LAUREA AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES
Yhdessä enemmän
Together we are stronger
www.laurea.fi

This is an electronic reprint of the original article. This reprint may differ from the original in pagination and typographic detail.

Please cite the original version: Hiilamo, A. ; Shiri, R. ; Kouvonen, A. ; Mänty, M. ; Butterworth, P. ; Pietiläinen, O. ; Lahelma, E. ; Rahkonen, O. & Lallukka, T. (2019) Common mental disorders and trajectories of work disability among midlife public sector employees – A 10-year follow-up study. Journal of affective disorders vol 247, 66-72.

doi: 10.1016/j.jad.2018.12.127

URL: https://doi.org/10.1016/j.jad.2018.12.127

©2019. This manuscript version is made available under the CC-BY-NC-ND 4.0 license

Manuscript Details

Manuscript number	JAD_2018_1206_R1
Title	Common mental disorders and trajectories of work disability among midlife public sector employees – A 10-year follow-up study
Article type	Research Paper

Abstract

OBJECTIVES We examined trajectories of work disability, indicated by sickness absence and disability retirement, among midlife public sector employees with and without common mental disorders (CMD) at baseline. We also examined adverse childhood events, occupational class, limiting long-standing illness, and health behaviour as determinants of the trajectories. METHODS A sample from the Helsinki Health Study was extracted comprising 2350 employees. Baseline characteristics were obtained from mail surveys conducted in 2000-2 and 2007. CMD were measured by the General Health Questionnaire. Participants were followed between the ages of 50–59. Work disability trajectories were modelled by the annual number of work disability months in group-based trajectory analyses. Multinomial regression was used to predict trajectory group memberships. RESULTS Three trajectories were identified: no work disability (consisting 59% of the all employees), stable/low (31%) and high/increasing disability (10%). Employees with CMD were more likely to belong to the stable/low (odds ratio 1.73 [95% confidence interval 1.37–2.18]), and the high/increasing (2.55 [1.81–3.59]) trajectories. Stratified models showed that the determinants of the trajectories were largely similar for those with CMD compared to those without CMD except that obesity was a somewhat stronger predictor of the high/increasing trajectory among employees with CMD. LIMITATIONS The focus on midlife public sector employees limits the generalisability to other employment sectors and younger employees. CONCLUSIONS CMD were strongly associated with a trajectory leading to early exit from employment and a stable/low work disability trajectory. These findings have implications for interventions promoting work ability of employees with mental ill-health.

Keywords	MENTAL PROBLEMS; WORK ABILITY; TRAJECTORY ANALYSIS; PUBLIC SECTOR; LIFESTYLE-RELATED RISK FACTORS

Corresponding Author	Aapo Hiilamo
Corresponding Author's Institution	Finnish Institute of Occupational Health
Order of Authors	Aapo Hiilamo, Rahman Shiri, Anne Kouvonen, Minna Mänty, Peter Butterworth, Olli Pietiläinen, Eero Lahelma, Ossi Rahkonen, Tea Lallukka
Suggested reviewers	Kristin Farrants, Anu Molarius, Mohammad Alavinia, Charlotte Björkenstam

Submission Files Included in this PDF

File Name [File Type]

Cover page.docx [Cover Letter]

Response letter.docx [Response to Reviewers]

Highlights.docx [Highlights]

Abstract.docx [Abstract]

Revised ms - final final.docx [Manuscript File]

Figure 1.jpg [Figure]

CONFLICTS OF INTEREST.docx [Conflict of Interest]

AUTHOR STATEMENT.docx [Author Statement]

To view all the submission files, including those not included in the PDF, click on the manuscript title on your EVISE Homepage, then click 'Download zip file'.

Cover page:

Common mental disorders and trajectories of work disability among midlife public sector employees – A 10-year follow-up study

Aapo Hiilamo, MSc,[1*] Rahman Shiri, MD, PhD,[1] Anne Kouvonen, PhD, [2,3,4] Minna Mänty, PhD,[5,6] Peter Butterworth, PhD,[7,8] Olli Pietiläinen, MSc,[5] Eero Lahelma, PhD,[5] Ossi Rahkonen, PhD,[5] Tea Lallukka, PhD[1,5]

[1]Finnish Institute of Occupational Health, Helsinki, Finland

[2]Faculty of Social Sciences, University of Helsinki, Helsinki, Finland

[3]SWPS University of Social Sciences and Humanities in Wroclaw, Wroclaw, Poland

[4]Administrative Data Research Centre - Northern Ireland (ADRC-NI), Queen's University Belfast, Belfast, UK

