for JD duration of one, two, and three years or longer, respectively, e2 represents participant-specific factors, and u2 is an error term.

In both models, we focused on the association between health outcomes in the concerned wave and JD experience to mitigate simultaneity bias. We also removed the respondents with PD or poor SRH in the previous year because they may have been psychologically distressed or unhealthy due to reasons other than JD. To check the robustness of the logistic mixed model results, we estimated the linear versions of Models 1 and 2 by replacing the binary health variable, H, with its continuous score.

Additionally, we estimated the logistic mixed model (Model 3) to predict JD in the concerned wave. Model 3 is given by

$$\ln[Pr(JDít = 1)/(1 - Pr(JDít = 1))] = γ0 + γiPDu\text{-}i + γ2poorSRHit\text{-}i + γ3JDTit\text{-}i + (covariates) + ε3i + u3it$$

where JD is a binary variable for JD. PD, poor SRH, and JDT are binary variables for PD, poor SRH, and JD duration of one year or longer, respectively, all of which were evaluated in the year before each concerned wave. e3 represents participant-specific factors, and u3 is an error term. This regression was aimed at examining the reverse causation from health to JD. To check the robustness of the estimation results, we estimated the logistic mixed model to predict JD using K6 and SRH scores instead of their binary variables. For all statistical analyses, we used the Stata software package (Release 15).

Results

Descriptive analysis

The proportion of participants who were dissatisfied with their jobs for >1 year before the concerned wave declined from 32.9% in the 2nd wave to 20.9% in the 14th wave. Table 1 summarizes the distribution of JD experience among the participants in the 7th wave, which was around the middle of the total number of waves, and compares the prevalence of each health outcome between those who were satisfied with their jobs and those who were dissatisfied with them. As seen in this table, 27.4% of men and 21.9% of women were dissatisfied with their job for >1 year before the 7th wave. The mean length of JD duration was 1.7 [standard deviation (SD) 1.1] years for men and 1.8 (SD 1.2) years for women. As expected, JD was associated with a higher prevalence of adverse health outcomes; for example, 3.8% of men who were dissatisfied with their jobs in the previous year experienced PD in the seventh wave, compared to 1.2% of men who were satisfied with their jobs. We also observed similar patterns in the other waves.

Based on pooled observations, figure 1 graphically illustrates a positive relationship between JD duration and the prevalence of each poor health outcome for both men and women. The slopes of the curves were not substantially different between genders for each health outcome, although the levels of the women's curves were higher than those of men for PD and HRR and lower for poor SRH. These results suggest a limited interaction between JD and gender.

Regression analysis

Table 2 presents the results of Model 1 for each health outcome. The odds ratios (OR) of reporting PD, poor SRH, and HRR in response to JD for >1 year were 1.96 [95% confidence interval (CI) 1.75-2.20], 1.33 (95% CI 1.26-1.40), and 1.57 (95% CI 1.40-1.73), all of which indicated a positive association between JD and poor health outcomes. We conducted a likelihoodratio rate test to test the null hypothesis that there were no individual-level random effects.

If this hypothesis is rejected, the mixed model must be applied; otherwise, we can use the pooled cross-sectional model. The test showed that the null hypothesis could be rejected (P<0.001) for all health outcomes, indicating that the mixed model was consistently preferred to the pooled cross-sectional model. In addition to these key results, the model showed that having no spouse, heavy alcohol consumption, and the lowest educational qualification (graduating from junior high school) were positively associated with poor health outcomes.

The bottom of table 2 presents the key estimation results obtained after including the interaction term between JD and being female. The OR of the interaction term was not significantly different from that in all models, while the OR of the interaction term in logistic regression models could not be interpreted in a straightforward manner (35). Thus, we present the regression results for the entire sample, rather than separately for men and women in what follows.

Table 3 summarizes the key results of Models 1 and 2, adjusted for covariates, and compares the results between the logistic and linear models. These three findings are noteworthy. First, JD was positively associated with poor health outcomes in all model specifications. Second, a longer JD duration was associated with poorer health outcomes in most model specifications, a result consistent with the observations in table 1 and Figure 1. For instance, as JD duration increased from 1 to >3 years, the OR of reporting PD increased from 1.67 (95% CI 1.42-1.96) to 2.49 (95% CI 2.09-2.96) in the mixed model. Third, the results obtained using the linear models were consistent with those obtained from the logistic results.

Table 4 presents the results of Model 3, which explains a binary variable for JD in the concerned wave by one-year lagged variables for PD, poor SRH, and JD. The table showed that JD was positively associated with both PD and poor SRH in the previous year with an OR of 1.50 (95% CI 1.35-1.67) and 1.37 (95% CI 1.30-1.43), respectively. The bottom panel of the table confirms that replacing binary variables for health with the continuous variables obtained results that were consistent with those in the binary model.

Discussion

In this study, we examined the association between JD and health outcomes among middle-aged workers, controlling for individual attributes. To take full advantage of repeated measures for each participant over time, we conducted a mixed model analysis of the 14-wave longitudinal data of middle-aged workers. As hypothesized, the results indicated that JD is a key predictor of adverse health outcomes in workers.

These results were generally consistent with those obtained in previous studies (3-13), most of which were based on cross-sectional or prospective cohort studies. In addition, the observed impact on HRR was in line with that reported in previous studies on the impact of JD on negative outcomes in the workplace (11-16). We confirmed the validity of the conventional view that JD is an important determinant of occupational health, even when controlling for participant-specific attributes.

Second, we observed that a longer JD duration moderately added to the risks of each poor health outcome, as shown in both the descriptive and mixed model analyses. While studies have shown that JD tended to discourage workers from staying in the workplace (11-16), the results suggest that a prolonged JD duration was associated with an average deterioration in health outcomes.

Third, behind this accumulating effect of JD duration, there may be cumulative causation between JD and health outcomes. As seen in table 4, JD was not only affected by JD duration until the previous year but also by the previous year's PD and poor SRH, which had been affected by JD duration beforehand, as suggested by the results in table 3. The existence of the latter route suggests that PD and poor SRH may mediate the impact of previous PD experience on current PD. This mediation mechanism is likely to enhance JD's selfsustainability and thus make JD adversely affect health over time.

This study focused on middle-aged workers, who were more exposed to the onset of health problems compared to other age groups (36, 37). Hence, the observations in this study may help assess the potential magnitude of the association between JD and health in all age groups. However, many studies have shown that age can be a moderator in the association between work characteristics and occupational well-being indicators (38); for instance, JD is known to be more sensitive to job instability among younger than older workers (39). Hence, it is reasonable to suspect that the association between JD and health outcomes may differ across age groups, suggesting the need to

expand the analysis to cover workers of all ages.

This study has several limitations. First, we ignored the possibility that JD may have various aspects and that each may affect health outcomes independently and differently because we combined three aspects of JD - dissatisfaction with ability utilization, workplace relationships, and working conditions - into a single-item measure. Previous observations that job dissatisfaction is substantially affected by psychosocial work factors, such as support from superiors and colleagues (40, 41), suggest a closer association of dissatisfaction with workplace relationships. Therefore, the relative effect of each JD aspect on PD and their relationships should be examined in future research.

Second, the association between job satisfaction and health outcomes is likely to be confounded by job status, especially in full-time and part-time jobs. Low job satisfaction and poor health status are more common among part-time than full-time workers (42), and the confounding effects of job status may be affected by socio-institutional factors related to equal treatment between full- and part-time workers. The analysis of these effects remains a topic for future research.

Third, this study ignored potential biases due to attrition. The proportion of participants who were dissatisfied with their job declined over the waves, suggesting the possibility that the observed association between JD and health outcomes may have been underestimated. Mixed models in this study focused on the short-term association between JD and health, but the analysis of the long-term impact of JD on health should control for potential attrition biases considering the possibility that unhealthy participants were more likely to have dropped out of the survey.

Concluding remarks

Despite these limitations, we can conclude that JD is modestly associated with poor health among middleaged workers. Policymakers and managers should regularly monitor employees' job dissatisfaction and make efforts to improve their work environments to enhance their occupational health.

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Sidebar

Our hazards model analysis showed that job dissatisfaction predicted earlier onsets of psychological distress, poor self-rated health, and health-related retirement among middle-aged workers, both male and female, after controlling for baseline covariates. The results suggest that job dissatisfaction sends a reliable signal for occupational health to enhance workers' health.

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Decades of workplace health promotion research: marginal gains or a bright future ahead

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ABSTRACT (ENGLISH)

The workplace is a promising setting for health promotion as workers spend a lot of time at work, and existing social networks for social support could be used to change behavior and enhance health. Workplace health promotion programs could be a way to improve workers' health and can for example include elements of support, policies, or environmental changes to encourage healthy behavior. Traditionally, programs have focused on providing workers with advice on how to change their behavior. Such programs have been criticized because they do not take a broader perspective such as the environment. However, still many of these traditional programs are offered to employees and evaluated. The effects of such programs remain disappointing thus far. Here, Robroek et al reflect on the body of research regarding workplace health promotion. They also describe gaps in the literature, most notably regarding the need for more targeted workplace health promotion, a systems approach for workplace health promotion, and the delivery of workplace health promotion. Furthermore, they propose some research agenda concerning workplace health promotion.

