**Predictors of depression- and musculoskeletal disorder-related work disability among young, middle-aged and ageing employees**

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**ABSTRACT**

**Objective:** To investigate the level and predictors of work disability in different age groups.

**Methods:** We followed young (18–34 years), middle-aged (35–50 years), and ageing (>50 years) employees (n=70417) for seven years (2005-2011) for all-cause and cause-specific work disability (sickness absence and disability pension). Using negative binomial regression, we obtained both relative risk estimates, and absolute rates, i.e., days of work disability per person-year.

**Results:** The greatest relative difference in all-cause, and specifically depression-related work disability, was between young women and young men, and between employees with low versus high levels of education. Ageing employees with a low education and chronic somatic disease had the highest levels of musculoskeletal disorder-related work disability.

**Conclusions:** The predictors of work disability vary by age and diagnosis. These results help target age-specific measures for the prevention of permanent work disability.

**INTRODUCTION**

Biological factors (e.g., older age, female sex), chronic diseases, multi-morbidity, and lower socioeconomic status have been associated with a higher risk of work disability, as expressed by sickness absence and disability pension.[1-7] Evidence has also accumulated which shows that modifiable work-related factors, such as job control and job demands, play a role in work disability.[8-11]

Sickness absence at a young age may be an alarming sign of future exclusion from the labour market because it is associated with an increased risk of subsequent sickness absence, along with a lower future income and premature mortality – a finding which may relate to the progression of a disease, difficulties in becoming attached to the labour market, and beliefs about future employability.[12] The likelihood of disability pension increases with age,[4,13] but the proportion of young adults receiving disability benefits has increased in many European countries,[14] especially among young women.[15,16] The economic costs of young people's permanent exit from the labour market are higher than those of the exit of ageing employees.

However, research regarding the modifying effect of age on the association between work disability risk factors and work disability is largely lacking. For example, age-related predictors may differ according to the illness causing the disability. Previous studies have found that the association between the risk of disability pension due to mental disorders and age was U-shaped, indicating equally high risks among both young (18–24 years) and ageing (>45 years) psychiatric outpatients.[17] Men's increasing age seems to cause longer musculoskeletal disorder-related absences, but older women had shorter absences than

younger women.[18] However, new evidence is needed regarding the predictors of work disability according to age. Taking age into account could benefit occupational health services and human resource management in their attempts to develop tools for tailored work disability prevention.

Our aim was to investigate the sociodemographic, health-related, and work-related psychosocial predictors of work disability in three different age groups: young (18–34), middle-aged (35-50) and ageing (>50 years) employees. To avoid problems related to self-reporting, we used measures of psychosocial factors aggregated at the work-unit level.[19,20] In addition to all-cause work disability, we specifically focused on the two most common causes of long-term work disability, depressive and musculoskeletal disorders. Based on earlier research[17,18] we hypothesized that the predictors of work disability would vary according to age, and that the effect of age may differ across diagnostic groups.

**METHODS**

**Study procedure**

This prospective cohort study is part of the Finnish Public Sector study of the employees of 10 municipalities and 21 hospitals.[8,9] The study was approved by the ethics committee of the Helsinki and Uusimaa hospital district. The study population consisted of those eligible for a questionnaire survey in 2004 (i.e., full-time employed at the time of the survey, short-term temporary employees excluded). From these data, we sourced employees who were not on disability pension or old-age pension at the beginning of the follow-up, on 1 January 2005 (n=71 791). These people were followed for seven years, until 31 December 2011. Survey data were linked to employers' registers and national health and disability registers through the personal identity number that is unique to each resident of Finland. The final analytic sample comprised 70 417 employees with full data on all variables of interest.

**Measures**

*Outcome: Work disability*

Sickness absence and work disability pension follow a continuum, in which long-term sickness absence (in Finland, when exceeding 300 compensated days) turn into disability pensions (usually preliminarily fixed-term, for a year at a time), if the employee remains unable to work. Thus, both outcomes were combined. Data on sickness absence were from the Sickness Allowance Register of the Social Insurance Institution, and included annual

compensated diagnosis-specific sickness absences (range 10 to 365 days), with beginning and ending dates. Information on disability pension was obtained from the Finnish Centre for Pensions. Sickness absence and disability pension days were combined to indicate total work disability, and linked to survey data. The main diagnosis assigned by the treating physician for all periods of granted work disability was coded according to the International Classification of Diseases, 10th Revision (ICD-10).[21] We examined all-cause work disability, and work disability specifically due to the most common diagnoses, i.e., depressive (F32-F34) and musculoskeletal (M00-M99) disorders. Dorsopathies (M40–M54) comprised 36% of musculoskeletal disorder-related sickness absences and 46% of the disability pensions. Arthropathies (M00–M25) in turn comprised 29% of sickness absences and 39% of disability pensions. The third largest group were soft tissue disorders (M60–M79; 34% of sickness absences and 12% of disability pensions).

*Predictors of work disability*

*Sociodemographic characteristics.* Information on age and sex in 2004 was retrieved from employers' registers. Age was categorized into 18–34, 35–50, and more than 50 years. Level of education was retrieved from Statistics Finland's register of completed education, and coded as high (over 12 years), intermediate (10–12 years) or basic education (max. 9 years).