[5]Department of Public Health, University of Helsinki, Helsinki, Finland

[6]Laurea University of Applied Sciences, Unit of Research, Development and Innovation, Vantaa, Finland

[7]Centre for Mental Health, Melbourne School of Population and Global Health, The University of Melbourne, Victoria, Australia

[8]Melbourne Institute of Applied Economic and Social Research, The University of Melbourne, Victoria, Australia

*Address for correspondence:

Aapo Hiilamo, Finnish Institute of Occupational Health, PO Box 40, 00032 Helsinki, Finland [E-mail: aapo.hiilamo@ttl.fi]

AUTHOR CONTRIBUTIONS:

AH and TL had the original idea for the present paper. AH conducted all phases of the statistical analyses and wrote the first draft of the manuscript and the later versions. RS, AK, MM, PB, OP, EL, OR and TL interpreted the results, reviewed and revised the manuscript. All the authors approved the final manuscript for submission to this journal.

ACKNOWLEDGMENTS/ FUNDING

TL and AH are supported by the Academy of Finland (Grants #287488 and #294096). AK is supported by the Economic and Social Research Council (ESRC) (grant ES/L007509/1). OR is supported by the Academy of Finland (grant 1294514) and the Juho Vainio Foundation. MM is supported by the Finnish Work Environment Fund (grant 115182) and the Juho Vainio Foundation. PB is supported by a Future Fellowship from the Australian Research Council (FT13101444).

HIGHLIGHTS

- We examined trajectories of work disability between ages 50-59
- Three trajectories were identified: *no*, *stable/low* and *high/increasing disability*
- Common mental disorders (CMD) were associated with the adverse trajectories
- Obesity was an important predictor for those with CMD
- The other predictors of the trajectories were largely similar despite CMD-status

Common mental disorders and trajectories of work disability among midlife public sector employees – A 10-year follow-up study

ABSTRACT

OBJECTIVES

We examined trajectories of work disability, indicated by sickness absence and disability retirement, among midlife public sector employees with and without common mental disorders (CMD) at baseline. We also examined adverse childhood events, occupational class, limiting long-standing illness, and health behaviour as determinants of the trajectories.

METHODS

A sample from the Helsinki Health Study was extracted comprising 2350 employees. Baseline characteristics were obtained from mail surveys conducted in 2000-2 and 2007. CMD were measured by the General Health Questionnaire. Participants were followed between the ages of 50–59. Work disability trajectories were modelled by the annual number of work disability months in group-based trajectory analyses. Multinomial regression was used to predict trajectory group memberships.

RESULTS

Three trajectories were identified: *no work disability* (consisting 59% of the all employees), *stable/low* (31%) and *high/increasing disability* (10%). Employees with CMD were more likely to belong to the *stable/low* (odds ratio 1.73 [95% confidence interval 1.37–2.18]), and the *high/increasing* (2.55 [1.81–3.59]) trajectories. Stratified models showed that the determinants of the trajectories were largely similar for those with CMD compared to those without CMD except that obesity was a somewhat stronger predictor of the high/increasing trajectory among employees with CMD.

LIMITATIONS

The focus on midlife public sector employees limits the generalisability to other employment sectors and younger employees.

CONCLUSIONS

CMD were strongly associated with a trajectory leading to early exit from employment and a stable/low work disability trajectory. These findings have implications for interventions promoting work ability of employees with mental ill-health.

KEY TERMS: **MENTAL PROBLEMS; WORK ABILITY; TRAJECTORY ANALYSIS; PUBLIC SECTOR; LIFESTYLE-RELATED RISK FACTORS**

~~Mental ill-health~~Common mental disorders and trajectories of work disability among midlife public sector employees – A 10-year follow-up study

ABSTRACT

OBJECTIVES

We examined trajectories of work disability, indicated by sickness absence and disability retirement, among midlife public sector employees with and without common mental disorders (CMD) at baseline. We also examined adverse childhood events, occupational class, limiting long-standing illness, and health behaviour as determinants of the trajectories.

METHODS

A sample from the Helsinki Health Study was extracted comprising ~~2337~~2350 employees. Baseline characteristics were obtained from mail surveys conducted in 2000-2 and 2007. CMD were measured by the General Health Questionnaire. Participants were followed between the ages of 50–59. Work disability trajectories were modelled by the annual number of work disability months in group-based trajectory analyses. Multinomial regression was used to predict trajectory group memberships.