FULL TEXT

The potential of workplace health promotion

Unhealthy behaviors (eg, insufficient physical activity, an unhealthy diet, high alcohol intake and smoking) and obesity are risk factors for adverse health outcomes (1, 2), productivity loss due to presenteeism or sickness

absence (3-6), and early exit from paid employment (7, 8). Poor health and unhealthy behaviors are more prevalent among workers from low socioeconomic positions (1, 2, 9), as are unemployment and work disability (10, 11). With a growing challenge in our societies to work longer, reflected in the increasing statutory retirement age in many European countries, an urgent need exists to enhance workers' health to remain in paid employment. Given the profound socioeconomic inequalities in health behaviors, health, and participation in paid employment, this is particularly pressing among workers in lower socioeconomic positions.

The workplace is a promising setting for health promotion as workers spend a lot of time at work, and existing social networks for social support could be used to change behavior and enhance health. In the past decades, numerous workplace health promotion programs have been offered and evaluated regarding their (cost-)effectiveness. Workplace health promotion programs could be a way to improve workers' health and can for example include elements of support, policies, or environmental changes to encourage healthy behavior. Traditionally, programs have focused on providing workers with advice on how to change their behavior. Such programs have been criticized because they do not take a broader perspective such as the environment (eg, workplace structures and conditions) into account (12). However, still many of these traditional programs are offered to employees and evaluated. The effects of such programs remain disappointing thus far. A recent review of reviews reported only small favorable long-term effects of workplace health promotion programs targeting physical activity and diet to reduce workers' body weight (13). This is in line with findings from recent individual participant data metaanalyses of Dutch workplace health promotion programs that showed small and statistically non-significant decreases in unhealthy behaviors and body mass index (14, 15). In this editorial, we reflect on the body of research regarding workplace health promotion. Gaps in the literature will be described, most notably regarding (i) the need for more targeted workplace health promotion, (ii) a systems approach for workplace health promotion, and (iii) the delivery of workplace health promotion. We will conclude this editorial with future directions for workplace health promotion research.

Gaps in the workplace health promotion literature

Targeted workplace health promotion_

A recent individual participant data meta-analysis showed that the effectiveness of workplace health promotion programs differed across target populations. Those programs focusing on indicated prevention (ie, on workers who are already at risk for unhealthy behavior, obesity or other health problems) were found to be more effective than universal prevention where a program is delivered to all workers within an organization (15). This is in contrast with the Geoffrey Rose paradigm, which implies that universal prevention, aimed at reducing the risk of an entire population, would be more effective from a public health perspective than interventions only targeting high-risk groups (16). However, as unhealthy behaviors and obesity are highly prevalent in the general population, the high-risk group consists of a large share of this population. It could therefore be argued that a targeted approach for workplace health promotion would be effective from a public health perspective as well.

In line with this and in an attempt to reduce socioeconomic health inequalities, effective interventions targeting workers in low socioeconomic position are needed. There are no indications that workplace health promotion programs differ in their effectiveness when delivered to different socioeconomic groups (14-16). However, a recent review on workplace health promotion showed that researchers substantially more often conduct studies on workplace health promotion among workers from higher compared to lower socioeconomic groups (17). This is striking because, as mentioned above, there is a particular need among workers in low socioeconomic groups to improve their health and reduce sickness absence and presenteeism. Researchers need to be encouraged to reach out to this group, even though it might be challenging.

A systems approach to workplace health promotion

As universal behavioral prevention strategies on health behaviors or weight reduction in health promotion programs show little-to-no effect (13-15), it could be questioned whether and - if so - how workplace health promotion programs are justified. As unhealthy behaviors and obesity often coincide with pressing life struggles, including relational, emotional, financial and physical problems, single component interventions are unlikely to result in

substantial changes (18). This notion is underlined by study results suggesting that improvements in health and productivity among workers is unlikely solely a behavioral issue. A recent article in this journal indicated that the work itself, rather than characteristics of the worker, account for one third of socioeconomic health differences (19). These recent findings reiterate discussion papers from decades ago arguing that health behavior change can hardly be reached by only providing people information and advice on how to become healthy (20). Approaches that combine individual interventions with changes in the environment and society are the most promising strategies to improve healthy behavior and reduce obesity (21). This means that more research is needed on the interplay between 'causes of the causes' of unhealthy behavior by trying to understand the 'system' in which people live and work. Only then, the structural determinants of health behavior among workers can be addressed. These so-termed system approaches are lacking within the occupation health setting or occur with only minimal changes in the environment.

The delivery of workplace health promotion

The ineffectiveness of workplace health promotion programs cannot only be attributed to the target population or the content of the programs, but can also be the result of the lack of a clear implementation strategy and understanding of factors that may hinder or enable adequate uptake of workplace health promotion. In other words, what, why and how programs work in 'real world' settings.

Even though implementation research receives more and more attention in occupational health, it is still underrepresented in publications, including in this journal. Proper &van Oostrom (13) conclude that more research is needed on the factors that contribute to successful implementation of interventions. A systematic review showed room for improvement as initial participation levels in studies regarding workplace health promotion had a median participation level of only 33% (22). A meta-analysis indicated larger intervention effects among workers with higher program compliance (14), which emphasizes the importance of sustained participation with regard to the effectiveness. It is a particular challenge to reach workers with a lower socioeconomic position who typically work in blue-collar occupations and jobs involving difficult work circumstances such as shift work. A review on shift workers suggested that, to enhance participation, workplace health promotion programs should adopt more flexibility in the time and location of delivery of the program and time off (23). To reduce socioeconomic inequalities, in addition to delivering effective workplace health promotion programs, there is a need to gain more knowledge on implementation strategies to reach specifically workers with lower socioeconomic positions and to implement interventions in their context.

Future directions of workplace health promotion research

Based on the knowledge gaps mentioned above, we propose the following research agenda concerning workplace health promotion. First, address underlying determinants of unhealthy behavior in workplace health promotion programs for workers with lower socioeconomic positions. Because of the persistent socioeconomic health inequalities and the low number of scientific studies conducted among workers with a lower socioeconomic position, there is undoubtedly a need for high quality studies on targeted interventions for these workers. These interventions should use approaches that go beyond a single behavioral component, for example a systems approach that considers underlying issues that coincide among workers with a low socioeconomic position (eg, unhealthy behaviors, unfavorable working conditions, health problems, and underlying social and financial issues).

Second, conduct process evaluations alongside effect evaluations to better understand how and why an intervention is (in-)effective. As aforementioned, although targeted interventions could be highly effective in the context of a research trial, it is important that they reach and retain the target group when implemented in a real-world setting. Designing the intervention and implementation strategies both deserve attention in the development phase of workplace health promotion programs to gain a better insight on what works for whom in which context and to make sure that successful workplace health promotion programs are sustainable in practice. To develop such implementation strategies, structured process evaluations to monitor the implementation alongside effect evaluations are needed (24). Although this suggestion is not new, and the number of process evaluations have increased in the past decades, publications of process evaluation still lag behind the publication of effects

evaluations. A review showed that of 307 effect evaluations of workplace health promotion programs, only 27 (7.2%) published a process evaluation, which were moreover often of poor-to-average quality (25). We encourage researchers to conduct process evaluations and submit papers consisting of both a process and effect evaluation. In line with this, editors should also be more willing to publish such studies.

In conclusion, workplace health promotion programs thus far show marginal gains, as the effectiveness and implementation of traditional universal preventative workplace health promotion interventions are still disappointing. A drastic turnaround in occupational health research would be needed for us to have a bright future ahead with better tailoring and delivering interventions to the needs of the target group, in particular for workers with low socioeconomic positions.

Sidebar

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DETAILS

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Exposure to workplace violence and threats and risk of depression: a prospective study

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ABSTRACT (ENGLISH)

Objectives Several studies have examined the health consequences of workplace threats and violence, however, due to methodological issues the epidemiological evidence is limited. The purpose of this study was to examine the prospective association between self-labelled exposure to work-related threats and violence and the risk of depression, measured by a standardized psychiatric interview and new prescriptions of anti-depressive medication. Methods Employees were recruited from the Danish PRISME cohort established in 2007 where 4489 Danish public employees answered a postal questionnaire with follow-ups in 2009 and 2011. In all three waves, depression was diagnosed by clinical interviews with the Schedules for Clinical Assessment in Neuropsychiatry (SCAN). In addition, we ascertained prescription of anti-depressive medication from a national register. Using logistic regression and Cox proportional hazard models, we estimated the association between exposure to threats and violence at baseline and SCAN depression and prescription of anti-depressive medication during two years of follow-up. Results Self-labelled exposure to work-related threats and violence was associated with a risk of SCAN diagnosed depression two years later, odds ratios (OR) 2.20 [95% confidence interval (CI) 1.13-4.28] and OR 2.11 (95% CI 1.05-4.24), respectively, with indication of a dose-response. Self-labelled exposure to work-related threats and violence was associated with prescription of anti-depressive medication in a two-year period, hazard ratios (HR) 2.55 (95% CI 1.47-4.40) and HR 1.47 (95% CI 0.70-3.06), respectively. Conclusion Exposure to work-related threats or violence is associated with an increased risk of depression two years later, measured with a psychiatric interview and register data on prescribed antidepressants.

