Psychosocial working conditions, pain, mental disorders, and disability pension

Annina Ropponen\textsuperscript{a,b}, Ellenor Mittendorfer-Rutz\textsuperscript{a}, and Pia Svedberg\textsuperscript{a}

\textsuperscript{a}Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden; \textsuperscript{b}Finnish Institute of Occupational Health, Helsinki, Finland

\textbf{ABSTRACT}

We aimed to investigate associations between psychosocial working conditions and disability pension (DP), and the role of co-existing pain or common mental disorders (CMDs). Survey data collected 1998–2003 on 25,135 Swedish twins born 1935–1958 were linked with national DP register data until 2013. Psychosocial working conditions, pain and CMDs were analyzed by Cox proportional hazards regression models (hazard ratios with 95% confidence intervals). One unit increase in job demands or control was associated with a higher risk for DP due to musculoskeletal disorders. One unit decrease in job demands predicted lower risk of DP due to mental diagnoses. Co-existing pain or CMD played no role for associations of job demands with DP, but pain influenced the associations with DP due to mental diagnoses. To conclude, psychosocial working conditions play different roles for DP depending on the diagnoses.

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\textbf{Introduction}

Long-term sickness absence (SA) and disability pension (DP) may have serious consequences for individuals, their families, and the society. Being excluded from the working life due to SA/DP is associated with a range of negative relational, financial, and psychological outcomes.\textsuperscript{1,2} The number of individuals with SA/DP is high and even increasing in many European countries, despite improved health conditions.\textsuperscript{2,3} A large amount of studies has previously reported associations between psychosocial working conditions and future SA/DP.\textsuperscript{4–7} However, we are not aware of studies investigating the associations between psychosocial working conditions and the risk of DP while controlling for the effect of underlying health conditions or symptoms in population-based samples.

In the European Union (EU), the EU Sustainable Development Strategy\textsuperscript{8} includes two dimensions in the core of sustainable working life: longer working lives and healthy life years. Longer working lives equals longer working life participation at both ends of the working lives as well as in the middle of the working career. More healthy life years expect prevention of diseases such as common mental disorders (CMDs), and musculoskeletal disorders (MSDs), which are known to cause a majority of years lost due to disability.\textsuperscript{9} It is well-known that mild mental disorders or symptoms are associated with SA/DP, still most people with these mild mental problems still work and are likely to benefit from working.\textsuperscript{10} However, since SA/DP due to mental disorders are in increase, even among unemployed,\textsuperscript{11} we need to know more about factors that influence absence from the labor market, such as working conditions and other influential factors including familial effects (genetics and shared environment mainly in the childhood). In regard to MSDs, pain is an important underlying aspect since pain is also often associated with CMDs,\textsuperscript{12,13} which may additionally hinder work ability.\textsuperscript{14} Hence, as a framework for this study, we utilize the assumption that psychosocial working and health conditions or symptoms commonly co-occur in working life and may have an interrelationship that further influences their predictive role for work incapacity.

The earlier studies of psychosocial working conditions predicting risk of DP have shown somewhat mixed results.\textsuperscript{6,7,15} Mixed findings may partially be due to focusing on DP in general or alternatively on
one diagnostics group only. Also, some of these studies have also been limited to some occupational groups or industrial sectors. Furthermore, these studies may have lacked power, or possibility to control for unmeasured confounding such as familial factors that are known to contribute both to psychosocial working conditions and DP, but also on pain and CMDs. To the best of our knowledge, no population-based study has reported psychosocial working conditions in association to DP due to various diagnoses and controlling for underlying symptoms of pain or CMD.

**Aims**

To investigate the associations between psychosocial working conditions and subsequent DP (due to all cause, musculoskeletal diagnoses or mental diagnoses). Furthermore, we investigate if co-existing pain and common mental disorders (CMDs) influence these associations. In specific, we aim to investigate the effect of familial confounding on the associations.

**Methods**

A prospective twin cohort study with data from the Swedish Twin project of Disability pension and Sickness absence (STODS) was conducted. Included were the twins born before 1958 whose age was <65 years, and not on old-age pension or DP at the time of the Screening Across the Lifespan Twin study (SALT) telephone interview was conducted by the Swedish Twin Registry (STR) between 1 January 1998 and 31 March 2003. The final sample consisted of 25,135 twin individuals, of which 8,439 were complete twin pairs and of these, 5,344 were same-sexed monozygotic (MZ) and dizygotic (DZ). Furthermore, 8,257 twin pairs and of these, these responses were coded into yes/no. For statistical analyses, these responses were coded into “no pain” if not any locations were reported and “pain” if at least one pain location was reported.