*Chronic somatic disease.* Chronic somatic diseases were defined as diabetes, hypertension, asthma, rheumatoid arthritis, or cancer at the beginning of follow-up. The information on all of these, except for cancer, was derived from the health records of the Special Refund Entitlement Register, which comprises individuals with severe and chronic conditions who are entitled to a higher rate of reimbursement for their medicines. To be eligible for special

reimbursement, a patient's condition must meet explicit predefined criteria, and a written certificate is required from the treating physician. The application is reviewed by a physician from the Social Insurance Institution to determine whether the uniformly defined requirements have been met. Cancer cases were obtained from the data of the Finnish Cancer Registry, which comprises information on malignant tumours.

*Psychosocial work environment.* Psychosocial work environment was operationalized as job demands and job control[22] measured by a questionnaire survey in 2004, and aggregated to work unit level. We determined each participant's work unit from the employers' administrative records in 2004 and identified 3242 work units (mean size 22 person-years, standard deviation 28, median 16, and interquartile range 9–25). Job demands and job control were measured by mean response scores: three job demand items (scale 1–5) and nine job control items (1–5), for which higher scores indicated higher job demands and higher job control. Work unit-based scores were calculated as the mean of all individual scores from the same work unit for all units with at least three respondents. As previously, each participant in the same work unit was given the same work unit-based score regardless of their survey response status.[8,9] Those with higher than median values were classified as having high job demands or control, and those with lower or equal to median as having low job demands or control.

**Statistical analysis**

We tested the differences between the baseline characteristics of the age groups using Chi-squared tests. We applied negative binomial regression analysis to examine the rate of work

disability days during the seven-year follow-up and the factors predicting this rate in the three age groups. The results are presented as rate ratios (RR) and their 95% confidence intervals (CI). We tested for possible effect modification of age using interaction terms (age × sex; age × education; age × somatic disease; age × job control; age × job demands). To demonstrate the absolute level of work disability of the different groups, we calculated the least square means per person-year, adjusted for covariates. SAS statistical software, version 9.4, was used for all analyses.

**RESULTS**

The characteristics of study participants by age group are described in Table 1. The sex distribution was similar in each age group. Young (aged 18–34 years) employees had a higher education, less chronic somatic diseases, higher job control, higher job demands, and less work disability days than the two older employee groups. Work disability days were highest among ageing (>50 years) employees. On average, ageing employees had four more days per person-year of depression-related disability, and 17 more days of musculoskeletal disorder-related disability than young employees.

Table 1. Characteristics of the study participants by age group. Frequency (percent).

| | 18-34 years | 35-50 years | >50 years | p for difference |
|---|---|---|---|---|
| Men | 2807 (24) | 8539 (24) | 5859 (24) | 0.21 |
| Women | 8669 (76) | 27479 (76) | 18438 (76) | |
| High education | 7312 (64) | 20197 (56) | 11497 (47) | <0.001 |
| Intermediate | 3717 (32) | 13189 (37) | 8351 (34) | |
| Low education | 447 (4) | 2632 (7) | 4449 (18) | |
| No chronic disease | 10843 (94) | 32017 (89) | 18772 (77) | <0.001 |
| Chronic disease | 633 (6) | 4001 (11) | 5525 (23) | |
| High job control | 6328 (56) | 17900 (51) | 10901 (46) | <0.001 |
| Low job control | 4941 (44) | 17467 (49) | 12880 (54) | |
| Low demands | 5270 (47) | 17698 (50) | 12173 (51) | <0.001 |
| High demands | 5999 (53) | 17669 (50) | 11608 (49) | |
| All-cause SA* | 6.6 | 10.2 | 15.2 | |
| SA* Depression | 0.82 | 1.37 | 1.65 | |
| SA* Musculoskel. | 1.71 | 3.79 | 6.41 | |
| All-cause DP** | 1.61 | 6.31 | 18.5 | |
| DP** Depression | 0.46 | 1.37 | 2.82 | |
| DP** Musculoskel. | 0.30 | 2.27 | 9.70 | |

*SA=sickness absence days per person-year

**DP=incidence rate of disability pension per 1000 person-years. Incidence rate is calculated as: (N of disability pension events during 7-year follow-up / 7 years / N of employees at risk) × 1000.

Table 2 shows the sociodemographic, health and psychosocial predictors of work disability from any cause and from depression- and musculoskeletal disorder-related causes, stratified by age group. The p-values for interaction terms are presented in Online Supplementary Table 1, which shows significant interactions of age with sex, education, chronic disease, and job control.