RESULTS

Three trajectories were identified: *no work disability* (consisting ~~61~~59% of the all employees), *stable/low* (~~30~~31%) and *high/increasing disability* (~~9~~10%). Employees with CMD were more likely to belong to the *stable/low* (~~relative risk~~ odds ratio 1.~~64~~73 [95% confidence interval 1.~~30~~37–2.~~07~~18]), and the *high/increasing* (2.~~30~~55 [1.~~62~~81–3.~~27~~59]) trajectories. Stratified models showed that the determinants of the trajectories were largely similar for those with CMD compared to those without CMD except that obesity was a somewhat stronger predictor of the high/increasing trajectory among employees with CMD.

LIMITATIONS

The focus on midlife public sector employees limits the generalisability to other employment sectors and younger employees.

CONCLUSIONS

CMD were strongly associated with a trajectory leading to early exit from employment and a stable/low work disability trajectory. These findings have implications for interventions promoting work ability of employees with mental ill-health.

KEY TERMS: **MENTAL PROBLEMS; WORK ABILITY; TRAJECTORY ANALYSIS; PUBLIC SECTOR; LIFESTYLE-RELATED RISK FACTORS**

INTRODUCTION

Work disability is a significant issue for ageing societies where it is vital to sustain or enhance rates of work participation. Work disability can be conceptualised as a mismatch between work environment and one's health (Ilmarinen, 2009), and is usually operationalised as an absence from work due to ill-health. In Finland, as in many other Western countries, mental disorders constitute a substantial proportion of the awarded work disability benefits, that is, longer sickness absences (SA) requiring a doctor's certificate, and disability retirements (DR) requiring a medical diagnosis and a 60% decrease in work ability (Finnish Centre for Pensions, 2017; The Social Insurance Institution of Finland, 2017). To prevent work disability and to support work participation despite mental ill-health, it is necessary to understand the factors associated with different work disability trajectories among employees showing signs of mental ill-health.

There is a complex relationship between general mental ill-health conditions, such as depressive symptoms and generalized anxiety disorders, and work disability, in which social, cognitive and comorbidity-related factors interact with contextual factors, including the workplace and wider social insurance context (Järvisalo et al., 2005). Mental ill-health with its many forms, comorbidities and varying severity is a direct risk factor for short, medium and long-term work disability (Knudsen et al., 2013; Knudsen et al., 2012; Ormel et al., 1994; van Rijn et al., 2014). In addition, mental ill-health is associated with other detrimental factors, such as childhood adversities (Kestilä et al., 2005), low socioeconomic position (Lorant et al., 2003), alcohol consumption (Jane-Llopis and Matytsina, 2006), physical inactivity (Molarius et al., 2009) and obesity (Luppino et al., 2010), each of which can have an independent effect on work disability (Alavinia et al., 2009; Halonen et al., 2017; Lahti et al., 2013). Furthermore, mental ill-health often co-occurs with physical illness, especially with pain/musculoskeletal disorders (Bair et al., 2008; Lee et al., 2015), which is itself a leading cause of work disability (Finnish Centre for Pensions, 2017).

Previous studies have investigated the association between mental ill-health and work disability by focusing on either frequential (SA) or dichotomous (DR) end-points (Ahola et al., 2011; Knudsen et al., 2013; Lahelma et al., 2015; Mauramo et al., 2018) but less research has considered heterogeneity in the development of work disabilities over time using a trajectory modelling approach (Farrants et al., 2018; Feldt et al., 2009; Laaksonen et al., 2016; Virtanen et al., 2015). A study analysing disability benefit records of all Finnish residents aged 30

to 64 found that DR awards follow heterogeneous SA trajectories, and that these trajectories were associated with the diagnostic reason of the DR award (Laaksonen et al., 2016).