All Swedish citizens are covered by a national social security DP scheme. Eligibility for DP requires a medically confirmed disorder or injury that permanently reduces work capacity by at least 25%. The Social Insurance Agency can grant a DP that covers about 65% of lost income based on a thorough assessment of level of work incapacity. In this study, date of DP and diagnosis according to the International Classification of Diseases version 10 (ICD-10) from 1994 to 2013 were used. The follow-up time for DP and censoring was from the date of SALT to DP, the age of 65, old-age pension (if before the age of 65), emigration (Statistics Sweden), date of death (the National Board of Health and Welfare), or until the end of follow-up on 31 December 2013, whichever occurred first. DP data were obtained from the National Social Insurance Agency Micro-data for Analysis of the Social Insurance System (MiDAS). For DP diagnoses, categorization into all cause DP (including all diagnoses), DP diagnosis groups as mental diagnoses (F00-F99), and DP due to MSD (M00-M99) was utilized. Data from the different national registers were linked together using the unique ten-digit Swedish identification number of each twin individual.

Before follow-up for DP, that started at the date of SALT (ie in years 1998–2003), psychosocial working conditions were assessed in 1992 based on Statistics Sweden LISA register data. Psychosocial working conditions were based on the occupational codes as suggested by the Job-Demand-Control-Support model through a validated psychosocial Job Exposure Matrix, JEM as has been described in detail earlier. The JEM includes control (7 items), demands (5 items), and support (4 items), and occupational code, sex, and age group from the same occupation. Based on the JEM, each occupation was assigned an age- and sex-specific mean score (range 1–10) of job demands, job control (ie decision authority and skill discretion), and social support. For job demands a score of 10 indicates low demands, whereas score 10 is high for control and support. Vice versa, a score of 1 indicates high job demands, but low control and support. The scores for job demands, job control, and social support were used as continuous variables in the statistical analyses.

In addition, we included pain and CMDs (major depression and anxiety) from the SALT interview. Pain was evaluated using a question that queried presence of back, shoulder, or neck pain with “Do you have, or have you had pain in [then came the list]?” with response alternatives yes/no. For statistical analyses, these responses were coded into “no pain” if not any locations were reported and “pain” if at least one pain location was reported. For CMD, the evaluation of major depression (MD) included current or previous history using the WHO’s Composite International Diagnostic Interview procedure as described in detail earlier. If one responded to the question “In your lifetime, have you ever had two weeks or more when you nearly every day felt sad, low, depressed?” yes, and yes to at least four additional symptoms (eight in total): lost interest (in general and/or in hobbies), weight change (gained or lost), trouble falling asleep, feeling tired, trouble concentrating, and/or thoughts about death, then, MD were coded. Current or
previous history of anxiety was also measured using Diagnostic and Statistical Manual of Mental Disorders, 4th Edition. Anxiety was evaluated with a question "Have you had an episode lasting at least a month in which you felt worried and anxious most of the time?", and having at least one (five in total) additional symptoms: feeling tense, irritable, tired, trouble sleeping, and the combination of being restless and on the edge. For statistical analyses, major depression and anxiety were further combined into dichotomized CMD which was coded "yes" if either MD or anxiety were present and "no" if neither existed.

Covariates were sex, marital status (cohabiting vs. living alone), children living at home (yes/no), occupation (eight categories), and type of living area (semi-rural/rural vs. cities) obtained from Statistics Sweden as reported in detail earlier. In addition, self-rated health (SRH) was surveyed with: "How would you rate your general health status?" The responses were collapsed into three alternatives: good, moderate, and poor.

For statistical analyses, Cox proportional regressions hazards were calculated for hazard ratios (HR) with 95% confidence intervals (CI) using follow-up time in days and with DP due to MSD, mental diagnoses and all cause as outcome variables. The proportional hazards assumption was graphically tested by observing that the "log-log" curves for the categories of risk factors were parallel, and continuous risk factors were tested by Schoenfeld residuals and no violations were detected. All analyses for the whole cohort were age- and sex-adjusted and clustered on pair identity to adjust 95% CIs due to within pair dependency of twin data.