Table 2. Factors associated with all-cause, depressive and musculoskeletal disorder-related sickness absence among young (18-34), middle-aged (35-50) and aging (>50) employees.

| | Sickness absence due to any diagnosis | | | | | | Sickness absence due to depression | | | | | | Sickness absence due to musculoskeletal disorder | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18-34 years (n=11269) | | 35-50 years (n=35367) | | >50 years (n=23781) | | 18-34 years (n=11269) | | 35-50 years (n=35367) | | >50 years (n=23781) | | 18-34 years (n=11269) | | 35-50 years (n=35367) | | >50 years (n=23781) | |
| | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI |
| Women (ref=men) | **1.57** | **1.41-1.76** | 1.22 | 1.15-1.30 | 1.14 | 1.05-1.22 | **2.50** | **1.67-3.75** | 1.38 | 1.10-1.73 | 1.30 | 0.96-1.68 | 1.37 | 1.13-1.65 | 1.35 | 1.21-1.51 | 1.27 | 1.12-1.45 |
| Intermediate education (ref=high) | 1.58 | 1.42-1.75 | 1.87 | 1.76-1.97 | 1.69 | 1.58-1.82 | 1.89 | 1.29-2.76 | 1.43 | 1.16-1.76 | 1.08 | 0.82-1.40 | 2.54 | 2.12-3.04 | 2.99 | 2.71-3.30 | 2.71 | 2.39-3.07 |
| Basic education (ref=high) | **2.31** | **1.80-2.95** | **2.44** | **2.20-2.71** | 1.95 | 1.78-2.13 | **3.20** | **1.31-7.78** | 1.67 | 1.14-2.44 | 0.98 | 0.70-1.36 | 3.86 | 2.52-5.91 | 4.55 | 3.80-5.46 | 3.38 | 2.89-3.94 |
| Somatic disease (ref=no) | 1.56 | 1.28-1.90 | **1.87** | **1.73-2.03** | 1.50 | 1.39-1.61 | 0.98 | 0.47-2.06 | 1.52 | 1.13-2.06 | 1.32 | 1.00-1.74 | **2.49** | **1.75-3.53** | 2.02 | 1.75-2.32 | 1.42 | 1.25-1.62 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low job control (ref=high) | 1.09 | 0.99-1.19 | 1.17 | 1.11-1.23 | 1.23 | 1.15-1.31 | **0.69** | **0.50-0.98** | 0.99 | 0.81-1.20 | 1.08 | 0.85-1.38 | 1.55 | 1.32-1.83 | 1.36 | 1.24-1.49 | 1.48 | 1.32-1.65 |
| High demands (ref=low) | 1.10 | 1.00-1.20 | 1.03 | 0.98-1.09 | 1.12 | 1.05-1.19 | 1.02 | 0.72-1.43 | 0.88 | 0.73-1.07 | 1.14 | 0.90-1.45 | **1.30** | **1.11-1.52** | 1.08 | 0.89-1.18 | 1.08 | 0.97-1.21 |

**Sociodemographic- and health-related predictors of work disability in different age groups**

As Table 2 shows, the association between sex and work disability was different in different age groups. Among young employees, the relative risk of women for all-cause work disability was 1.61 times higher than that of men (95% CI 1.44-1.81), while among ageing employees, this relative risk was 1.19 (95% CI 1.10-1.28) (p for interaction <0.001). These relative differences were highlighted in depression-related disability, of which the excess risk among women was 2.64-fold among young and 1.56-fold among ageing employees.

Lower education presented a higher risk of work disability among the younger employees than among the older age groups. Among young employees, basic education was associated with a 2.46-fold (95% CI 1.91-3.16) higher risk of all-cause work disability compared to that among those with a high level of education. The corresponding risk was 2.04 (95% CI 1.86-2.24) among those aged over 50. This finding was further demonstrated in work disability due to depression: among young employees, having only a basic education was associated with a 3.86-fold (95% CI 1.56-9.59) higher risk than that among those with a high education, whereas among the oldest age group, education was not associated with depression-related work disability (RR=0.95, 95% CI 0.68-1.33). A similar trend was observed with regard to musculoskeletal disorders. Basic education was associated with an increased risk of work disability; relatively more so among young (RR=4.23; 95% CI 2.75-6.52) than among ageing employees (RR=3.49; 95% CI 2.98-4.08). (Table 2.)

The interaction between education and age predicting depression-related work disability is illustrated in Figure 1. Young women with a low education had, on average, four days of depression-related work disability per person-year, which corresponds to the level seen among ageing men with low or intermediate education. In absolute terms, the highest number of depression-related work disability days per person-year (5 to 6 days) was observed among women aged over 50, regardless of their education.

The interaction between chronic somatic disease and age predicting work disability due to musculoskeletal disorders is illustrated in Figure 2. Having a chronic somatic disease was associated with an increased risk of work disability due to musculoskeletal disorders; relatively more so among young employees (RR=2.99; 95% CI 2.09-4.27) than among the ageing (RR=1.54; 95% CI 1.35-1.76). (Table 2.) In absolute terms, ageing employees who had a low education and chronic somatic disease had the most musculoskeletal disorder-related work disability (a mean of 34 days per person-year). Among young employees with a high education and no chronic somatic disease, the mean of musculoskeletal disorder-related disability was one day per person-year.

**Psychosocial predictors of work disability in different age groups**

The association between low job control and all-cause work disability became stronger as age increased. Among young employees, low job control was not associated with a higher risk of work disability (RR=1.06, 95% CI 0.97-1.17), but the association was 1.20-fold (95% CI 1.14-1.27) among middle-aged, and 1.27-fold (95% CI 1.18-1.36) among ageing employees.