FULL TEXT

Headnote

Rudkjoebing LA, Hansen ÅM, Rugulies R, Kolstad H, Bonde JP. Exposure to workplace violence and threats and risk of depression: a prospective study. Scand J Work Environ Health. 2021;47(8):582-590. doi:10.5271/sjweh.3976

Objectives Several studies have examined the health consequences of workplace threats and violence, however, due to methodological issues the epidemiological evidence is limited. The purpose of this study was to examine the prospective association between self-labelled exposure to work-related threats and violence and the risk of depression, measured by a standardized psychiatric interview and new prescriptions of anti-depressive medication. Methods Employees were recruited from the Danish PRISME cohort established in 2007 where 4489 Danish public

employees answered a postal questionnaire with follow-ups in 2009 and 2011. In all three waves, depression was diagnosed by clinical interviews with the Schedules for Clinical Assessment in Neuropsychiatry (SCAN). In addition, we ascertained prescription of anti-depressive medication from a national register. Using logistic regression and Cox proportional hazard models, we estimated the association between exposure to threats and violence at baseline and SCAN depression and prescription of anti-depressive medication during two years of follow-up.
Results Self-labelled exposure to work-related threats and violence was associated with a risk of SCAN diagnosed depression two years later, odds ratios (OR) 2.20 [95% confidence interval (CI) 1.13-4.28] and OR 2.11 (95% CI 1.05-4.24), respectively, with indication of a dose-response. Self-labelled exposure to work-related threats and violence was associated with prescription of anti-depressive medication in a two-year period, hazard ratios (HR) 2.55 (95% CI 1.47-4.40) and HR 1.47 (95% CI 0.70-3.06), respectively.
Conclusion Exposure to work-related threats or violence is associated with an increased risk of depression two years later, measured with a psychiatric interview and register data on prescribed antidepressants.
Key terms anti-depressive medication; bullying; longitudinal study; SCAN interview; workplace harassment.
Being threatened with or exposed to physical violence in the workplace is a serious occupational hazard, and work-related threats and violence have received increased attention in recent years. The prevalence of workplace threats and violence varies considerably according to occupational setting, definitions and measurement methods (1). Furthermore, there is a difference in how countries require employers to assess and prevent violence in the workplace (2). The healthcare sector has been the focus of most studies in this area. Among nurses in eight European countries, 22% reported frequent violent episodes from patients and relatives (3), and a recent meta-analysis similarly reported a one-year prevalence of 19% for physical violence against healthcare professionals (4). Several negative work functioning consequences of exposure to work-related violence have been highlighted, such as malpractice, low quality of care, absenteeism and high turnover (5). In addition, acute and long-term psychological and emotional consequences for individual well-being have been reported (1). However, in longitudinal studies with long follow-up reverse causation is an issue: workplace violence may cause occupational stress, and subsequently the distressed employee may be more exposed to violence than other workers (6, 7).
In a recent review we assessed the association between workplace violence and poor mental health, especially the risk of developing depressive disorder (8). Most studies addressing major depression had important methodological limitations. Many studies were cross-sectional and depression ascertainment relied mostly on self-reported symptoms (8). Only one study explicitly addressed the risk of medically diagnosed depressive disorder (although together with other mood disorders) (9). Two cohort studies used the prescription of anti-depressive medication as a proxy for depressive disorder (10, 11). The results from these three studies suggested an increased risk of depression after exposure to violence or threats of violence at work. Recently a Danish job exposure matrix study on violence at work and depression reported that being employed in jobs with a high likelihood of work-related violence (eg, police offices, prison guards, teachers and personal care workers) was associated with a modest risk of developing depression, measured by hospital treatment in registers (12). The study was based on an inception cohort including a large sample with more than 950 000 Danish employees followed for 6.9 million person-years. For women the association was found across industries while for men it was only found for certain industries (12). The findings support the notion that the association between work-related violence and depression may be causal, however, measuring work-related violence using a JEM may have resulted in misclassifications of exposure.
Measuring clinical depression in epidemiological studies is challenging as different methods have both advantages and disadvantages. The gold standard measure is a psychiatric interview (usually either a structured clinical interview or a clinical diagnostic interview), conducted by a trained interviewer, allowing diagnoses in accordance with the International Classification of Diseases and Related Health Problems (ICD) by the World Health Organization or the Diagnostic and Statistical Manual of Mental Disorders (DSM) by the American Psychiatric Association (13). However, it is a major limitation of psychiatric interviews that they ascertain depressive disorders only at a single point of time during follow-up. Consequently, individuals who developed a depressive disorder shortly after baseline but are in remission at the time of the follow-up interview may be misclassified as non-cases.

Further, individuals who do not show up at the follow-up interview are lost to the study. Misclassification of cases and loss to follow-up can be avoided when study participants are continuously monitored in national health registers that provide the exact date when an individual, for example, purchases anti-depressive medications. However, the major disadvantages of prescription databases are that they only identify those cases of depressive disorders where the individual contacted the healthcare system and was subsequently diagnosed, causing selection bias related to healthcare seeking behavior (14). Further, there is a problem concerning the specificity of measuring only depression, as anti-depressive medication is also used to treat conditions such as anxiety disorders and post-traumatic stress disorder (15, 16).

The aim of this study was to examine the prospective association between exposure to workplace violence or threats of violence and depression, while using both a standardized psychiatric interview and a national prescription drug register to measure onset of depression. To the best of our knowledge, no previous studies have examined the association between workplace violence and depression using a standardized psychiatric interview. Further, only one previous study on work-related violence has combined different types of depression assessment (the use of psychotropic medications and health claims for treatment of depression) (10) as we did by combining a psychiatric interview with register data on prescribed antidepressants. We reasoned that if we found an association between threats and violence and depression in both measures of depression, we would feel more confident that the association indicates a causal relation than if we were to find an association for only one measure of depression.

Methods

Study design and population

This study examines the longitudinal association between exposure to violence or threats of violence at work and depression. In the first part of the study, depression was diagnosed using a standardized psychiatric interview, the Schedules for Clinical Assessment in Neuropsychiatry (SCAN) study, and we assessed the risk of depression two years after self-reported exposure to violence or threats of violence. In the second part - the prescription study - we examined the risk of prescription of antidepressants after exposure to work-related violence or threats in a period of two years. Data was retrieved from the Danish PRISME study (17, 18). The structure of the study population is shown in figure 1. In the first wave of the study in 2007, 10 036 employees were recruited within public service workplaces in the county and municipality of Aarhus, Denmark and a total of 4489 employees (45%) participated by completing a postal questionnaire concerning working conditions and health. These 4489 participants were then sent a similar questionnaire in 2009 with a response rate of 72% (3224 employees) and again in 2011 with a response rate of 73% (3278 employees). In the SCAN study, we excluded all individuals with an ICD-10 depression diagnosis at baseline (N=100 in 2007 and N=83 in 2009), and only included participants who responded to two subsequent surveys, N=5803. Missing answers on exposure to threats or violence were 3% in both cases, resulting in a final study population of 5621 employees in the analyses regarding threats and 5614 employees in analyses of violence.

In the prescription study, we excluded employees with previous prescriptions of antidepressants (from 1997 to baseline), N=890 in 2007 and N=717 in 2009, and employees with previous self-reported episodes of depression (N=290), a family history of depression (N=1585) and depressive symptoms at baseline (N=272), based on the six-item subscale SCL-DEP6 for depression in the Mental Disorder Questionnaire (CMDQ), cases with a sum-score >3 in >2 questions were defined as cases of depressive symptoms (19). This resulted in a population of 4678 employees but, because of missing exposure information of 3%, we ended up with 4524 and 4519 employees in the analyses regarding threats and violence, respectively.

Measures of violence and threats of violence

The participants were asked if during the past 12 months they had been exposed to five different acts: 1 (verbal or written threats), 2 (threatening behavior), 3 (push, minor blow, kicks, bites), 4 (violence that threatens your health) and 5 (life-threatening violence). The first two questions measured threats and the last three violence. Each question had five response categories, which we combined into three to obtain strata with reasonable numbers, namely 'never' (comprising the category 'no'), 'occasionally' (comprising 'yes, one time' and 'yes, two-five times'), and

'frequently' (comprising the response categories 'yes, six-ten times' and 'yes, more than ten times'). Analyses were also performed using continuous-scale exposure information.

Furthermore, we calculated an index combining the frequency and severity of the threatening or violent acts. For threats, the severity score was 1 (verbal or written threats) and 2 (threatening behavior) and for violence the severity score was 1 (push, minor blow, kicks, bites), 2 (violence that threatens your health) and 3 (life-threatening violence), with higher values indicating more severe acts. The frequency was scored as either 0 (never), 1 (once), 2 (2-5 times), 3 (6-10 times) or 4 (>10 times). The severity-frequency index was calculated by multiplying each severity score by the frequency score and then adding them together separately for threats and violence, resulting in a value of 0-12 for threats and a value of 0-24 for violence. The following example illustrates this index: an employee reporting exposure to verbal or written threats (severity score 1) 6-10 times (frequency score 3) and exposure to threatening behavior (severity score 2) once (frequency score 1) will have a severity-frequency index of 5 for threats (1 x 3 + 2 x 1). The distribution of the index variable is strongly skewed to the left reflecting that frequent exposure to more severe violence is infrequent (supplementary material www.sjweh.fi/article/3976, figures A and B). The index is reported continuously. Exploratory analyses bases eg, on tertiles of the index variable distribution was not possible due to the strongly skewed distribution, but division into equidistant groups based on the value of the index variable indicates, that risk is increasing monotonously by increasing index value (data not shown). However, the analyses based upon grouping of the index variable does not add to the results already shown by the analyses based upon the frequency of threats/violence.