To investigate the effect of various covariates including children living at home, marital status, SRH, occupation, and type of living area, these were added simultaneously into a so called full model. Further, to investigate the mutual effect of psychosocial working conditions and the effect of pain locations or CMD, we ran stratified analyses for pain and CMD separately but also included them as additional covariates in the full model.

Third, we investigated the potential confounding by familial factors utilizing a co-twin control design. Conditional proportional hazards were calculated using co-twin control design among twin pairs discordant for DP; ie one twin had a DP during the follow-up while the other twin had not. These models utilize the follow-up time to DP in relation to the

Table 1. Descriptive statistics (frequency with percentage or mean with standard deviation, SD) for different DP diagnosis groups in the final sample of 25,135 Swedish twins.

|                                      | DP due to MSDa (n = 1,264) | DP due to mentalb (n = 605) | All cause DPa (n = 3,046) | No DP (n = 22,089) |
|--------------------------------------|---------------------------|-----------------------------|---------------------------|-------------------|
|                                      | N %                       | N %                         | N %                       | N %               |
| Pain (at least 1 location)d          | 1,043 83                  | 388 64                      | 2,171 71                  | 11,618 47         |
| CMD (yes)e                          | 351 29                    | 319 58                      | 1,005 35                  | 4,413 21          |
| Sex (women)                         | 831 66                    | 423 70                      | 1,882 62                  | 10,861 49         |
| Marital status (living alone)        | 878 70                    | 348 58                      | 2,022 67                  | 15,311 69         |
| Children living at home (no)         | 856 68                    | 410 68                      | 2,038 67                  | 15,875 72         |
| Type of living area (semi-rural/rural) | 502 40                     | 176 29                      | 1,076 35                  | 6,996 32          |
| Occupational groups                  |                           |                             |                           |                   |
| Administration & management          | 121 10                    | 97 16                       | 397 13                    | 4,018 10          |
| Technology, natural and social science & art | 89 7                        | 141 23                     | 421 14                    | 4,446 20          |
| Health care & social work            | 331 26                    | 178 29                      | 752 25                    | 4,002 18          |
| Commercial work                      | 96 8                      | 35 6                        | 201 8                     | 1,726 7           |
| Agriculture, forestry & fishing      | 51 4                      | 7 1                         | 85 3                      | 748 3             |
| Transport                            | 72 6                      | 28 5                        | 169 6                     | 1,062 5           |
| Production & mining                  | 323 26                    | 75 12                       | 672 22                    | 4,249 19          |
| Service & military work              | 180 14                    | 44 7                        | 341 11                    | 1,844 8           |
| Self-rated health                    |                           |                             |                           |                   |
| Good                                 | 600 48                    | 305 50                      | 1,464 48                  | 18,468 84         |
| Moderate                             | 380 39                    | 162 27                      | 893 29                    | 2,991 14          |
| Poor                                 | 281 22                    | 136 22                      | 674 22                    | 626 3             |
| mean SD                              | mean SD                   | mean SD                    | mean SD                  | mean SD           |
| Age at 1990 (years)                  | 44.3 5.3                  | 42.8 5.1                   | 43.9 5.3                | 42.4 6.4          |
| Job demands (range 1–10, high score is low) | 6.3 0.7                    | 5.8 0.8                    | 6.1 0.8                  | 5.9 0.7           |
| Job control (range 1–10, high score is high) | 6.1 1.2                    | 6.7 1.1                    | 6.4 1.2                  | 6.8 1.2           |
| Social support (range 1–10, high score is high) | 6.5 0.7                    | 6.5 0.5                    | 6.5 0.6                  | 6.3 0.6           |

aDP due to MSD = disability pension due to musculoskeletal diagnoses.
bDP due to mental = disability pension due to mental diagnoses.
cAll cause DP = disability pension due to any diagnoses.
dPain in neck, shoulder or low back area.
eCMD = common mental disorders.
Table 2. (Conditional) Cox proportional hazards regressions (HR) with 95% confidence intervals (CI) for associations between psychosocial working conditions and DP due to different diagnosis groups.