Despite efforts to integrate group-based trajectory analysis (GBTA) into the research on work disability (Bjorkenstam et al., 2015; Feldt et al., 2009; Ferdiana et al., 2014; Haukka et al., 2017; Virtanen et al., 2015), the existing studies employing GBTA focus on relatively short or medium length follow-ups that cover only a small part of the working life span, and typically utilise either only survey or register-based data, although some exceptions exist (Virtanen et al., 2015). Furthermore, we are unaware of previous studies focusing on work disability trajectories through age, not time, among initially midlife employees with and without mental-ill health indicated by common mental disorders (CMD). It is important to investigate and understand the association between mental ill-health and work disability beyond time-to-event based methods in order to support work participation of mentally vulnerable groups. To address these gaps, we investigated the trajectories of work disability in a cohort of public sector employees in their 50s. This age range was selected as a large part of premature exit from paid employment occurs after the age of 50. The main aim of this study was to investigate how mental ill-health is associated with different work disability trajectories, and to identify predictors of these trajectories among employees with and without CMD. Within this conceptual framework, we hypothesized that mental ill-health would be associated with adverse work disability trajectories, while childhood adversity, occupational class, lifestyle-related risk factors and limiting long-standing illness would have a role in the development of work disability over time (Figure S1).

METHODS

The data for this study were derived from the Helsinki Health Study (HHS), a well-established ongoing record linkage cohort study focusing on work, social and lifestyle-related determinants of health and wellbeing among mid-life employees of the City of Helsinki, Finland (Lahelma et al., 2013). As the aim was to study the development trajectories of work disability between the age of 50 and 59, the focus was on a subsample of ~~2337~~2350 participants born in either 1950-1952 or 1955-1957 and having an employment contract with the City of Helsinki at the age of 50. This subgroup was selected to ensure that 10 years of registry data was available following the completion of a baseline survey. These surveys, conducted in 2000-2002 for those born in 1950-1952 and in 2007 for those born in 1955-1957 provide data on baseline characteristics and predictors at the age of 50 (or 50-52 for the second survey; for the study design, see Figure S2).

Those participants who provided informed consent for record linkage were linked to both employer's register and national administrative social insurance records of the Finnish Centre for Pensions and The Social Insurance Institution of Finland - Kela. The follow-up period started the year a participant turned 50 and lasted for ten years or until the end of the job contract with the City of Helsinki without a subsequent DR. To account for the potential history effects between the two different survey groups, the start year of the follow-up was used as a covariate in all models. The deceased, unemployed, voluntary and statutory retirees, and those who changed employer during the follow-up were censored, but the number of participants in these categories was relatively small and attrition during the follow-up period was low. The mean follow-up time was 9.~~03~~ 08 years. We further excluded participants with over 5-months of work disability due to SA or DR at the age of 50 (the start year of the follow-up) as our aim was to focus on those employees without initial full work disability.

Variables

Work disability

Work disability was measured by the annual number of disability months, a measure ranging from 0 to 12. To construct the work disability measure, the annual number of net SA or DR days was firstly calculated in line with procedures used previously (Farrants et al., 2018). Although the two have distinct inclusion criteria, work disability is commonly a heterogeneous process combining some periods of the two (Laaksonen et al., 2016). We obtained information of the start and end dates of every SA and DR period of any length between the ages of 50 and 59. Part-time disability retirees were also included with half weights. Next, we calculated the annual

months of absence from work due to work disability. No work disability months was defined as having 7 or less annual work disability days. One work disability month was defined as having 8 to 29 days, two as having 30 to 59 work disability days and so forth until 12 disability months was defined as having 330 or more disability days.

Mental ill-health

The indicator of mental ill-health was self-reported CMD measured by the General Health Questionnaire (GHQ-12) (Goldberg et al., 1997), and collected with the surveys around the age of 50-52. We followed previous procedures and used scores of 3 or higher on the GHQ-12 as a cut-point for the dichotomous CMD measure (Goldberg et al., 1997). The rationale for using this measure of mental ill-health was that previous studies, also using the present cohort data, have shown that this measure is a particularly strong predictor of short, medium (Mauramo et al., 2018) and long-term (Lahelma et al., 2015) work disability due to mental disorders and even mental ill-health related mortality (Lahelma et al., 2016).

Other predictors

We selected a range of socio-demographics, chronic ill-health and lifestyle-related variables potentially associated with both mental ill-health and work disability (Ahola et al., 2011; Harkonmaki et al., 2007; Jane-Llopis and Matytsina, 2006; Molarius et al., 2009). Occupational class was obtained from the employer's register, and for those lacking register information occupation was obtained from the questionnaire. Occupational class was categorised into managers and professionals, semi-professionals, routine non-manuals, and manual workers. A dichotomous variable measuring childhood adverse events was included (Halonen et al., 2017). Information on self-reported childhood adverse events was collected from all participants in 2000-2 and based on reporting one or more of the following before the age of 16: chronic disease, repeated bullying experience, economic difficulties, parental divorce, parental death, parental mental health problem, and parental drinking problem (Makinen et al., 2006).