Measures of diagnosis of depression using the SCAN interview

Depression was diagnosed according to the International Classification of Diseases, Tenth Revision, Diagnostic Criteria for Research (ICD-10-DCR) (20) by applying the SCAN interview, version 2.1, part I. Section 3 (worrying and tension), section 4 (panic anxiety and phobias) and sections 6-8 (depression) were used (21). Each interview took about an hour and focused on the recent 3-5 months. It was computer aided and semi-structured and was conducted by psychology and medical students trained to manage these interviews (22).

Participants in the SCAN interview were selected by four screening criteria, slightly different in the three rounds, and described in detail by Kolstad et al (18) and Gullander et al (22).

Measures of diagnosis of depression by prescription of antidepressant medication

Following the World Health Organization-developed Anatomical Therapeutic Chemical (ATC) classification system (23), antidepressants were identified with the code N06a. Baseline was set the day the participants answered the questionnaire. The participants were linked to a national registry of prescription medication purchases to detect incident use of anti-depressant medication over a 2-year follow-up period as this was the period between the questionnaires.

Statistical analysis

All analyses were undertaken on pseudo-anonymized data on a remote platform at Statistics Denmark using SAS 9.4 software (SAS Institute, Cary, NC, USA).

Crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) for the risk of newly onset SCAN depression according to self-reported threats or violence at baseline were calculated using logistic regression. The follow-up period from baseline to ascertainment of outcome was approximately two years and each participant could contribute to <2 follow-up periods. The proc Genmod repeated measures procedure accounted for the lack of independence of the <2 follow-up periods in the same individual.

Cox proportional hazards models with days as the underlying timescale were used to calculate hazards ratios (HR) and 95% CI for the prospective association between exposure to workplace violence or threats and the risk of prescription of antidepressants. Employees were followed from the date they completed the questionnaire until the first prescription of anti-depressive medication event or the end of follow-up (two years), whichever came first. We performed traditional analyses with threats and violence measured at baseline and first prescription of antidepressant during follow-up (20072009 and 2009-2011). Cox regressions were performed applying the PHREG procedure.

The proportional hazards assumption was tested using the assess proportionality statement for all the variables in the final model and the assumption was not violated by any of the variables.
All the analyses were performed with exposure divided into three categories (never, occasionally and frequently, described above) and an exposure severityfrequency index, explained above.
In the final analyses, we included confounders measured in the baseline questionnaire: gender, age (19-29, 30-39, 40-49, 50-59 and >59 years), education beyond primary or high school (<3, 3-4 and >4 years), weekly alcohol consumption (<7 units, >7 units), smoking (never, former smoker, smoker), neuroticism (0-2, 3-6 on the neuroticism scale of the Eysenck Personality Questionnaire Revised-Abbreviated version), and traumatic life events during the last six months (measured with nine questions on eg, serious illness or injury, assault, death of a relative or friend, marital problems or serious illness or assault of a close relative (24), with a positive answer to a minimum of one question being scored as yes, otherwise scoring as no). In the logistic regression analyses we also adjusted for previous episodes of depression (yes/no), family history of depression (yes/no) and depressive symptoms [based on the six-item subscale SCL-DEP6 for depression in the Mental Disorder Questionnaire (CMDQ) (19)]. In the prescription study, these participants were excluded but due to a smaller sample and fewer cases, we would have lost too much power in the SCAN study. However, we conducted separate analyses, which excluded employees with previous episodes of depression.
We tested for interaction between gender and violence and threats, between participants reporting earlier depression and violence/threats and between occupational group (nurses versus the rest) and violence/ threats, all of which were statistically non-significant.
Results
In the first round (2007), 4489 employees participated (45% of all invited). The prevalence of threats was 37.4% while the prevalence of violence was 18.4%. The baseline prevalence of SCAN depression was 2.2% and 6.8% had a prescription of anti-depressive medication in the year before baseline. The most common professions were nurses (28%), social work and counselling professionals (17%) and teachers (8%).
Table 1 presents baseline characteristics of employees who answered the questionnaire both in 2007 and 2009, the first follow-up of the SCAN study, in relation to violence. The exposure to violence was the same among females and males. Employees reporting frequent exposure to violence were younger, less educated, had a greater tendency to be smokers and reported more traumatic life events during the last six months than employees not exposed to violence. An overlap was seen between threats and violence and employees reporting threats also reported more frequent exposure to violence than employees who did not report threats.
The results of the SCAN analyses are presented in table 2. Employees reporting frequent exposure to threats had an increased risk of depression two years later (OR 2.20, 95% CI 1.13-4.28), with a dose-response and the continuous severity-frequency index also showed an increased risk (OR 1.09, 95% CI 1.02-1.16 per 1-unit increase). Frequent exposure to violence at work also increased the risk of depression two years later, OR 2.11 (95% CI 1.05-4.24) with a dose-response and a significant OR on the continuous scale. The continuous severity-frequency index also showed and increased risk of depression OR 1.12 per 1-unit increase (95% CI 1.02-1.22 per 1-unit increase).
The results from the analyses excluding employees with previous episodes of depression are reported in supplementary table B. Point estimates were similar to the estimates in the main analyses (except for occasional threats where the OR was 0.71 compared to 1.04 in the main analysis, although not significant in any of the cases), while CI were wider, indicating lower precision.
Table 3 presents the results from the prescription study. Frequent exposure to threats at work was associated with a higher risk of purchasing prescribed antidepressants within a two-year period (HR 2.55, 95% CI 1.47-4.40). There was an indication of a dose-response association with a continuous scale score of HR 1.48 (95% CI 1.13-1.94) and the severity-frequency index of HR 1.09 (95% CI 1.03-1.15 per 1-unit increase). Regarding violence, we again found a dose-response; however, the adjusted results did not reach the significance level, except for the continuous severityfrequency index (HR 1.09, 95% CI 1.01-1.18 per 1-unit increase).
Discussion

We observed a prospective association between selflabelled exposure to frequent violence and threats of violence at the workplace and the occurrence of depression two years later among employees without depression at baseline. The risk of depression was related to the severity and frequency of the violent and threatening episodes. Furthermore, we found that employees exposed to work-related threats had an increased risk of getting a prescription of anti-depressive medication within a two-year period. To our knowledge, this is the first study examining the longitudinal association between exposure to work-related violence and threats and depression diagnosed by a standardized psychiatric interview and the first study on work-related violence that combines two measures of depression.

The results corroborate the findings from our recent review and meta-analyses in which we found a weighted averaged relative risk (RR) of depression, RR 1.42 (95% CI 1.31-1.54) after exposure to work-related violence and threats (8). This result was based on four studies, in which only one study, a registry-based study, explicitly addressed the risk of medically diagnosed depressive disorders; however, this was not separated from other mood disorders (9). Two of the four studies used the prescription of antidepressants as a proxy measure of depressive disorder, which we did in the second part of this study (10, 11). Madsen et al (11) used a sample of 15 246 Danish employees not using anti-depressive medication at baseline, who were linked to a national registry of prescription medication purchases to detect incidence use of antidepressants over a six years follow-up. They found that self-reported violence (threats or physical) was associated with the purchase of antidepressants, HR 1.38 (95% CI 1.09-1.75). Dement et al (10) used exposure information from workers' compensation claims and incident reports to examine the association between violent episodes and prescriptions of antidepressants among nurses, police officers and security workers. They found a RR of 1.65 (95% CI 1.10-2.48). Neither of these studies examined violence and threats of violence separately as we did in this current study. We also found elevated HR for the associations between violence and threats of violence and the prescription of antidepressants. However, the CI for occasional and frequent violence compared to no violence were wide due to the low number of cases, but the severity-frequency index showed an association between both violence and threats of violence and the prescription of antidepressants. The study population in the study by Dement consisted of 'high risk' workers and might not be comparable to the more generalized working population. They reported a prevalence of antidepressants and anxiolytics of 14.8% in the reference group, which is significantly higher than the general prevalence of depression in the general population [around 6% worldwide (25)]. In the present study, participants came from a wide range of occupations, which was also the case in the study by Madsen et al (11). The baseline prevalence of prescriptions of antidepressants in the current study was 6.8%, and 4.1% in the study by Madsen et al (11).