|                      | Age and sex adj | Full model<sup>a</sup> | Discordant twin pairs<sup>**</sup>, adjusted for pain and CMD |
|----------------------|----------------|-------------------------|---------------------------------------------------------------|
|                      | Pain           | No pain                 | Pain                                           | No pain | All (n = 421) | MZ (n = 178) | DZ (n = 243) |
|                      | HR 95%CI       | HR 95%CI                | HR 95%CI                                      | HR 95%CI | HR 95%CI      | HR 95%CI      | HR 95%CI      |
| Job demands          |                |                         |                                               |         |               |               |               |
|                      | 1.56 1.44, 1.68| 1.81 1.55, 2.11         | 1.15 1.04, 1.28                               | 1.23     | 1.00 1.50     | 1.16 0.96, 1.41| 1.36 0.89, 2.08| 1.11 0.89, 1.37|
|                      | 0.76 0.73, 0.80| 0.68 0.62, 0.74         | 0.91 0.85, 0.96                               | 0.84     | 0.73, 0.95    | 0.79 0.70, 0.90| 0.90 0.74, 1.10| 0.74 0.63, 0.87|
| Social support       | 1.12 0.97, 1.29| 1.11 0.78, 1.59         | 1.07 0.93, 1.23                               | 0.98     | 0.69, 1.38    | 0.81 0.62, 1.07| 0.86 0.51, 1.43| 0.78 0.56, 1.07|
|                      |                |                         |                                               |         |               |               |               |
|                      | CMD No CMD     | CMD No CMD              |                                               |         |               |               |               |
|                      | 1.71 1.52, 1.94| 1.73 1.59, 1.88         | 1.27 1.08, 1.50                               | 1.11     | 1.00, 1.25    | 1.07 1.01, 1.20|               |               |
|                      | 0.73 0.68, 0.78| 0.72 0.69, 0.76         | 0.84 0.76, 0.94                               | 0.91     | 0.85, 0.97    |               |               |               |
|                      | 1.40 1.07, 1.84| 1.09 0.93, 1.29         | 1.10 0.87, 1.40                               | 1.03     | 0.88, 1.20    |               |               |               |
|                      |                |                         |                                               |         |               |               |               |
|                      | Pain No Pain   | Pain No Pain            |                                               |         |               |               |               |
|                      | 0.83 0.73, 0.95| 0.77 0.65, 0.91         | 0.72 0.60, 0.86                               | 0.80     | 0.66, 0.98    | 0.83 0.63, 1.10| 1.24 0.75, 2.04| 0.63 0.41, 0.97|
| Job control          | 1.07 0.99, 1.17| 1.14 1.00, 1.29         | 1.09 0.97, 1.22                               | 1.08     | 0.93, 1.26    | 1.07 0.90, 1.28| 0.94 0.64, 1.39| 1.14 0.94, 1.38|
| Social support       | 1.33 1.07, 1.64| 0.87 0.68, 1.11         | 1.52 1.20, 1.92                               | 1.00     | 0.75, 1.34    | 1.18 0.75, 1.84| 1.78 0.84, 3.75| 0.93 0.51, 1.67|
|                      |                |                         |                                               |         |               |               |               |
|                      | CMD No CMD     | CMD No CMD              |                                               |         |               |               |               |
|                      | 0.87 0.76, 1.00| 0.84 0.71, 1.00         | 0.77 0.65, 0.91                               | 0.73     | 0.58, 0.90    |               |               |               |
| Job control          | 1.05 0.95, 1.16| 1.10 0.98, 1.22         | 1.04 0.92, 1.18                               | 1.16     | 1.01, 1.32    |               |               |               |
| Social support       | 1.14 0.90, 1.44| 1.26 0.96, 1.64         | 1.24 0.96, 1.38                               | 1.37     | 1.05, 1.80    |               |               |               |
|                      |                |                         |                                               |         |               |               |               |
|                      | all cause DP   | all cause DP            |                                               |         |               |               |               |
|                      | 1.25 1.18, 1.32| 1.23 1.13, 1.34         | 1.01 0.93, 1.08                               | 0.99     | 0.89, 1.10    | 1.02 0.91, 1.15| 0.99 0.80, 1.21| 1.04 0.90, 1.21|
| Job control          | 0.86 0.83, 0.89| 0.85 0.81, 0.90         | 0.95 0.91, 1.00                               | 0.95     | 0.88, 1.02    | 0.94 0.88, 1.00| 0.96 0.86, 1.08| 0.92 0.85, 1.01|
| Social support       | 1.16 1.06, 1.28| 1.03 0.89, 1.20         | 1.14 1.03, 1.25                               | 0.99     | 0.85, 1.15    | 0.95 0.81, 1.12| 0.79 0.60, 1.03| 1.03 0.84, 1.27|
|                      |                |                         |                                               |         |               |               |               |
|                      | CMD No CMD     | CMD No CMD              |                                               |         |               |               |               |
|                      | 1.20 1.11, 1.30| 1.40 1.31, 1.49         | 0.98 0.89, 1.08                               | 1.02     | 0.94, 1.11    |               |               |               |
| Job control          | 0.86 0.82, 0.91| 0.82 0.79, 0.84         | 0.92 0.86, 0.99                               | 0.97     | 0.92, 1.02    |               |               |               |
| Social support       | 1.16 1.00, 1.34| 1.17 1.06, 1.30         | 1.06 0.92, 1.22                               | 1.12     | 1.01, 1.24    |               |               |               |

