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Long-term sickness absence from combined factors related to physical work demands: prospective cohort study

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Background: The working environment plays an important role in public health. This study investigates the risk for long-term sickness absence (LTSA) from the combination of factors related to physical work demands. Methods: Employees (n = 22 740) of the general population (the Danish Work Environment & Health study 2012) were followed for two years in the Danish Register for Evaluation of Marginalisation. Using Cox regression analyses we determined the risk of LTSA from four factors: (i) physical work demands, (ii) physical exertion during work, (iii) fatigue after work and (iv) work-limiting pain. Results: During follow-up 10.2% experienced LTSA. Each of the four factors increased the risk of LTSA with hazard ratios (HR) ranging from 1.30 to 1.57. Scoring high on one (30.3% of the respondents), two (24.4%), three (19.9%) and all four factors (9.2%) gradually increased the risk of LTSA (HR’s of 1.39 [95% CI 1.16–1.66], 1.66 [95% CI 1.39–1.99], 1.90 [95% CI 1.57–2.29] and 3.02 [95% CI 2.47–3.68], respectively). Risk estimates remained robust in stratified analyses of age, sex and socioeconomic position. Population attributable fractions were high across all subgroups; 39% (general population), 36% (younger workers), 45% (older workers), 36% (men), 41% (women), 30% (higher socioeconomic position) and 45% (lower socioeconomic position). Conclusion: The risk of LTSA gradually increased with number of factors related to high physical work demands, underlining the importance of targeting combined factors in risk assessment and preventive interventions.

Introduction

High physical work demands remain a relevant risk factor for developing health problems.¹–³ With access to high-quality registers in the Nordic countries this has been studied in relation to labour market consequences. In the general population of Denmark and Norway, the proportion of long-term sickness absence (LTSA) from work that could be attributed to high physical work demands were 25% and 26%, respectively.¹,⁴ Thus, appropriate preventive measures at the workplaces related to these demands could theoretically prevent up to one quarter of all LTSA in the population. Among a subgroup of blue-collar workers in the Danish study the corresponding number was 40% showing an even higher potential for prevention among workers with manual labour and high physical work demands.⁵ Similar subgroup analyses could be relevant to perform where differences in the balance between physical capacity of the individual worker and physical work demands may exist, for example, men vs. women and younger vs. older workers. The latter is especially relevant in the light of the demographic changes in the population towards an increased proportion of elderly. Many European countries have increased statutory retirement age and reduced the access to early retirement to keep older workers longer at the labour market.

It is well known that high physical work demands can be experienced as physically exerting, and lead to fatigue after work and work-limiting musculoskeletal pain.¹–⁴ These factors related to high physical work demands constitute an inter-dependent causal chain to long-term health problems. Despite of the inter-dependency of these factors, previous studies have investigated their independent effects on health. Thus, high physical work demands, such as frequent lifting, heavy lifting, working with bent or twisted back, prolonged standing and working with arms above shoulder height are known risk factors for both musculoskeletal disorders and LTSA.¹–⁵ High physical work demands are also known to cause an acute perception of higher physical exertion during work,⁶ which by itself increases the risk for both musculoskeletal pain⁷ and LTSA.¹⁵ Likewise, musculoskeletal pain by itself is an early predictor of LTSA.¹⁶,¹⁷ Figure 1 illustrates the conceptual model in this causal chain to long-term health consequences. Because of the clear inter-dependency of these factors in a causal chain to health impairments, treating them as independent might provide underestimated risk estimates for long-term health problems. Moreover, because many workers (e.g. several blue-collar groups) experience the combination of these factors, the results of previous studies may be misleading for preventive interventions at the workplaces.

This study investigates the risk for register-based LTSA from the combination of factors related to physical work demands among employees from the general population.

Methods

Study design and population
The study design is a prospective register follow-up on questionnaire respondents. Reporting is in accordance with the STROBE
high by the following procedure: Low was defined as those '5–15 kg', '16–29 kg' and '30 kg or above'. For the subsequent analyses, physical exertion during work was dichotomized to low and high as 0–5 and 6–10, respectively.