A similar association seemed to exist for high job demands, but the interaction was non-significant, due to overlapping confidence intervals. (Table 2.)

Low job control and high job demands were both associated with a higher risk of musculoskeletal disorder-related work disability irrespective of age. Low job control was associated with a 40%–60% higher risk, and high job demands were associated with a 7%–30% higher risk of musculoskeletal disorder-related work disability. Job control and job demands were not associated with depression-related work disability.

**Sensitivity analysis: occupational position**

To account for the diverse physical demands of different occupations, we examined occupational position (classified as upper-grade non-manual, lower grade non-manual, and manual work) as a predictor of work disability. Due to the high correlation between occupational position and education (90% of employees in upper-grade non-manual positions had a higher education, and 60% of manual workers had a basic education; Pearson r=0.61, p<0.001), we did not include education in these analyses. Because of missing information on occupational position, the analytic sample in the sensitivity analyses was 70 319.

As Supplementary Table 2 shows, age moderated the effect of occupational position on all-cause work disability (p for interaction = 0.03). Consistent with the results regarding education, employees in manual occupations were at a greater risk of all-cause work disability than employees in upper-grade non-manual occupations, and the relative risk was greater

among younger than older employees. When adjusted for occupational position, the age $\times$ job control and age $\times$ job demands interactions were still significant (p=0.01) in relation to all-cause work disability. The association between low demands or high control and all-cause work disability grew stronger as age increased.

Occupational position was associated with both depression- and musculoskeletal disorder-related work disability, irrespective of age. The role of occupational position was highlighted in musculoskeletal disorders: the risk of musculoskeletal disorder-related work disability was seven times higher among manual workers than among upper-grade non-manual workers (Supplementary Table 2). In absolute terms, this corresponds to two days among upper-grade non-manual workers, and 16 days among manual workers (adjusted least square means, data not shown in tables). The interactions of age $\times$ sex and age $\times$ occupational position in relation to depression-related work disability were non-significant (p>0.09).

Regarding musculoskeletal disorder-related work disability, the interaction of age $\times$ chronic disease was robust to adjustment for occupational position (p<0.001). Adjustment for occupational position diluted the association between high job demands and musculoskeletal disorder-related work disability, but the association with job control was robust to the adjustment. (Supplementary Table 2.).

**DISCUSSION**

We showed that age has an important role as an effect modifier with regard to the association between the individual and work-related risk factors of work disability. The most obvious results were found for depression-related work disability; although women at any age were at a higher risk than men, the difference between men and women was strongest among the young (18–34 years) employees. Moreover, we found that a low educational level was associated with a high relative risk of work disability among the young in particular, and was also predominantly related to work disability due to depression. Although the highest absolute rates were found among ageing women (five to six days per person-year), the level of depression-related work disability among young women with a low education was similar to that observed among ageing (>50 years old) men (four days).

Ageing employees with chronic somatic disease and a low level of education had the highest absolute burden of musculoskeletal disorder-related work disability, an average of 34 days per person-year. We also found a large relative risk of ending up on musculoskeletal disorder-related work disability among young employees with a low education and chronic somatic disease. Indeed, among highly educated young employees, the absolute rate of musculoskeletal disability with a chronic somatic disease was four days per person-year, whereas the corresponding rate for their counterparts without such a disease was one day. In line with our findings, a previous study showed that a low education level and other risk factors of failing to integrate into working life, i.e., teenage parenthood, single status, and poor attachment to the labour market, were the strongest determinants of disability pension among young adults with chronic musculoskeletal pain.[23] Furthermore, the number of

comorbid conditions has shown to correlate with insurance physicians' assessments of young people's work disability.[24,25]

Also congruent with previous research,[3,26] our findings on work disability followed a clear socioeconomic gradient. However, a novel finding was that socioeconomic work disability differences were stronger among younger age groups. Low education may be a marker of early or more severe symptoms of ill-health and earlier disease onset, especially with regard to mental disorders: those with the poorest mental health at a young age are less likely to achieve a high education.[27,28]

Previous studies have linked work-related psychosocial factors with work disability.[8-11] We found that age modified the association of low job control and all-cause work disability. The adverse effect of low control on work disability increased with growing age. This may be related to, for example, longer exposure of older workers to adverse psychosocial working conditions. Another explanation may lie in the different expectations and needs of young and ageing employees: inexperienced employees who have short job tenure are often young, may even benefit from guidance, supervision and less decision latitude, while older, experienced employees might desire more autonomy.

Low job control and high job demands were associated with an increased risk of musculoskeletal disorder-related work disability irrespective of age, which corresponds to the results of a previous study on the adverse effect of job strain on musculoskeletal disorder-related disability pension.[9] We found that the risk of musculoskeletal disability was minimal among young, highly educated employees who also were often in upper-grade non-manual

occupations. In turn, musculoskeletal burden was high among ageing employees with a low education, people who were most often in manual jobs. Since physical workload is higher in manual occupations, longer exposure to physically demanding work is a plausible explanation for these findings.