The results are also in accordance with a newly published Danish study measuring exposure to violence by a JEM and the risk of depression measured by hospital treatment in registers (12). The modest association between being employed in jobs with a high likelihood of workplace violence and subsequent risk of diagnosed depression reported in this JEM study was depending on gender and industry, with robust association among women but not men. Our population sample mostly comprised female employees employed in jobs conducting person-related work, which is likely a high-risk occupation regarding risk of depression. This may explain the stronger association between workplace violence and depression in our study. Further, measuring work-related violence by a JEM could lead to misclassification of the exposure and a depression diagnosis based on registers only may lead to an underestimation of the effect because many cases of depression are untreated or treated entirely in primary care (26). The participation rate for the initial survey was low, 45%, which raises concerns about selection bias. Kaerlev et al (17) explored the consequences of this low response rate in an earlier study. They found that the respondents differed from non-respondents by gender, age and social class. However, using registry data also available from non-respondents they did not observe any substantial differences in sick leave and use of antidepressants according to work-unit measures of the psychosocial work environment (17). Loss to follow-up was limited, but selection may still have biased our results. We compared the characteristics of respondents and non-respondents in supplementary table A. Respondents were older and more educated than nonrespondents. There were more former smokers among non-respondents, and they drank less alcohol than the respondents. Non-respondents reported

more depressive symptoms than respondents did, but respondents and non-respondents did not differ regarding the SCAN depression diagnosis.

In the prescription study, we excluded employees with previous episodes of depression but in the smaller SCAN study sample we adjusted for previous depression to ensure reasonable statistical power. In supplementary analyses of the SCAN study, we excluded those with previous depression, which resulted in point estimates similar to those in the main analysis, but with wider CI as expected. The most reliable method would have been to analyze the employees with previous episodes of depression separately; unfortunately, we did not have the power to do this in the current study.

Strengths and limitations

A major strength of the study is the combination of psychiatric interview and register data to ascertain depression. To our knowledge, this has not been done before in relation to workplace violence. Our confidence in the results is strengthened by the fact that we found an association between work-related violence and threats of violence and depression in all measures of depression when using the frequency-severity index. Regarding the exposure categories, we found the same tendency of an increased risk of depression even though the estimates of the association between violence and antidepressants had low precision.

Another important strength of our study is that in our exposure assessment we not only asked 'have you been exposed to threats?' and 'have you been exposed to violence?' like many studies do, but we asked questions in more detail, in particular about violence. We measured threats by two questions, one about verbal or written threats and one about threatening behavior, and five response categories regarding the frequency of the acts. Violence was measured by three questions with increasing severity of the violent acts and the same five response categories regarding the frequency. Furthermore, we used this information in the severity-frequency index as an attempt to measure exposure in more detail. This was not a validated tool; however, by asking about different acts we reduced the risk of differential misclassification compared to only asking one single question. The reported prevalence (37.4% for threats and 18.4% for violence) did not differ from earlier studies. The relatively large size of the final sample, and knowledge about a broad set of covariates, are further strengths of the study.

One limitation is our self-reported retrospective assessment of exposure, which could result in response bias; however, violent and threatening episodes are often severe exposures and the risk of not recalling them may be relatively small.

Another limitation is the follow-up period of 2 years. One could imagine that violence might trigger a depressive disorder without delay and that targets will recover within a few months, which has been reported in studies about traumatic life events and depression (27). In this case, an increased risk may be difficult to detect after two years. Yet we do find an increased risk in this current study. This may be because violence and threats were repeated during the two-year follow-up period, with half of the employees reporting violence and/or threats in 2007 reporting exposure in 2009 as well (data not shown). In this way threats and violence remain a long-term contextual threat. The time-lag of two years is however less important because we also used the antidepressants measure. The risk of getting antidepressants prescribed was measured throughout the two-year period by Cox regression. These results support the increased risk of depression with a higher risk of prescriptions of antidepressants in response to threats and violence although the CI were wide in relation to violence and only the severity-frequency index was statistically significant.

Concluding remarks

We found that exposure to work-related violence or threats of violence increased the risk of ICD-10 diagnosed depression two years later and increased the risk of prescriptions of antidepressants in the same time period. Replication studies using refined and validated tools for measuring exposure to violence and threats are recommended in future research to further improve the evidence of a causal association between work-related threats and violence and depression.

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The authors declare no conflicts of interest.

Sidebar

This is the first study to examine the prospective association between work-related threats and violence and depression while using a standardized psychiatric interview. The results suggest that exposure to work-related threats and violence increases the risk of developing depression, measured by a psychiatric interview, and the risk of getting antidepressants prescribed.

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Additional material

Please note that there is additional material available belonging to this article on the Scandinavian Journal of Work, Environment &Health -website.

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DETAILS

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Are resident handlings in eldercare wards associated with musculoskeletal pain and sickness absence among the workers? A prospective study based on onsite observations

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ABSTRACT (ENGLISH)

Objectives We aimed to identify eldercare wards with different types of resident handling characteristics ('phenotypes') and determine the prospective association between these characteristics and musculoskeletal pain and sickness absence among workers during a one-year follow-up. Methods Our study was based on the DOSES cohort, including 467 workers at 103 eldercare wards. At baseline, resident handlings were assessed using onsite observations. Workers' self-reported musculoskeletal pain and sickness absence were assessed during the following year using text messages. Observations of the frequency of handlings per shift, use of assistive devices, assistance from others, and barriers (interruptions and impediments) were estimated for each worker, aggregated at ward level, and entered into a latent profile analysis, identifying ward phenotypes. We then used generalized estimating equations to determine associations between ward phenotypes, musculoskeletal pain and sickness absence. Results We identified four ward phenotypes: 'turbulent' (many handlings with devices and assistance, many barriers), 'strained' (many handlings without devices or assistance, some barriers), 'unpressured' (few handlings, yet without devices or assistance, few barriers) and 'balanced' (some handlings with devices and assistance, some barriers). Compared to workers in balanced wards, workers in turbulent wards had more days with neck-shoulder and low-back pain (LBP); and those working in strained wards had more days with LBP and higher pain intensities. Conclusion We found that ward phenotypes based on resident handling characteristics were predictive of musculoskeletal pain and sickness absence over one year. This shows that organizational factors related to resident handling are important determinants of musculoskeletal health among eldercare workers.

FULL TEXT

Headnote

Januario LB, Mathiassen SE, Stevens ML, Holtermann A, Bergström G, Rugulies R, Karstad K, Hallman DM. Are resident handlings in eldercare wards associated with musculoskeletal pain and sickness absence among the workers? A prospective study based on onsite observations. Scand J Work Environ Health. 2021;47(8):609-618. doi:10.5271/sjweh.3979

Objectives We aimed to identify eldercare wards with different types of resident handling characteristics

('phenotypes') and determine the prospective association between these characteristics and musculoskeletal pain and sickness absence among workers during a one-year follow-up.
Methods Our study was based on the DOSES cohort, including 467 workers at 103 eldercare wards. At baseline, resident handlings were assessed using onsite observations. Workers' self-reported musculoskeletal pain and sickness absence were assessed during the following year using text messages. Observations of the frequency of handlings per shift, use of assistive devices, assistance from others, and barriers (interruptions and impediments) were estimated for each worker, aggregated at ward level, and entered into a latent profile analysis, identifying ward phenotypes. We then used generalized estimating equations to determine associations between ward phenotypes, musculoskeletal pain and sickness absence.
Results We identified four ward phenotypes: 'turbulent' (many handlings with devices and assistance, many barriers), 'strained' (many handlings without devices or assistance, some barriers), 'unpressured' (few handlings, yet without devices or assistance, few barriers) and 'balanced' (some handlings with devices and assistance, some barriers). Compared to workers in balanced wards, workers in turbulent wards had more days with neck-shoulder and low-back pain (LBP); and those working in strained wards had more days with LBP and higher pain intensities.
Conclusion We found that ward phenotypes based on resident handling characteristics were predictive of musculoskeletal pain and sickness absence over one year. This shows that organizational factors related to resident handling are important determinants of musculoskeletal health among eldercare workers.
Key terms healthcare; latent profile analysis; longitudinal study; patient handling.
Eldercare workers often report low-back pain (LBP), neck-shoulder pain (NSP) and musculoskeletal sickness absence, likely due to high physical workload and poor psychosocial working conditions (1-3). This is not only an issue for current workers, it also impedes recruitment of a new workforce required to look after the increased number of elderly in need of care in Europe (4, 5).
As proposed in previous exposure-effect models (6, 7), musculoskeletal health at work is determined in a complex interplay between factors pertaining to tasks, jobs, and the work environment (external exposures), and other factors influencing the eventual mechanical load on individual workers (internal exposures such as postures, movement and forces). In eldercare work, resident handlings are a key external exposure in the development of musculoskeletal disorders (8, 9) since they lead to complex and high biomechanical demands, including pronounced arm elevation, trunk flexion and trunk rotation, often while handling large loads (10, 11). This external exposure to handlings is, in turn, influenced by surrounding organizational factors setting conditions for performing the handlings (6). Examples are under-staffed wards, shortage of time to perform tasks as prescribed, and broken assistive devices, all of which can result in compromised resident handling. The resulting internal exposure on the individual worker gives rise to acute responses (eg, increases in oxygen consumption, heart rate, and perceived exertion), which may, in the long term, have effects on musculoskeletal health (6). Several aspects of handlings - such as their frequency, possible interruptions, and use (or not) of assistive devices - may influence the eventual internal exposure and thus musculoskeletal health (11). For instance, failure to follow handling guidelines can negatively influence musculoskeletal health (12-14). Since handling aspects occur in parallel, they should be addressed together, instead of one at a time, as in previous eldercare studies (15, 16).
To a major extent, previous studies in eldercare have also been based on self-reported data on physical workload, which are prone to bias (17). As an alternative, observational exposure assessment tools have been developed to measure physical workloads during caretaking (18-21). However, to our knowledge, onsite observations have not been applied in any study addressing effects on health of combined handlings characteristics in eldercare.
Eldercare homes are often organized in separate wards, differing in organizational, managerial and structural characteristics that likely influence resident handlings and consequently the musculoskeletal health of workers at the wards. Therefore, examining handlings at a ward level would allow a better understanding of the organizational determinants of exposures, which, in turn, could lead to evidence-based interventions at that level, eg, addressing staff ratio or the availability of assistive devices. Such interventions would likely be more effective and sustainable than initiatives focusing solely on the behaviors of the individual worker (eg, personal training programs), which are