<sup>a</sup>Full model adjusted for age, sex, marital status, children living at home, type of living area, self-rated health, occupational group, mutually adjusting for other psychosocial working conditions, and while stratifying for pain locations for CMD (= common mental disorders) and vice versa.<br>
<sup>**</sup>Only same-sexed complete pairs.<br>
<sup>a</sup>DP due to MSD = disability pension due to musculoskeletal diagnoses.<br>
<sup>b</sup>DP due to mental = disability pension due to mental diagnoses.<br>
<sup>c</sup>All cause DP = disability pension due to any diagnoses.
follow-up time of the co-twin with stratification by twin pair. Hence, each twin pair had his/her own baseline hazard. Familial factors, ie genetics and shared environment exist when twin pairs reared together share both their genetic make-up and home and family environment. For interpretation of results, this means that if the association between psychosocial working conditions and DP is due to familial factors, the association should be found only between twin pairs reared together, but not within, which means that the association should be seen in the whole cohort but not in discordant twin pairs. Instead, familial confounding would be seen if the association exist within DZ twin pairs (share of segregating genes on average 50%), but not within MZ twin pairs (share of genes 100%). Last, if the association is not influenced by familial factors, the association should be found within both MZ and DZ twin pairs. Statistical analyses were conducted with Stata version 13.1 (Stata Corporation, College Station, TX, USA).

The study was approved by the Regional Ethical Review Board in Stockholm (2007/524-31).

Results

During follow-up, DP due to MSD was granted to 5%, DP due to mental diagnoses to 2%, and DP due to any diagnoses to 12% in the final sample. The median follow-up time was 8.9 years. The final sample included mainly women (62–70%), the mean age was 43.4 years in 1990, and a majority (64–83%) had at least one pain location and 29–58% had CMDs (Table 1).

The role of psychosocial working conditions was different for different DP diagnosis groups, and the role of pain or CMD in the associations yielded mixed results (Table 2). One unit decrease in job demands was associated with a higher risk of DP due to MSD both among those with or without pain or CMD. Still this association attenuated to statistical non-significance among discordant twins. Instead one unit decrease in job demands was associated with a decrease in risk of DP due to mental diagnoses both among those with or without pain or CMD. The analyses with additional covariates (full model in the Table 2) or adjustment for familial confounding indicated that the associations remained, ie being independent from covariates or familial effects. For all cause DP, one unit decrease in job demands indicated higher risk, but the association attenuated to statistical non-significance when controlling for covariates or familial factors, ie suggesting effect from covariates or familial factors.

One unit increase in job control was associated with a lower risk for DP due to MSD, both among those with or without pain or CMD (Table 2). The analyses of discordant twins confirmed these associations pointing into direction of little or no influence of familial effects. Job control was not associated with DP due to mental diagnoses in any of the tested models and only in the age and sex-adjusted model for all cause DP.

Social support did not play a role for DP due to MSD except among those with CMD in the model adjusted for age and sex. Instead for DP due to mental diagnoses, one unit increase in social support showed importance among those with pain. Social support for all cause DP indicated mixed findings: first one unit increase in social support was associated with higher risk of all cause DP among those with CMD but after controlling for covariates the association remained only for those without CMD (Table 2).