Using a modified version of the Standardised Nordic Questionnaire for Musculoskeletal Symptoms, the question for work-limiting pain was 'Have you due to pain been limited in your work during the last 3 months?' with a response scale of 'No', 'Yes, a little', 'Yes, somewhat' and 'Yes, very'. For the subsequent analyses, work-limiting pain was dichotomized to low and high as not fatigued to 'a little fatigued' and 'somewhat fatigued' to 'completely fatigued', respectively.

Outcome variable, LTSA

Information about sickness absence was derived from Danish Register for Evaluation of Marginalisation (DREAM) and linked to the questionnaire reply of the Danish Work Environment & Health Study through the unique personal identification number which is given to all Danish citizens at birth or foreigners immigrating to Denmark. The sickness absence data in DREAM are based on the municipalities' actual payments of benefits, and the validity is therefore considered to be high. The necessity for such a register in research on sickness absence is important, because self-reports—which are typically inaccurate due to recall bias—only show low agreement with the DREAM register for temporary transfer income such as sickness benefit and unemployment benefit. For the present analyses, we defined LTSA as having registered sickness absence in DREAM for a period at least six consecutive weeks during 2-year follow-up starting the week after the questionnaire reply.

Control variables

Age (continuous variable) and sex for each individual were drawn from the Central Person Register of Denmark. The four dimensions of the psychosocial work environment were based on the Copenhagen Psychosocial Questionnaire (COPSOQ) and each included two questions about (i) influence at work, (ii) support from colleagues, (iii) support from superiors and (iv) emotional demands, that were converted to a scale of 0–100, where 100 is best and included as a continuous variable. Lifestyle included smoking status (categorical variable: daily, once in a while, ex-smoker, never), body mass index (continuous variable, BMI, kg/m²), leisure-time physical activity (continuous variable, hours of moderate to high intensity leisure physical activity). Previous LTSA was determined from the DREAM register in the same way as described above, but for two years prior to the questionnaire reply (categorical variable, yes/no). Treatment for chronic disease during the last year (categorical variable, yes/no) included depression,
diabetes, cardiovascular disease, stroke and cancer. Socioeconomic position (categorical variable) were drawn from the Employment Classification Module and included top leaders, academics, people with 3–4 years of vocational education, skilled workers, unskilled workers as well as a smaller group of unknown position. These control variables were chosen because they may be associated with both predictors and outcome, although it may be argued that some of them will lead to over-adjustment. Thus, we chose to present both a minimally and fully adjusted model, as well as a sensitivity analysis.

Statistical analyses

The Cox proportional hazard model was used to model the probability of LTSA during 2-year follow-up (Proc PHREG of SAS version 9.4.). The estimate from this model is hazard ratios (HR), which assess ratios between number of cases and person-time (time-to-event). For simplicity we use the term ‘risk’ when discussing the results. The outcome variable was LTSA. Data on LTSA correspond to survival times which in most cases are censored as most of the study population did not experience a LTSA-event during follow-up. Data were also censored in case of one of the following events: early retirement, disability pension, statutory retirement, emigration or death. When individuals had an onset of LTSA during follow-up, survival times were non-censored and referred to as event times.

The four factors related to the physical work environment were the explanatory variables. As a first step, these four factors were analysed separately, and as a second step they were combined as an index of 0–4, where 0 and 4 is scoring low and high on all four, respectively, and as a third step, the analyses of the index were stratified for sex, age and socioeconomic position [categorized into lower (skilled workers, unskilled workers) and higher (top leaders, academics, people with 3–4 years of vocational education)]. The analyses were performed in three successive models. Model 1 was adjusted for age and sex. Model 2 (final model) was the same as Model 1, but additionally included psychosocial work environment, lifestyle, previous LTSA and chronic disease, and socioeconomic position. Model 3 was a sensitivity analysis of Model 2, excluding those with previous LTSA. Results are reported as HR’s with 95% confidence intervals (95% CI).

Population attributable fractions (PAF) were calculated for the 0–4 index based on the HR’s and proportions exposed (Pe) from Model 2 of the second and third set of analyses where PAF = \( \sum_{r=0}^{4} \frac{Pe \cdot (HR_r - 1)}{\sum_{r=0}^{4} Pe \cdot (HR_r - 1)} \times 100 \). The Pe included all above index 0. PAF expresses the contribution of a risk factor to LTSA.