Information on chronic ill-health and lifestyle-related risk factors was obtained from the surveys (in 2000-2002 or 2007). Chronic illness was measured by a dichotomous variable of a limiting long-standing illness. Lifestyle-related risk-factors were measured with four variables. Weekly metabolic equivalent of task (MET) hours were computed from the self-reported responses about quantity and intensity of different leisure-time physical

activities (Lahti et al., 2013), and physical activity was categorised to indicate physical inactivity (under 14 total MET-hours/week), moderate (overall MET hours more than 14 while less than 14 hours in high-intensity physical activity) and vigorous physical activity (at least 14 MET-hours/week in high-intensity physical activity). Body mass index was calculated from self-reported height and weight, and then categorised as healthy weight (BMI<25), overweight (25≤BMI<30) or obese (BMI≥30). Smoking status was categorised into no smoking, past smoking or current smoking. Problem drinking was measured by CAGE questionnaire ("cut-annoyed-guilty- eye") and dichotomised with a cut-point of greater than one, in line with previous procedures (Ewing, 1984).

Statistical analysis

Work disability trajectories were examined by conducting a group-based trajectory analysis (GBTA). GBTA is an application of finite mixture modelling and identifies distinct groups of the study population with approximately similar trajectories on a selected time or age-varying outcome (Nagin, 2005; Nagin and Odgers, 2010). The annual number of disability months was used as a repeated outcome with a zero-inflated Poisson distribution given the excess number of zeros in the outcome. In line with previous advocacies, the number of optimal trajectory groups and trajectory shapes were assessed based on four criteria: Bayesian information criteria (BIC), posteriors probabilities of trajectory group membership higher than 0.7, sizes of trajectory groups larger than 5% and a distinct interpretability of the identified trajectory groups (Nagin, 2005; Nagin and Odgers, 2010). For the model fit statistics see the Supplementary Table S1. Each participant was assigned to the trajectory group for which they had the highest probability of group membership.

The composition of the work disability trajectory groups was initially examined with cross-tabulations and chi2 tests. Next, three multinomial logistic regression models investigated the predictors of the trajectory group memberships (a three-category outcome variable). ~~As~~Due to the small number of men in our sample and the fact that no consistent gender ~~interactions~~effect modifications were found with ~~the~~ CMD ~~variable~~, we included men and women in the same ~~model~~models but conducted the models while adjusting for gender. The first model investigated the predictors of work disability trajectory groups~~ies~~ among participants with CMD, the second among participants without CMD, and the third included all participants in the same model. The potential differences in the coefficients between the two stratified groups were tested with predictor-CMD interaction terms in a separate all employees pooled model (full model shown in Supplementary Table S2). The participants

with missing values were excluded at this stage (about 7% of the sample). This approach was chosen because our primary analysis yielded ~~very~~somewhat similar results when using multiple imputation or when setting a separate category for item missingness in each categorical variable~~. Relative risk ratios (RRRs~~ (the results using multiple imputations by chained equations are shown in supplementary tables S3 and S4). Coefficient were log transformed to odds ratios (ORs) with their 95% confidence intervals were reported. Statistical analyses were conducted using Stata 15 and the user written TRAJ command (Jones and Nagin, 2013).

RESULTS

As Table ~~S3~~S5 shows, ~~602~~604 of the ~~23372~~2350 employees (26%) included in this study reported CMD at baseline. Without adjustments, there were no statistically significant differences between women and men, nor between the baseline survey years in the prevalence of CMD. Furthermore, the unadjusted prevalence of CMD was highest in the manager/professional occupational class (31%) and lowest among manual workers (21%). Those with CMD reported more adverse events in childhood, and were more likely to report limiting long-standing illness and lifestyle-related risk factors.

< Insert Figure 1 about here >

A GBTA consisting of three distinct trajectories showed the best fit without too small group sizes (Figure 1). The first identified trajectory group, *"1. no work disability",* had a constant very low or nonexistent work disability trajectory between the ages 50 and 59. Before any adjustments, around ~~50~~47% of the employees with CMD were assigned to this trajectory group while the figure for those without CMD was significantly higher at ~~65~~63% (Table 1). The second group, named *"2. stable/low work disability"*, followed a low course of work disability, and ~~36~~37% and ~~28~~29% of the employees with and without CMD, respectively, were assigned to this group. The third group, named "*3. high/increasing work disability"* reached high levels of work disability at the age of 58-59. Around ~~15~~16% of those with CMD were assigned to this group compared to ~~7~~8% of the others.