The strengths of this study include a large cohort with a long follow-up. Due to the large sample size, we had sufficient statistical power to detect interaction effects. We thus contributed to existing evidence by examining the effect modification of age on the predictors of work disability. The measurements of most variables were register-based and thus reliable. With regard to psychosocial factors, we aimed to increase the validity and reliability of the measures by using work unit-level measures of job control and demands instead of self-reported data. This approach is seen as less vulnerable to reverse causation and subjectivity bias than using individual-level measures.[8,9,29]

The study also has some limitations. The healthy worker effect is more pronounced among younger employees,[30] which means that young employees who have been able to get a job are healthier than those unattached to the labour market. This may have led to an underestimation of the effect of some variables. Thus, work-related hazards may be masked by the better health of young people on the workforce than that of the general population. Furthermore, we had no information regarding disease severity, age at the onset of chronic disease, or the treatment received. This could cause some bias with regard to differences between age groups, since diseases are more likely to have lasted longer among older people. However, since young people with chronic somatic disease were at an especially high relative risk of work disability, more severe diseases among older employees seem an unlikely explanation

for our results. Although we had a rather wide range of predictor variables, from sociodemographic factors to health and psychosocial work environments, some residual confounding is still possible. For example, we had no exact information regarding physical workload although we used occupational position as a proxy for physical working conditions. The public sector employee cohort with its higher number of women also limits the generalizability of our findings. Moreover, the Finnish sickness benefit and compensation system may affect the results, and lower the generalizability of our findings to other social security systems.

To conclude, these results suggest that ageing women in general and young women with a low level of education in particular, are at a high risk of depression-related work disability. The greatest burden of musculoskeletal work disability was among ageing employees in manual occupations, and among those with low education and somatic diseases. These results could benefit occupational health services and human resource management in their attempts to develop tools for age-specific work disability prevention, which in turn may promote work disability prevention in clinical practice and public policies.

**REFERENCES**

1. Besen E, Young AE, Pransky G. Exploring the relationship between age and tenure with length of disability. *Am J Ind Med*. 2015;58:974-987.

2. Jetha A, Besen E, Smith PM. Comparing the relationship between age and length of disability across common chronic conditions. *J Occup Environ Med*. 2016. Online first. Doi:10.1097/JOM0000000000000702.

3. Sumanen H, Rahkonen O, Pietiläinen O, et al. Educational differences in disability retirement among young employees in Helsinki, Finland. *Eur J Public Health*. Published online 17 December 2015. doi: 10.1093/eurpub/ckv226.

4. Laaksonen M, Mastekaasa A, Martikainen P, et al. Gender differences in sickness absence – the contribution of occupation and workplace. *Scand J Work Environ Health*. 2010;36:394-403.

5. Melchior M, Krieger N, Kawachi I, et al. Work factors and occupational class disparities in sickness absence: findings from the GAZEL cohort study. *Am J Public Health*. 2005;95:1206-1212.

6. Christensen KB, Labriola M, Lund T, et al. Explaining the social gradient in long-term sickness absence: a prospective study of Danish employees. *J Epidemiol Community Health*. 2008;62:181-183.

7. Marmot MG, Smith DG, Stansfeld S, et al. Health inequalities among British civil cervants: the Whitehall II study. *Lancet* 1991;337:1387-1393.

8. Laine S, Gimeno D, Virtanen M, et al. Job strain as a predictor of disability pension: the Finnish Public Sector Study. *J Epidemiol Community Health.* 2009;63:24-30.

9. Mäntyniemi A, Oksanen T, Salo P, et al. Job strain and the risk of disability pension due to musculoskeletal disorders, depression or coronary heart disease: a prospective cohort study of 69 842 employees. *Occup Environ Med*. 2012;69:574-581.

10. Niedhammer I, Chastang J-F, Sultan-Taïeb H, et al. Psychosocial work factors and sickness absence in 31 countries in Europe. *Eur J Public Health*. 2012;23:622-628.

11. Duijts SFA, Kant I, Swaen GMH, et al. A meta-analysis of observational studies identifies predictors of sickness absence. *J Clin Epidemiol*. 2007;60:1105-1115.

12. Thomson L, Griffiths A, Davison S. Employee absence, age and tenure: a study of nonlinear effects and trivariate models. *Work & Stress* 2000;14:16-34.

13. Allebeck P, Mastekaasa A. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 5. Risk factors for sick leave-general studies. *Scand J Public Health.* Supplement 2004;63:49-108.

14. Kaltenbrunner Betnitz B, Grees N, Jakobsson Randers M, et al.. Young adults on disability benefits in 7 countries. *Scand J Public Health*. 2013;41(Suppl 12):3-26.

15. Karlsson N, Borg K, Carstensen J, et al. Risk of disability pension in relation to gender and age in a Swedish county: A 12-year prospective population-based cohort study. *Work* 2006;27:173-179.