known to have limited effectiveness (22). In the present study, we combine the need to address several handling aspects in parallel with the idea of acting at the ward level by determining latent sub-populations of wards sharing similar resident handling characteristics, using latent profile analysis. We label these sub-populations as ward 'phenotypes', referring to the term used in genetics for a set of observable characteristics of an organism (23). This study aims to identify phenotypes of wards sharing similar physical and psychosocial conditions for resident handlings and then determine the extent to which they are associated with musculoskeletal pain and sickness absence among workers at the wards over the course of one year.

Methods

Design and study population

This prospective study uses data from the Danish Observational Study of Eldercare work and musculoskeletal disorders (DOSES), collected between September 2013 and January 2016 and previously described (24). Briefly, DOSES is a prospective study, in which data at multiple organizational levels were considered. In total 553 eldercare workers, employed in 126 wards nested in 20 eldercare homes, were included with the following inclusion criteria: aged 18-65 years; employed >15 hours/week; working on day, evening or rotating shifts (ie, not exclusively at night); and spending >25% of their working time in tasks associated with actual resident care. The Danish Data Protection Agency and the regional Ethics Committee in Copenhagen, Denmark, (H-4-2013-028) approved the study and all participants provided written informed consent to participate. Baseline data collection included questionnaires and onsite observations. During a one-year follow-up, data on self-reported musculoskeletal pain and sickness absence were collected. In our subsequent analyses, we excluded workers who refused to be observed, did not report their work schedules and/or did not answer the questions related to musculoskeletal pain and/or sickness absence at baseline and/or follow-up. To ensure that handlings were representative of wards, we only included wards with >2 participating workers. Eventually, the present study included 467 workers distributed across 103 wards in 20 eldercare homes.

Measurements

Descriptive characteristics. At baseline, ward managers were asked to complete a questionnaire addressing conditions at their ward. These ward managers were, in general, responsible for communicating with higherlevel management, taking decisions at their own ward, and managing the staff there. The questionnaire asked about type of ward (somatic, dementia, rehabilitation or psychiatric unit), resident information (ie, number of residents in the wards; weight, physical and psychosocial function level of each resident), staff ratio, and how often assistive devices were not in place (daily, 1-3 times/week, 2 times/month or <1 time/month). Physical function level was categorized based on the resident's need for physical assistance (light, moderate, extensive or complete need). Psychosocial function level was categorized based on the resident's usual behavior (mostly neutral, mostly positive/appreciative, mostly resistant, and mostly aggressive).

The eldercare workers answered a baseline questionnaire asking about age, smoking habits (smoker or non-smoker) and musculoskeletal pain and sickness absence due to NSP and/or LBP, as described in detail below. Body mass index (BMI) was calculated based on measured height and weight (kg/m2).

Observations - resident handling characteristics. Handling tasks were observed using the DOSES observation instrument, shown previously to have a good reliability (20). At any particular ward, trained research assistants followed workers for 4 hours during day shifts and 4-5 hours during evening shifts, recording, to the extent possible, all handlings of all residents on a tablet, using the Noldus Observer XT 11 software (Noldus, Wageningen, The Netherlands). A previous observational study in Danish eldercare homes (21) showed that more than 70% of all handlings occurred during these periods and thus, to save resources, observations in DOSES were limited to these periods.

The observation instrument was composed of 26 items in four sections: setting and surroundings, manual handling activities, psychosocial interactions with the residents, and barriers (20). Observations of manual handling activities and of barriers were included in the subsequent identification of ward phenotypes. Manual handling activities were classified in terms of whether the worker used an assistive device or not (including the type of device used) and

whether the handling was performed by the worker alone, or with the assistance of another person (typically a co-worker or a visitor). Barriers included interruptions and impediments (25) during the care of the resident. An interruption was defined as an event that significantly interrupted the eldercare worker in performing a task (eg, an urgent request for assistance from a co-worker); and an impediment was defined as an obstacle for completing a task requiring some effort (eg, broken or missing assistive device).

Each single observation was registered as an exposure associated with the observed resident. Thus, some residents had more registered observations than others because they were in need of more handlings during a shift. A majority of residents in the 20 eldercare homes were observed (88% in day shifts and 79% in evening shifts). Reasons for not observing a resident could be that (i) the resident was not in need of care or was hospitalized, (ii) the eldercare worker taking care of that resident declined to be followed, and (iii) there was a shortage of research assistants at that point in time. Estimates of handling characteristics for non-observed residents were obtained by imputation. Next, handlings at the level of individual eldercare workers were estimated based on work schedules, which were obtained from the ward managers for all workers, irrespective of whether they participated in observations or not. Schedules were then combined with the data based on handlings at the resident level to give a task-based estimate of the number of handlings per shift for each worker, as well as the associated handling characteristics. In our eventual analysis of phenotypes, we considered (i) the frequency of handlings per shift, and calculated (ii), the proportion of those handlings done without any assistive device and (iii), the proportion of handlings done without any assistance from others. We also considered the number of (iv) interruptions per shift and (v) impediments per shift. We aggregated observations of these five variables at the ward level by averaging the handling exposure estimates of all eldercare workers in each specific ward. In this study, observations during day and evening shifts were summarized in terms of values per shift, disregarding time of day. Then, we used these ward-level scores in a latent profile analysis of handling characteristics.

Musculoskeletal pain and sickness absence. The eldercare workers reported musculoskeletal pain and sickness absence at baseline by answering a questionnaire, and during the one-year follow-up by answering, at the most, six questions in text messages (www.sms-track. com) (24, 26). At baseline and every four weeks during follow-up, the workers were asked to report the number of days they experienced NSP and LBP during the preceding four weeks (0-28 days). If participants reported any pain in one or both of these regions, they received a follow-up question about the intensity of their NSP and/or LBP (scale 0-10), and the number of days (028) when pain interfered with work ("Within the past four weeks, how many days did pain in your low-back and/or neck-shoulder made it difficult to perform your normal work, ie, interfered/limited your performance at work?").

At baseline, and every 12 weeks in follow-up, the workers were also asked to report the number of days on sickness absence due to NSP and/or LBP in the past three months (0-84 days). Answers to pain-related work interference were dichotomized into 0 or >1 days, while the other two variables describing number of days were kept continuous.

Statistical analysis

Based on the handling characteristics of each of the 103 wards (frequency of handlings, proportion of handlings done without assistive devices, proportion of handlings done without assistance from others, number of interruptions, and number of impediments), we performed a latent profile analysis, using the Latent Gold software (version 5.1, Statistical innovations, Belmont, MA, USA). This technique allows multiple variables to be combined in an analysis identifying latent profiles, ie, subpopulations within a population sharing similar properties with respect to the set of observed variables (27-29). In our case, the latent profile analysis was used to identify wards sharing handling characteristics, as a basis for identifying 'phenotypes' of wards (see below), which could then be examined for their ability to predict musculoskeletal pain and sickness absence.

The latent profile analysis requires the user to decide the number of profiles that suits data the best. In this process, we considered model fit indices as well as the interpretability of identified profiles. Model fit statistics included the Akaike information criterion (AIC) and the Bayesian information criterion (BIC), showing the trade-off between the simplicity of the model and the goodness of fit, and entropy, describing the degree of certainty of the classification. We also required each profile to contain at least five wards so that even the smallest profile would be generalizable.

To better understand the distinct handling characteristics of the eventually identified profiles, we compared the characteristics of wards, workers and residents in each profile, using analysis of variance (ANOVA) for descriptive continuous variables and Chi-squared tests for descriptive categorical variables. At this point, and after further examining the specific ward characteristics expressed in each profile, we labeled the ward profiles as phenotypes, in the sense that they reflect a set of observable and interpretable characteristics pertaining to the ward.

To estimate the effects of working at a certain ward phenotype (ward-level predictor) on reported musculoskeletal pain and sickness absence during the one-year follow-up (individual-level outcome) we used generalized estimating equations (GEE) (30). In these analyses, each worker was assigned the ward phenotype in which they worked as a predictor, and their self-reported musculoskeletal pain and sickness absence at each time point during follow-up as the outcome (14 time points for pain and 5 time points for sickness absence). We included time as a within-subject covariate, and workers and wards as random effects in an unstructured correlation matrix. For the continuous outcome variables (days with NSP, intensity NSP, days with LBP, intensity LBP, and sickness absence due to NSP/LBP), we used a Poisson distribution model, with a log link function. For the dichotomous variable (pain-related work interference), we used a binary logistic model.