< Insert Table 1 about here >

Descriptive statistics displayed in Table ~~S4~~2 show that the employees with CMD and in the *no work disability* trajectory group were mostly from higher occupational classes and had no limiting long-standing illnesses. In contrast, around 76% of those employees with CMD and assigned to the *high/increasing work disability* trajectory also had a limiting long-standing illness, and ~~72~~70% had experienced at least one adverse event in childhood.

< Insert Table 2 about here >

The results from the three multinomial regression models are shown in Table 3. The *no work disability* trajectory group was used as a reference category. The stratified Models 1 and 2 show that for the employees with and without CMD, the predictors of work disability trajectory group memberships were largely similar except that obesity was a somewhat stronger predictor of the *high/increasing work disability* in those with CMD (~~relative risk~~ odds ratio 4.~~21 [1.99 – 8.94~~63 [2.19 – 9.79]) than in those without (1.~~87~~94 [1.~~07~~12 – 3.~~28~~35]) in comparison with the *no work disability* trajectory~~,~~ (p-value for CMD#obesity interaction = 0.~~09~~076 [supplementary Table s2]). For both groups female gender, lower occupational class, limiting long-standing illness and current smoking were associated with the stable/low work disability or the *high/increasing* work disability trajectory when compared to the *no work disability* trajectory. The all employees pooled Model 3 indicated that after the adjustments, CMD was associated with a higher risk of the *stable/low* (1.~~64~~73 [1.~~30~~37 – 2.~~07~~18]) and the *high/increasing* (2.~~30~~55 [1.~~62~~81 – 3.~~27~~59]) work disability trajectories when compared to the *no work disability* trajectory.

< Insert Table ~~2~~3 about here >

DISCUSSION

We investigated work disability trajectories between the ages 50 and 59 among the City of Helsinki employees with and without CMD. Three different work disability trajectories were found among midlife employees: *no work disability, stable/low* and *high/increasing work disability*. The main finding was that membership of these three groups differed substantially on key characteristics, including mental health. Female gender, childhood adversity, low occupational class, lifestyle-related risk factors, and chronic ill-health were associated with the poorer work disability trajectories irrespectively of mental health status. Similar factors predicted both the *stable/low work disability* and the *high/increasing work disability* trajectories with only a few exceptions. Childhood adversity was more associated with the *high/increasing* work disability group whereas alcohol problems and overweight were only positively associated with the *stable/low work disability* trajectory when compared to the *no work* disability trajectory.

Overall, the composition of the three trajectory groups were consistent with expectations based on previous studies focused on cohorts of employees and either sickness absence or disability retirement (Ahola et al., 2011; Besen and Pransky, 2015; Ervasti et al., 2017b; Halonen et al., 2017; Kaila-Kangas et al., 2014; Lahelma et al., 2015; Mauramo et al., 2018). A meta-analysis of the health determinants of early exit from employment found that those with mental health problems had a 1.8-fold increased risk of disability retirement after adjusting for relevant covariates (van Rijn et al., 2014). We found that mental ill-health was strongly associated with a trajectory leading to early exit from employment while the risk for the *stable/low work disability* was weaker. The current study is relatively novel in its application of the GBTA method. A French-Finnish study analysed work disability trajectories using the annual number of work disability days, not months, as a repeated end-point among employees with and without diabetes (Virtanen et al., 2015). Despite the differences in the study designs and the length of the follow-up periods, some similarities are evident. The prior study found five distinct trajectory groups and concluded that ill-health and lifestyle-related risk factors were associated with higher work disability trajectories, similar to the current findings.

Most of the employees (~~61~~59%) followed through the 10-year period were in the *no work disability* trajectory. In general, this group consisted mostly of employees with a higher occupational status, fewer lifestyle-related risk factors and who were less likely to have a limiting long-standing illness compared to the *stable/low* (~~30~~31%) or the *high/increasing work disability* (~~9~~10%) trajectory groups. Of the employees with CMD in the *no*

work disability trajectory (4750%), more than half were from higher occupational classes and did not have a long-standing illness. In line with this finding, a recent meta-analysis showed that somatic comorbidity significantly decreases the return to work probability after depression-related work disability (Ervasti et al., 2017a).