16. The ATP Group (Denmark), Finnish Centre for Pensions, The Social Security Administration (Iceland), et al. *Expected effective retirement age in the Nordic countries.* Statistical Report 2/2008. Helsinki: Finnish Centre for Pensions, 2008. Available from: http://www.etk.fi/fi/gateway/PTARGS_0_2712_459_440_3034_43/http%3B/content.etk.fi%3 B7087/publishedcontent/publish/etkfi/fi/julkaisut/tilastojulkaisut/tilastoraportit/expected_effe ctive_retirement_age_in_the_nordic_countries_7.pdf. (Accessed 3 February 2016)

17. Arcas MM, Delclos GL, Torá-Rocamora I, et al. Gender differences in the duration of non-work-related sickness absence episodes due to musculoskeletal disorders. *J Epidemiol Community Health*. 2016. Online First. doi:10.1136/jech-2014-204331.

18. Mittendorfer-Rutz E, Härkönen T, Tiihonen J, et al. Association of socio-demographic factors, sick-leave and health care pattern with the risk of being granted a disability pension among psychiatric outpatients with depression. *PLoS One* 2014;9:e99869.

19. Kolstad HA, Hansen AM, Kærgaard A, et al. Job strain and the risk of depression: is reporting biased? *Am J Epidemiol*. 2011;173:94-102.

20. Vahtera J, Laine S, Virtanen M, et al. Employee control over working times and risk of cause-specific disability pension: the Finnish Public Sector Study. *Occup Environ Med.* 2010;67:479-485.

21. World Health Organization. *International Classification of Diseases, 10th Revision.* Geneva: World Health Organization, 1992.

22. Karasek R, Theorell T. *Healthy work: Stress, Productivity, and the Reconstruction of Working Life*. New York, NY: Basic Books, 1990.

23. Myhr A, Haugan T, Espnes GA, et al. Disability pensions among young adults in vocational rehabilitation. *J Occup Rehabil*. Published online 4 July 2015. doi: 10.1007/s10926-015-9590-5.

24. Holwerda A, Groothoff JW, de Boer MR, et al. Work-ability assessment in young adults with disabilities applying for disability benefits. *Disabil Rehabil*. 2013:35:498-505.

25. Joensuu M, Mattila-Holappa P, Ahola K, et al. Clustering of adversity in young adults on disability pension due to mental disorders: a latent class analysis. *Soc Psychiatry Psychiatr Epidemiol.* Published online 15 September 2015. doi: 10.1007/s00127-015-1123-1.

26. Sumanen H, Pietiläinen O, Lahti J, et al. Sickness absence among young employees: trends from 2002 to 2013. *J Occup Health*. 2015;57:474-481.

27. Breslau J, Lane M, Sampson N, et al. Mental disorders and subsequent educational attainment in a US national sample. *J Psychiatr Res*. 2008;42:708-716.

28. Gibb SJ, Fergusson DM, Horwood LJ. Burden of psychiatric disorder in young adulthood and life outcomes at 30. *Br J Psychiatry*. 2010:197:122-127.

29. Kivimäki M, Head J, Ferrie JE, et al. Why is evidence on job strain and coronary heart disease mixed? An illustration of measurement challenges in the Whitehall II study. *Psychosom Med. 2006;68:398-401*.