We adjusted each of the six models for their corresponding outcome values obtained at baseline. We further adjusted the models for age, BMI and smoking habits. We also did a sensitivity analysis by re-running each of the six primary models solely with participants reporting 'little' pain at baseline, defined as pain <5 days/month, pain intensity <2 (0-10 scale), 0 days with pain-related work interference, and 0 days with sickness absence. We performed all tests in SPSS (Statistical Package for Social Science, v. 20, IBM Corp, Armonk, NY, USA) and set the significance level at 0.05.

Results

Identification and characterization of ward phenotypes

According to the model fit statistics (supplementary material, https://www.sjweh.fi/article/3979, table S1), models with four and five profiles were the more certain (higher entropy values), while still being sufficiently parsimonious according to BIC and AIC values. These two models also fulfilled the criterion of the smallest profile containing at least five wards. Taking into account that the model with four profiles showed better parsimony and had more workers in the smallest profile than the model with five profiles, and that the differences in the handling characteristics between the four ward profiles were more intuitive than those in the fiveprofiles model, we settled on the four-profile solution.

We then examined the four ward profiles (see figure 1) and described their properties in terms of four phenotypes with the following labels:

'Turbulent' wards: many handling operations (mean 11.8, standard deviation (SD) 7.1 per shift], some of which are done without assistive devices [mean 41 (SD 18) %] or assistance from others [mean 20 (SD 9) %], and with many barriers [mean 6.2 (SD 2.5) interruptions per shift; mean 2.7 (SD 1.8) impediments per shift].

'Strained' wards: many handling operations [mean 11.4 (SD 4.3) per shift], many of which are done without assistive devices [mean 52 (SD 18) %] or assistance from others [mean 67 (SD 10) %], with some barriers [mean 3.1 (SD 1.8) interruptions per shift; mean 1.9 (SD 1.3) impediments per shift].

'Unpressured' wards: few handling operations [mean 4.9 (SD 1.8) per shift], even if many of which are done without assistive devices [mean 53 (SD 21) %] or assistance from others [mean 61 (SD 24) %], and few barriers [mean 1.7 (SD 0.8) interruptions per shift; mean 1.5 (SD 0.7) impediments per shift].

'Balanced' wards: some handling operations [mean 9.2 (SD 1.6) per shift], some of which without assistive devices [mean 47 (SD 12) %] or assistance from others [mean 34 (SD 11) %], and with some barriers [mean 2.9 (SD 1.0) interruption per shift; mean 2.1 (SD 0.7) impediments per shift].

Based on the latent profile analysis, mean 7 (6.8%), 21 (20.4%), 52 (50.5%) and 23 (22.3%) of the 103 wards were categorized as turbulent, strained, unpressured, and balanced, respectively. Table 1 presents descriptive statistics on wards, workers and residents, stratified by ward phenotype.

At turbulent wards, the staff ratio was smaller than at the other ward phenotypes and a higher proportion of residents

were classified as needing complete physical assistance. At strained wards, devices were reported to be misplaced daily more often than in the other ward phenotypes, and the workers had higher BMI. Unpressured and balanced wards were not extreme in any respect. Descriptive characteristics of the eldercare workers' musculoskeletal pain and sickness absence at baseline and during the one-year follow-up, stratified by ward phenotype, are shown in table 2.

Associations between ward phenotypes, musculoskeletal pain and sickness absence

During the one-year follow-up, turbulent wards were significantly associated with more days per month with NSP (ß=0.54; P<0.01) and LBP (ß=0.37; P<0.01) among the workers than balanced wards (table 3). Similar associations were found after adjustments for age, BMI and smoking habits, although only statistically significant for LBP (ß=0.35; P=0.01). Thus, the adjusted model predicted that the number of days with LBP per month at follow-up would be 0.35 days larger at turbulent versus balanced wards.

Strained wards were associated with higher intensity of NSP pain (ß=0.14; P=0.03), more days with LBP (ß=0.21; P=0.02), and higher intensity of LBP (ß=0.15; P=0.04) and were more likely to report pain-related work interference [odds ratio (OR) 1.67; P=0.01] compared with balanced wards. Strained wards were also associated with more days with musculoskeletal sickness absence (ß=0.83; P=0.07) than balanced wards. After adjustments these results remained significant and with slightly higher effect estimates (table 3). Unpressured wards did not differ significantly from balanced wards in pain and sickness absence.

The sensitivity analysis of workers with low pain and no sickness absence at baseline showed, in general, stronger and more significant associations at followup in this sub-population than in the total population (supplementary table S2).

Discussion

Summary of findings

To our knowledge, our study is the first to collect onsite observations of resident handlings in eldercare, interpret those in terms of ward phenotypes, and address the prospective association of these phenotypes with musculoskeletal pain and sickness absence among eldercare workers. We identified four distinct ward phenotypes, labeled as turbulent, strained, unpressured, and balanced, representing distinctly different combinations of various handling characteristics. After adjusting for age, BMI and smoking habits, we found that workers at turbulent and strained wards reported a larger increase in pain during the one-year follow up than workers at balanced wards.

Identified ward phenotypes

Among the four ward phenotypes, two (turbulent and strained) appeared to have a less favorable combination of handling characteristics, while the two others (unpressured and balanced) had more beneficial profiles. To our knowledge, this is the first study to evaluate different aspects of resident handlings concomitantly.

At turbulent wards, workers had high physical demands reflected by a high frequency of handlings, but they also had resources to perform these handlings, as shown by the high proportion of handlings done with assistive devices and assistance from others. Handling assistance has been shown to reduce physical load during handling tasks (15, 31). On the other hand, handlings at turbulent wards also suffered many barriers, which has been associated with poor health (21, 25). Turbulent wards had a low staff ratio compared to other ward phenotypes (table 1), and the high number of interruptions may be explained by workers being disturbed more often because their colleagues needed assistance.

The strained wards also appear to have less favorable handlings characteristics; handlings were both frequent and, to a considerable extent, performed without assistive devices or assistance from others, likely have increasing the physical load on workers (15, 16, 31). Unpressured and balanced wards showed more favor- able handling characteristics, even though they were not ideal. Based on results from previous studies, 'ideal' wards would have <10 handlings per shift (11), most of these performed with assistive devices or assistance from others (15, 16, 31), and only few barriers (21, 25). Our current sample of wards did not include any such ideal ward phenotype. While interesting, a further examination of the determinants of ward-level handling characteristics, and hence of the handling phenotypes, was beyond the aims of the present study.

Association of ward phenotypes with musculoskeletal pain and sickness absence

Compared with balanced wards, working in a turbulent ward was associated with more frequent NSP and LBP, while working in a strained ward was associated with more days of LBP, higher intensity of NSP and LBP and a higher likelihood of pain interfering with work. This suggests that the risk of musculoskeletal pain increases with the frequency of handlings, particularly when handlings are more often performed without the use of assistive devices or assistance from others. This is consistent with previous studies reporting that a higher frequency of handlings is associated with persistent LBP in eldercare workers (11) and a higher risk of back injuries among hospital healthcare workers (32). Notably, these previous studies, like several others (12-14, 31, 33), considered just one aspect of handlings at the time and were focused on individual-based exposure assessment. Previous studies suggest that pain intensity and pain-related work interference have clear associations with sickness absence among healthcare workers (34). But we did not find a statistically significant association between sickness absence and the ward phenotypes, even though we observed a tendency for more absence days due to musculoskeletal pain among workers at strained wards.

Performing resident handlings without assistive devices, as observed to a larger extent in strained wards, have been associated with LBP among nurses (35), but evidence supporting the efficacy of using assistive devices in reducing musculoskeletal pain among healthcare workers is still limited (36). A possible explanation is that studies often consider the use of assistive devices as an isolated factor and ignore other important organizational factors that may act in parallel and correlate with the use of devices. By including job barriers (interruptions and impediments), defined as poor organizational, psychosocial and/or physical work conditions impeding the performance of work tasks (20, 37, 38), we addressed factors beyond the mere physical aspects of handlings. Thus, our ward phenotypes reflect a set of important external exposures associated with resident handlings, and our study considers the eventual results of these exposures in terms of individual outcomes, ie, pain and sickness absence, as illustrated in the exposure-effect model (6). A previous study showed that interruptions and impediments assessed using onsite observations were associated with musculoskeletal disorders in urban transit operators (25), but to our knowledge no previous study has examined this association among eldercare workers.

We found a large variability in reported pain and sickness absence at baseline, and so we also performed a sensitivity analysis including only those workers with little pain and no sickness absence. Ward phenotype predicted musculoskeletal pain and sickness absence even stronger in this sub-population, suggesting that the handling characteristics at turbulent and strained wards could, indeed, increase the risk of workers developing musculoskeletal disorders.