Our stratified analysis showed that the predictors of the work disability trajectory assignments were largely similar among the employees with and without CMD, with an exception that obesity was a somewhat more strongly associated with the *high/increasing* work disability among employees with CMD. This finding might be related to the strong comorbidity of mental ill-health, obesity and musculoskeletal disorders. For example, it is shown that obesity is an important risk factor for various musculoskeletal problems, such as low back pain (Shiri et al., 2009), which, in turn, might increase the risk of CMD (Fishbain et al., 1997). When we ran the regression analysis only for employees without limiting long-standing illness, the interaction effect of obesity and CMD on work disability trajectories was no longer significant at 10% level (data not shown). This supports the hypothesis that some specific physical ill-health-related third factors might be important for work disability and, therefore, more detailed scrutiny is needed to better understand the potential joint effect of obesity and CMD on work disability.

According to our results the association between childhood adversity and work disability was not explained by mental health status. In the all employees pooled model, childhood adversity was associated with a 1.7875-fold increased risk of the *high/increasing disability* trajectory group compared to the *no work disability* group. This is no surprise given the fact that earlier Finnish studies have shown a direct association between adverse childhood events and disability retirement after adjusting for multiple health conditions (Halonen et al., 2017; Harkonmaki et al., 2007). Nevertheless, this study contributes to the existing knowledge by showing that childhood adversity is something that predicts more a premature exit from employment than a constant low work disability compared to the *no work disability* trajectory. ~~However, for those without CMD, a small indication was found that childhood adversity was also weakly linked to the *stable/low work disability* trajectory.~~ Furthermore, regarding the other predictors used here, we confirmed prior findings of the gendered nature of work disability among older employees (Albertsen et al., 2007; Laaksonen et al., 2008) using a trajectory-based modelling approach.

Given the exploratory nature of this study, we were unable to investigate causal relationships between our variables, but rather our aim was to investigate the characteristics associated with the different trajectories in order to recognise protective and risk factors. Nevertheless, it can be argued that mental ill-health is a likely causal factor for the work disability trajectories. This is a widely accepted hypothesis, supported by previous research, that the self-reported measures of mental ill-health are strong predictors of subsequent disability retirement due to mental disorders (Lahelma et al., 2015; Mauramo et al., 2018). Nevertheless, the association found between mental ill-health and the work disability trajectories might be partly explained by some unaccounted factors, such as aspects of physical ill-health, that we were not able to control for. The evidence shows that measures of mental ill-health also have predictive power for musculoskeletal disorders-related disability retirement, and these disorders often co-occur with mental ill-health (Ahola et al., 2011; Lee et al., 2015). We adjusted our models for limiting long-standing illnesses, but it is possible that some residual bias still exists. Our sensitivity analyses with an alternative measures of ill-health, namely less than good self-rated health, showed similar results although the associations were to some extent weaker (Table ~~S5~~S6). This suggests that important comorbidities exist, and further studies are needed with larger samples to investigate the role of comorbidities while employing a wide range of physical health measures simultaneously.

Our results suggest that investigating the development of work disability using trajectory modelling can provide additional insights into work disability status over and above traditional frequential or dichotomous approaches. Analyses using frequential and dichotomous work disability measures with the present cohort and mental ill-health measures used here have already established the link between mental ill-health and work disability (Lahelma et al., 2015; Mauramo et al., 2018). The added value of this study was, therefore, the GBTA approach and its ability to distinguish stable low work disability from a work disability leading to a premature exit from employment. According to our findings, largely similar factors, except for childhood adversity, alcohol problems and overweight, predicted both trajectories. Furthermore, our descriptive statistics showed that around half of the employees were able to sustain very low work disability or very high work ability in their 50s despite showing signs of mental ill-health. The characteristics of these employees might offer guidance for potential intervention studies promoting work ability of employees with mental ill-health.

Methodological considerations

This study used a long follow-up cohort data with a low attrition and a highly reliable register-based information on work disability. We had information on all disability-related absences including short sickness absences, unlike many other previous register-based studies. A further major advantage of this study was the follow-up design through age, not time. It is shown that many predictors of work disability differ by age group (Ervasti et al., 2017b; Mattila-Holappa et al., 2017) and trajectory-based modelling on work disability through time might lead to biased work disability trajectories given age is one of the most important determinants of work disability. We were additionally able to investigate the association between mental ill-health and the work disability trajectories using a well-validated measure of self-reported mental ill-health, i.e. GHQ-12 (Pevalin, 2000).