30. Carpenter LM. Some observations on the healthy worker effect. Editorial. *Brit J Ind Med*. 1987;44:289-291.
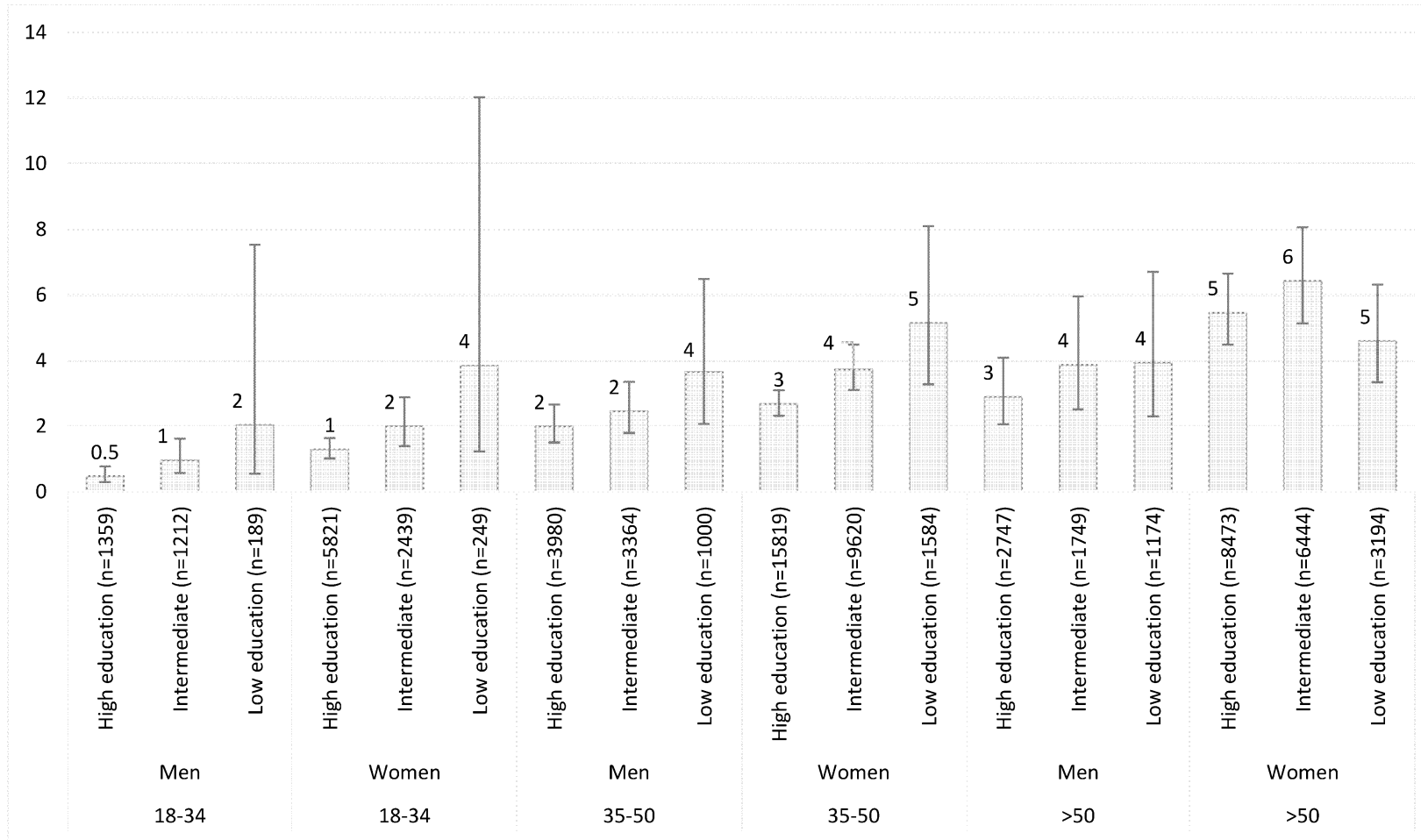
**Figure 1.** Mean days of depression-related work disability per person-year. P for age×sex interaction <0.001; age×education =0.002; age×sex×education = 0.83. Figures are adjusted for sex, education, chronic somatic disease, job control, and job demands. Error bars indicate 95% confidence intervals.
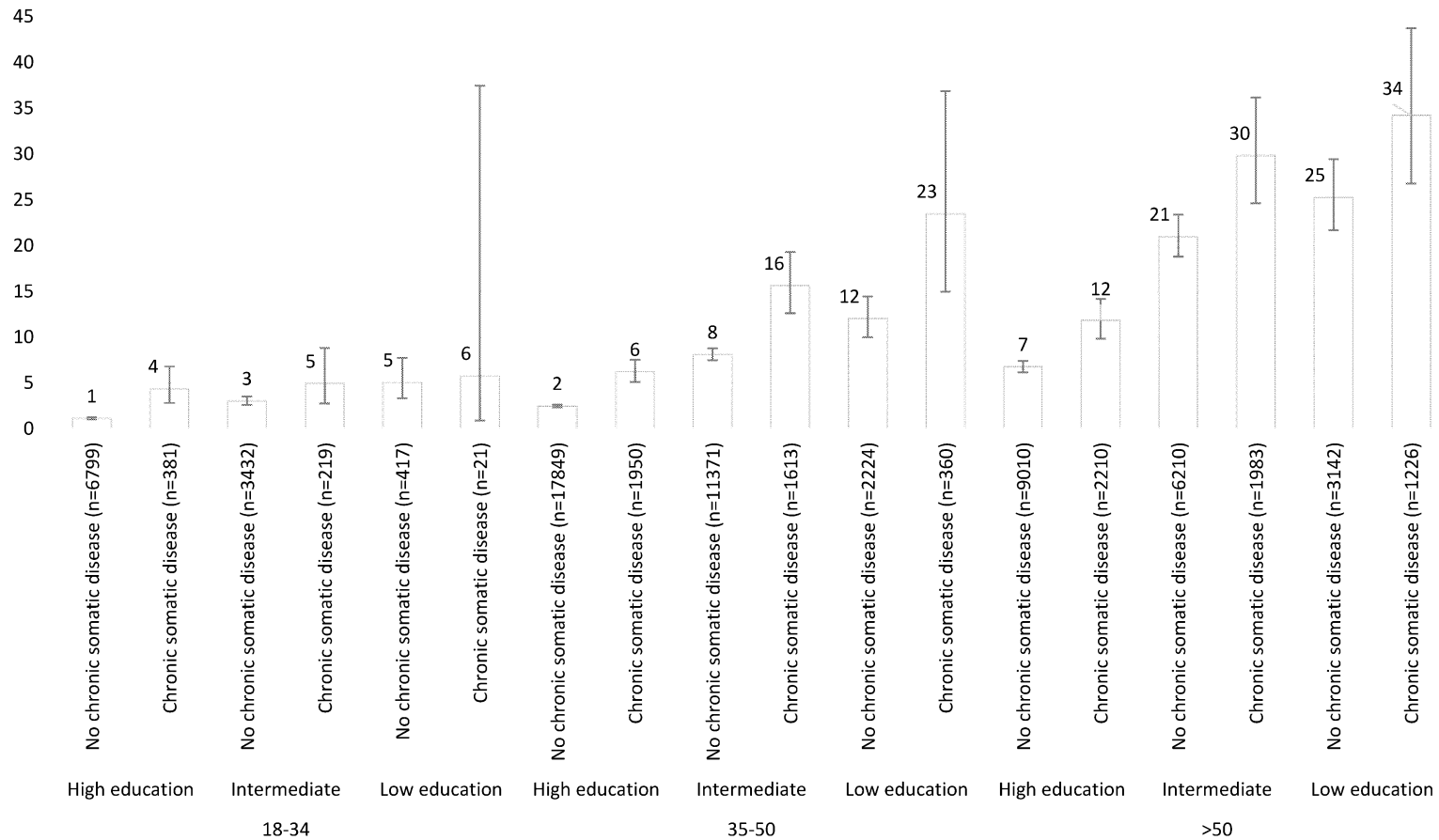
**Figure 2**. Adjusted mean days of musculoskeletal disorder-related work disability per person-year in age groups. P for age×education interaction =0.05; age×somatic disease <0.001; age×education×somatic disease = 0.57. Figures are adjusted for sex, education, chronic somatic disease, job control and job demands. Error bars indicate 95% confidence intervals.