Methodological considerations, implications and future research

The use of a systematic and reliable onsite observation tool for assessing resident handlings characteristics (20, 24) is a strength of this study as it provided information that will likely be more accurate than that obtained, eg, by self-reports from the workers. Also, this approach eliminates the risk of common method bias, which is a likely fallacy in studies where both exposures and outcomes are based on self-report (17). In aggregating observations at the ward level, thus obtaining 'nonindividualized' information about general handling characteristics at a specific ward, we further reduced the risk of common method bias. Another strength of the study is the novel use of latent profile analysis, which allowed us to identify clusters of wards sharing similar combinations of handling characteristics, which we could then interpret and label in terms of ward phenotypes. The use of latent profile analysis also allowed us to integrate physical and psychosocial aspects of handlings, and thus to examine their combined impact on musculoskeletal health. We believe that 'clustered' exposure assessment approaches like this offer an appealing alternative to standard multivariate regression, where exposure variables are entered in parallel, and correlations may severely challenge the interpretation of results. The extensive assessment of pain and sickness absence, using 14 and 5 repeated measurements, respectively, may also be considered a strength of the study.

Still, the study also suffers some limitations. Even though the use of an observational tool can be considered an advantage compared to self-reports, it should ideally be combined with direct measurements of exposures (39), which we did not. Observations at a particular ward were performed during a short period of time, and the estimated

handling variables at the ward level are subject to some inaccuracy due to variability between days, both on the short term, for instance because residents have different needs on different days, and on the longer term, because residents may be replaced by other residents with different needs, or staffing may change. Also, handlings for, on average, about 15% of the residents at a ward were obtained by imputation, which may have introduced additional variance. However, based on our experiences in eldercare, we believe these sources of exposure variability to be moderate, and thus having only a minor impact on the accuracy of the average ward-level exposure. Notably, our exposure assessment strategy was not sensitive to the proportion of participating workers, since work schedules were obtained for everybody, directly from the ward manager (24). Ward phenotypes were determined in a datadriven process, and even though our phenotypes appear representative of eldercare conditions, it is possible that the ward classification could be different in other populations. Future studies are needed to verify the stability of the phenotyping across wards in general.

The assessment of pain and sickness absence during the one-year follow-up relied solely on self-reports, which could introduce bias. However, we trust this risk to be reduced by the frequent assessment of outcomes, reducing recall bias, and we emphasize that common method variance of exposures and outcomes is likely small, due to the use of observational-based, aggregated exposures. Finally, while we believe each of the six selected outcomes to be important in reflecting different aspects of pain (severity, duration) and its consequences (interference with work, sickness absence due to musculoskeletal pain), we acknowledge the risk of obtaining significant results by chance in multiple tests.

Our results, in illustrating the importance of wardlevel characteristics to health can be used in future studies as a basis for designing ward-level tools for preventing musculoskeletal symptoms in eldercare workers, as an alternative to, or complementing, individualized interventions, such as having workers attend courses in lifting techniques. While we believe that intervening on organizational and structural determinants of handlings would lead to more effective and sustainable results than interventions directed towards the behaviors of individual workers, future studies should verify the effectiveness of ward-level organizational tools, for example in randomized control trials, before they are generally recommended for practice (40).

Concluding remarks

Based on onsite observations of resident handlings in eldercare, we were able to identify four handling phenotypes at the ward level. Our results show that turbulent and strained ward phenotypes were associated with some indicators of musculoskeletal pain during the one-year follow-up. Thus, our study suggests that ward phenotypes with frequent handlings, either combined with limited use of assistive devices or with many barriers, may impose an increased risk of musculoskeletal pain among the workers. Our findings encourage future studies devoted to the development of ward-level, organizational interventions in eldercare homes.

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The authors declare no conflict of interest.

Sidebar

This is the first multi-level study to use onsite observations of resident handlings in a latent profile analysis, interpret those in terms of ward 'phenotypes', and address the prospective association of phenotypes with musculoskeletal pain and sickness absence among eldercare workers. Our findings indicate that combined organizational factors, e.g. frequent handlings and use of devices, are important determinants of musculoskeletal health.

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Additional material

Please note that there is additional material available belonging to this article on the Scandinavian Journal of Work, Environment &Health -website.

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de Wind, A., PhD, Beckers, D. G. J., PhD., Nijp, H. H., PhD., Hooftman, W., PhD., de Boer, Angela G E M, PhD, & Geurts, S. A. E., PhD. (2021). Working from home: Mismatch between access and need in relation to work–home interference and fatigue. Scandinavian Journal of Work, Environment & Health, 47(8), 619-627,619A. doi:https://doi.org/10.5271/sjweh.3983

Objectives Working from home (WfH) is a promising practice that may enable employees to successfully and sustainably combine work and private life. Yet, not every employer facilitates WfH and not every employee has similar needs concerning the practice. The current study aims to examine the association of a WfH mismatch with work-home interference (WHI) and fatigue. Methods Data on WfH, WHI, and fatigue of a quasi-representative sample of 2374 Dutch employees in 2012/13 and a follow-up measurement one year later were used. Cross-sectional and longitudinal regression analyses were conducted to investigate the cross-sectional and temporal associations between WfH mismatch on the one hand and (changes in) time-based and strain-based WHI and fatigue on the other hand. Results In the cross-sectional analyses, WfH mismatch was significantly associated with higher time-based WHI (B=0.13), strain-based WHI (B=0.17) and more fatigue (B=0.32). WfH mismatch was not associated with changes in these outcomes after one year of follow-up. Conclusions A tailored WfH organizational policy, in which employees' need for working from home is taken into account, may be a fruitful approach to utilize WfH as a way for employees to successfully and sustainably combine work and private life to its full potential.

Kaltenegger, H. C., M.Sc, Becker, L., PhD., Rohleder, N., PhD., Nowak, D., M.D., & Weigl, M., PhD. (2021). Associations of working conditions and chronic low-grade inflammation among employees: A systematic review and meta-analysis. Scandinavian Journal of Work, Environment & Health, 47(8), 565-581,565A. doi:https://doi.org/10.5271/sjweh.3982

Objectives Chronic low-grade inflammation has been identified as a key pathway linking stress experience to human health. However, systematic evaluations on the relationship of work stress and immune function are scarce and predominantly based on cross-sectional studies. We performed a systematic review and meta-analysis of prospective studies on associations of working conditions and inflammatory biomarkers. Methods In line with our previously established study protocol and the PRISMA-guidelines, we systematically searched electronic databases for prospective studies on working conditions as well as workplace interventions and inflammatory markers in employees. We classified studies (by design, type of exposure/intervention, outcome) and performed rigorous risk-of-bias assessments. Studies were summarized qualitatively, and a meta-analysis was conducted. Results We identified 23 eligible studies (N=16 432) with a broad scope of working conditions and inflammatory markers. For interventional designs, we differentiated between individual-directed/behavioral (including physical and mental) and organization-directed/structural interventions. Workplace physical exercise interventions were associated with a decrease in C-reactive protein (k=5; d=-0.61; P<0.001). For other workplace interventions, ie, mental and organizational/structural, results were inconclusive. Concerning observational studies, dimensions of the job demand-control(-support) model were most frequently investigated, and results showed weak - if any - associations with inflammatory markers. Conclusions The research base was heterogeneous and high-level evidence was limited. More prospective studies are needed with broader consideration of work stressors and inflammatory markers. For practical occupational health management, exercise interventions are effective measures to reduce chronic low-grade inflammation.

Kaila-Kangas, L., Leino-Arjas, P., Koskinen, A., M.Sc, Takala, E., M.D., Oksanen, T., M.D., Ervasti, J., PhD., & Kausto, J., PhD. (2021). Sickness absence and return to work among employees with knee osteoarthritis with and without total knee arthroplasty: A prospective register linkage study among finnish public sector employees. Scandinavian Journal of Work, Environment & Health, 47(8), 600-608,600A. doi:https://doi.org/10.5271/sjweh.3989

Objective This study aimed to examine duration of sickness absence due to knee osteoarthritis (OA) and sustained return to work (RTW) among municipal employees who had at least one compensated sickness absence period due to knee OA. The contribution of sociodemographic characteristics, diabetes and previous sickness absence were

assessed. We differentiated between participants with and without total knee arthroplasty (TKA). Methods Data from 123 506 employees in the Finnish Public Sector Study were linked with national health and mortality register information. There were 3 231 sickness absence periods (2372 participants) due to knee OA in 2005-2011. Kaplan-Meier curves for sustained RTW were obtained and median time with inter-quartile range (IQR) calculated for those with and without TKA. Cox regression analyses were carried out in multivariable analyses. Results The median time to RTW from the beginning of sickness absence was 21-28 days when TKA was not related to sickness absence and 92-145 days when it was. Among participants with no TKA, age 60-64, non-sedentary work, diabetes, and previous sickness absences predicted longer time to RTW, while pain medication predicted a shorter time. Among participants with TKA, non-sedentary work and previous sickness absences predicted a longer time to RTW. Conclusions The clinical relevance of the difference in time to RTW between employees with or without TKA was substantial. Employees with knee OA working in physically demanding jobs need work modifications after TKA, and this calls for a dialog between occupational health care professionals and workplaces.

Oshio, T., PhD. (2021). Job dissatisfaction as a predictor of poor health among middle-aged workers: A 14-wave mixed model analysis in japan. Scandinavian Journal of Work, Environment & Health, 47(8), 591-599,591A. doi:https://doi.org/10.5271/sjweh.3985

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