Results

During follow-up, 10.2% of the study population experienced LTSA with a mean (SD) time to event of 46.6 (32.6) weeks. A total of 5.6% were censored before the end of 2-year follow-up with a mean (SD) time to censoring of 44.5 (31.0) weeks.

Table 2 shows that all individual factors were risk factors for LTSA. In the fully adjusted Model 2, the HR’s ranged from 1.30 to 1.57. These results remained in a sensitivity analyses (Model 3), excluding those with previous LTSA.

Table 2 also shows the risk for LTSA increased gradually from scoring high on one to all four factors. In Model 1 and Model 2, respectively, scoring high on all four factors increased the risk of LTSA with HR’s of 5.01 and 3.02. Figure 2 shows the survival plot of Model 2 (using direct adjusted survivor functions). The unadjusted percentage of LTSA during follow-up among those scoring high on 0, 1, 2, 3 and 4 factors were 4.9%, 7.6%, 10.5%, 12.8% and 21.2%, respectively (not shown in the table).

Table 3 shows that the main results (Model 2 of table 2), remained stable in stratified analyses of sex, age and socioeconomic position. This was further confirmed by three separate interaction analyses of sex, age and socioeconomic position with the number of factors related to the physical work environment, which all showed non-significant interactions.

PAF’s were high across all subgroups; 39% (general population), 36% (younger workers), 45% (older workers), 36% (men), 41% (women), 30% (higher socioeconomic position) and 45% (lower socioeconomic position).

Discussion

The main finding of our study was that the risk of LTSA gradually increased with number of factors related to high physical work demands. This underlines the importance of targeting the combination of such factors in risk assessment and preventive interventions at workplaces.

In agreement with several previous studies regarding factors related to physical work demands and health, our register follow-up of >20 000 employees from the general population showed that high physical work demands, physical exertion during work, fatigue after work and work-limiting pain are risk factors of LTSA. Separately, each of the four factors related to the physical work demands increased the risk of LTSA with HR between 1.30 and 1.57. This finding confirms the relevance of each respective factor for the risk of developing long-term health problems.

As a novel finding, our study showed that scoring high on more factors related to physical work demands gradually increased the risk estimates for LTSA, that is, with HR going from 1.39 for one to 3.02
Table 2  Risk of long-term sickness absence during 2-year follow-up from scoring high in physical work demands, physical exertion during work, fatigue after work or work-limiting pain, as well as scoring high in one to four of these factors (index). On the basis of Model 2 the population attributable fraction is 39% for the index. Estimates are hazard ratios (HR) and 95% confidence intervals (CI).

|                              | N     | %     | Model 1 HR (95% CI) | Model 2 HR (95% CI) | Model 3 HR (95% CI) |
|------------------------------|-------|-------|---------------------|---------------------|---------------------|
| Physical work demands        |       |       |                     |                     |                     |
| Low                          | 9491  | 42.7  | 1                   | 1                   | 1                   |
| High                         | 12756 | 57.3  | 1.90 (1.73–2.08)    | 1.49 (1.34–1.65)    | 1.56 (1.38–1.76)    |
| Physical exertion during work|       |       |                     |                     |                     |
| Low                          | 15904 | 70.9  | 1                   | 1                   | 1                   |
| High                         | 6515  | 29.1  | 1.83 (1.69–1.99)    | 1.39 (1.25–1.53)    | 1.43 (1.27–1.60)    |
| Fatigue after work           |       |       |                     |                     |                     |
| Low                          | 8003  | 35.6  | 1                   | 1                   | 1                   |
| High                         | 14449 | 64.4  | 1.60 (1.46–1.76)    | 1.30 (1.17–1.44)    | 1.30 (1.16–1.46)    |
| Work-limiting pain           |       |       |                     |                     |                     |
| Low                          | 16834 | 75.2  | 1                   | 1                   | 1                   |
| High                         | 5561  | 24.8  | 2.09 (1.92–2.27)    | 1.57 (1.43–1.73)    | 1.54 (1.38–1.72)    |
| Index                        |       |       |                     |                     |                     |
| 0 of 4                       | 3569  | 16.2  | 1                   | 1                   | 1                   |
| 1 of 4                       | 6698  | 30.3  | 1.57 (1.32–1.87)    | 1.39 (1.16–1.66)    | 1.34 (1.10–1.63)    |
| 2 of 4                       | 5383  | 24.4  | 2.18 (1.84–2.59)    | 1.66 (1.39–1.99)    | 1.66 (1.36–2.02)    |
| 3 of 4                       | 4405  | 19.9  | 2.76 (2.33–3.27)    | 1.90 (1.57–2.29)    | 1.85 (1.51–2.27)    |
| 4 of 4                       | 2028  | 9.2   | 5.01 (4.20–5.97)    | 3.02 (2.47–3.68)    | 3.09 (2.48–3.86)    |