Discussion

The population-based twin sample with over 25,000 working-age twins was utilized to investigate whether pain or CMDs would alter the associations between psychosocial working conditions and DP due to various diagnosis groups. This study may have been among the first with a relatively large population-based sample and possibility to control for various influential factors including familial ones. Our results clearly indicate that the role of pain and CMD for the associations between psychosocial working conditions (job demands, job control, and social support) and DP differs depending on the diagnosis group. Furthermore, the role of psychosocial working conditions differed between DP diagnosis groups and depending on the various confounding factors accounted for. This adds to the existing knowledge that has so far been based on some specific occupational groups (such as construction), different industrial sectors (such as the public sector) or on all cause DP.4,5,17,23

Job demands showed to predict DP due to MSD and mental diagnosis in different ways. For DP due to MSD, one unit decrease in job demands predicted higher risk as has been shown earlier based on a study partially based on the same dataset,7 whereas for DP due to mental diagnoses the association was opposite, ie toward lower risk. Lower job demands and lower risk of DP might reflect some coping strategies or possibilities for work task adjustments, since earlier studies have indicated, eg that this effect might depend on occupational sectors6 or being linked with...
However, further studies are warranted to clarify these qualitative aspects of working life. Instead we noted that pain or CMD did not affect these associations. Furthermore, these associations were independent of effects of various covariates including occupational group and self-rated health. Moreover, we detected no or little effect of familial factors on the association between job demands and DP due to mental diagnoses in line with an earlier study. The association between job demands and all cause DP was detected only in the age and sex adjusted model which implies that investigating the diagnosis groups for DP is important as the underlying condition clearly plays a role. Differences in results depending on DP diagnosis group has earlier been shown in studies of health behaviors, health conditions, and shift work as predictors for diagnosis specific DP. One unit increase in job control within the Job-Demand-Control-Support model showed to be protective for DP due to MSD regardless of pain or CMD being in line with earlier results. However, we did not detect an effect of familial confounding, which suggests that genetics and shared environment that is mainly the social background and values within families in the childhood, are not influential. Familial factors are known to affect DP, MSD, pain, and CMD being the grounds why we expected these to influence the associations of psychosocial working conditions and DP due to MSD. However, we did not detect any associations between job control and DP due to mental diagnosis or all cause. This may imply that psychosocial working conditions play a different role for work incapacity based on the underlying condition. Furthermore, this finding might be important for workplaces and occupational health care in terms of job modification and early prevention.

Social support yielded the most consistent associations with DP outcomes in this study, but the existence of comorbidity (ie pain or CMD) seemed to play a role for these associations. This may be related to the social acceptance of pain versus expected stigma related to CMDs which might be easier if social support exist. Furthermore, management might be an influential factor for this finding as leadership has been shown to play a role in social support and both management and social support are linked with DP. Alternatively, pain and/or CMDs may be affected by various circumstances both in private life (marital status, children living at home, SRH) and at the workplace (occupational group).

Strengths of this study included comprehensive register and survey data for >25,000 individuals, which provided censoring with no loss to follow-up. A unique strength is the access to twin data which provides control for familial factors adding to the existing knowledge based on results from nonrelated individuals in epidemiological studies. Despite the strengths, a weakness was that power was rather low in the discordant pair analyses for MZ and DZ twins separately. Hence, even larger samples should be available to confirm the findings from this study. For the interpretation of the results, one need to acknowledge that the JEM was applied to the register data in 1992 which means that psychosocial working conditions were evaluated around ten years before measuring pain locations and CMDs in 1998–2003 by self-reports although the questions covered lifetime pain and CMD. Even though this might have not been the optimal solution, it provided us the possibility to investigate both comprehensive register data and relevant follow-up over almost ten years for DP due to different diagnosis groups with a sample over 25,000 working-age individuals. This may of course affect the observed associations, but still these results are in line with those published in Sweden earlier. Another weakness may be that this study was done within the Nordic welfare model with individuals at their middle age (mean age was 43.4 years) which may affect generalizability to other countries, settings or age groups.

To conclude, the role of psychosocial working conditions varies based on DP diagnosis groups and co-existing pain or CMD further complicates the associations. The varying role of job demands, job control, and social support for DP due to MSD or mental diagnoses implies that the underlying condition and potential symptoms should be acknowledged at the workplace while seeking solutions for influencing psychosocial conditions. Furthermore, familial factors (ie genetics and shared environment) seem to play a minor role for the associations between psychosocial factors and DP which suggests that workplace interventions or occupational health care could provide effective means to influence the DP risk through psychosocial working conditions.

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