**Supplemental Digital Content**

**Supplementary table 1.** P-values for age interactions.

| Age × | All-cause work disability | Depression-related work disability (F32-F34) | Musculoskeletal disorder-related work disability (M00-M99) |
|---|---|---|---|
| Sex | <0.001 | 0.05 | 0.99 |
| Education | 0.002 | 0.006 | 0.05 |
| Chronic somatic disease | <0.001 | 0.08 | <0.001 |
| Job control | 0.02 | 0.10 | 0.35 |
| Job demands | 0.10 | 0.30 | 0.12 |

**Supplementary Table 2.** Factors associated with all-cause, depression- and musculoskeletal disorder-related work disability among young (18–34), middle-aged (35–50) and ageing (>50) employees (n=70319).

| | All-cause work disability | | | | | | Depression-related work disability (F32–F34) | | | | | | Musculoskeletal disorder-related work disability (M00–M99) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18–34 years | | 35–50 years | | >50 years | | 18–34 years | | 35–50 years | | >50 years | | 18–34 years | | 35–50 years | | >50 years | |
| | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI | RR | 95% CI |
| Occupational grade | | | | | | | | | | | | | | | | | | |
| Upper-grade non-manual | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Lower-grade non-manual | 2.21 | 1.98-2.47 | 1.92 | 1.80-2.04 | 1.92 | 1.76-2.08 | 1.41 | 0.95-2.09 | 1.51 | 1.20-1.89 | 1.27 | 0.96-1.68 | 3.67 | 3.02-4.46 | 3.49 | 3.14-3.88 | 3.33 | 2.91-3.82 |
| Manual | 3.28 | 2.80-3.86 | 3.22 | 2.96-3.50 | 2.82 | 2.56-3.10 | 2.04 | 1.14-3.65 | 1.57 | 1.16-2.13 | 0.94 | 0.66-1.32 | 7.04 | 5.33-9.30 | 7.99 | 6.93-9.22 | 6.22 | 5.29-7.32 |
| Sex | | | | | | | | | | | | | | | | | | |
| Men | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Women | 1.54 | 1.37-1.73 | 1.22 | 1.15-1.31 | 1.19 | 1.10-1.29 | 2.15 | 1.43-3.26 | 1.34 | 1.06-1.71 | 1.45 | 1.08-1.95 | 1.31 | 1.07-1.61 | 1.35 | 1.20-1.51 | 1.33 | 1.15-1.52 |
| Somatic disease | | | | | | | | | | | | | | | | | | |
| No | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Yes | 1.76 | 1.44-2.16 | 2.12 | 1.95-2.30 | 1.60 | 1.48-1.73 | 0.81 | 0.38-1.72 | 1.86 | 1.37-2.53 | 1.31 | 0.99-1.74 | 3.69 | 2.58-5.29 | 2.39 | 2.07-2.76 | 1.54 | 1.35-1.76 |
| Job control | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Low | 0.95 | 0.86-1.06 | 1.12 | 1.06-1.18 | 1.13 | 1.06-1.22 | 0.73 | 0.50-1.07 | 1.03 | 0.84-1.27 | 1.21 | 0.94-1.56 | 1.41 | 1.19-1.68 | 1.30 | 1.18-1.43 | 1.28 | 1.14-1.45 |
| Job demands | | | | | | | | | | | | | | | | | | |
| Low | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| High | 0.98 | 0.89-1.08 | 1.00 | 0.94-1.05 | 1.12 | 1.05-1.20 | 0.90 | 0.64-1.27 | 0.91 | 0.75-1.11 | 1.23 | 0.97-1.57 | 1.08 | 0.92-1.27 | 0.92 | 0.84-1.01 | 1.05 | 0.93-1.17 |