Notes: Model 1: Adjusted for age and sex.
Model 2: Model 1 + psychosocial work environment (influence at work, support from colleagues, support from leader, emotional demands), lifestyle (smoking, BMI, leisure physical activity), previous long-term sickness absence, chronic disease (depression, diabetes, cardiovascular disease, stroke, cancer) and socioeconomic position.
Model 3: Sensitivity analysis of Model 2, excluding those with previous long-term sickness absence.

Figure 2  Survival plot. X-axis is the time from baseline and y-axis is the survival probability based on the final model (Model 2) using direct adjusted survivor functions. The lines represent from above to below 0 of 4, 1 of 4, 2 of 4, 3 of 4 and 4 of 4 factors (high physical work demands, physical exertion during work, fatigue after work and work-limiting pain), respectively.
them separately may therefore lead to flawed conclusions. For example, an office worker having work-limiting pain but with low physical demands, low exertion and low fatigue is likely to only have slightly increased risk for LTSA, while for example a construction worker with work-limiting pain having high physical demands, high exertion and high fatigue can be expected to be at considerably increased risk for LTSA. Thus, when studying complex phenomena like labour market attachment, combining interdependent factors to investigate the risk for long-term health consequences can provide a more realistic picture. This has relevance not only for research, but also for risk assessment and preventive interventions at the workplaces.

**Strengths and limitations**

Our study has both strengths and limitations. First, because the employer is prohibited by law to ask the employee for the reason of sickness absence, the DREAM register does not contain such information. However, this also minimizes the potential bias of self-reported reasons for sickness absence as well as recall bias of period and length of sickness absence. Because the employer has a strong economic incentive to be reimbursed for the economic loss of sickness absence, the accuracy of the DREAM register is considered to be high. Second, the four factors related to physical work demands used as risk factors or predictors of LTSA in the present study were self-reported, that is, obtained from questionnaires, which is less accurate than direct measurements at the workplace. However, direct measurements are time-consuming and expensive, and questionnaires are therefore commonly used in epidemiology. The results can therefore easily be compared with previous studies. The results of the study have high generalizability as we used a representative sample of the general population. Furthermore, the risk estimates of the four-factor index remained robust across different strata of age, sex and socioeconomic position, further strengthening the validity and generalizability of the observed results. Thus, our results are unlikely to be caused by, for example, socioeconomic confounding. In addition, the analyses were controlled for several other factors known to influence the risk for sickness absence, and a sensitivity analysis (Model 3) excluding those with prior sickness absence showed similar results as the final Model 2.

**Conclusion**

The risk of LTSA gradually increased with number of factors related to high physical work demands, that is, HR—going from one to all four factors—increased gradually from 1.39 to 3.02. This underlines the importance of targeting the combination of these factors in risk assessment and preventive interventions at workplaces. Furthermore, analyses of PAF’s showed that potential for prevention is high across all strata of society, and particularly among elderly and workers in lower socioeconomic position.

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**Ethical approval**

The study has been notified to and registered by The Danish Data Protection Agency. According to Danish law, questionnaire and register based studies neither need approval by ethical and scientific committees, nor informed consent. All data were de-identified and analysed anonymously on the server of Statistics Denmark.

**Conflicts of interest:** None declared.

**Key points**

- Previous studies show that high physical work demands can be exerting, lead to fatigue after work and work-limiting musculoskeletal pain.
- Although these factors are dependent and influence each other, most studies have investigated their independent effects on health.
- There is gradually increased risk of long-term sickness absence with the number of factors related to high physical work demands.
• Preventive interventions in the working environment ought to target the combination of high physical work demands, perceived exertion, fatigue after work and work-limiting musculoskeletal pain, rather than treating them as independent factors.

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