However, some aspects of the study design must be taken into consideration when interpreting the results. First, the medium-sized sample was large enough to detect only major direct and interaction effects. Second, for a small minority of our sample, the baseline characteristics were asked in surveys at ages 51 and 52 although their work disability follow-up started at age 50. This could cause problems due to potential reverse causality, although we adjusted all our models for a categorical baseline year variable. Third, we could not take into consideration the medical diagnoses of the absence nor the number of distinct absence periods and weighted all work disability days/periods equally. The number of distinct sickness absence periods may provide important information (Virtanen et al., 2017) but taking this into account would have significantly increased the complexity of this study.

Fourth, this study has some limitations related to the survey nature, namely non-response and potential reporting bias. While these limit the interpretation of the findings, earlier non-response analysis has shown that the current data with its record linkages represent acceptably the target population, that is, midlife employees of the City of Helsinki (Lahelma et al., 2013). Furthermore, for both surveys the overall response-rates were moderate or high (response rates of 67% and 82%). Fifth, our data included an unbalanced number of men and women due to female majority in the municipal sector in Finland. Therefore, some important gender interactions might exist that we were unable to capture due to small number of men in our data. Sixth, our data only consisted of persons with an employment contract with the City of Helsinki at the age of 50. Those with more severe mental ill-health may have already exited from paid employment, limiting the generalisation of our results to younger employees.

It is important to discuss the nature of GTBA modelling used in this study. As any statistical method, GBTA is not without limitations. The selection criteria of the optimal number of trajectory groups are somewhat arbitrary and the method is not always comparable across heterogeneous samples. However, the added value of the method is its ability to capture and summarise the heterogeneity within the data and recognise similar subgroups on work disability development. The trajectories found are always approximations of the real trajectories and should, therefore, be interpreted as statistically significant simplifications of the actual trajectories (Nagin, 2005; Nagin and Odgers, 2010). Here the major advantage of the GBTA method was its ability to distinguish a mild and severe work disability, and further take into consideration the possibility of shorter periods of work disability ~~retirement~~ after which one might return to work.

Conclusion

Mental ill-health was associated with the different work disability trajectories found among mid-life employees in particular with a trajectory leading to early exit from employment. Potential intervention studies aiming to support work ability of employees with signs of mental ill-health should consider lifestyle-related and comorbidity factors, especially obesity, as important characteristics.

Acknowledgments/ Funding

AK is supported by the Economic and Social Research Council (ESRC) (grant ES/L007509/1). OR is supported by the Academy of Finland (grant 1294514) and the Juho Vainio Foundation. MM is supported by the Finnish Work Environment Fund (grant 115182) and the Juho Vainio Foundation. PB is supported by a Future Fellowship from the Australian Research Council (FT13101444).

References:

Ahola, K., Virtanen, M., Honkonen, T., Isometsa, E., Aromaa, A., Lonnqvist, J., 2011. Common mental disorders and subsequent work disability: a population-based Health 2000 Study. J Affect Disord 134, 365-372.

Alavinia, S.M., van den Berg, T.I., van Duivenbooden, C., Elders, L.A., Burdorf, A., 2009. Impact of work-related factors, lifestyle, and work ability on sickness absence among Dutch construction workers. Scand J Work Environ Health 35, 325-333.

Albertsen, K., Lund, T., Christensen, K.B., Kristensen, T.S., Villadsen, E., 2007. Predictors of disability pension over a 10-year period for men and women. Scand J Public Health 35, 78-85.

Bair, M.J., Wu, J., Damush, T.M., Sutherland, J.M., Kroenke, K., 2008. Association of depression and anxiety alone and in combination with chronic musculoskeletal pain in primary care patients. Psychosom Med 70, 890-897.

Besen, E., Pransky, G., 2015. Examining the Relationship Between Productivity Loss Trajectories and Work Disability Outcomes Using the Panel Study of Income Dynamics. J Occup Environ Med 57, 829-835.

Bjorkenstam, C., Alexanderson, K., Wiberg, M., Hillert, J., Tinghog, P., 2015. Heterogeneity of sickness absence and disability pension trajectories among individuals with MS. Mult Scler J Exp Transl Clin 1, 2055217315595638.

Ervasti, J., Joensuu, M., Pentti, J., Oksanen, T., Ahola, K., Vahtera, J., Kivimaki, M., Virtanen, M., 2017a. Prognostic factors for return to work after depression-related work disability: A systematic review and meta-analysis. J Psychiatr Res 95, 28-36.

Ervasti, J., Mattila-Holappa, P., Joensuu, M., Pentti, J., Lallukka, T., Kivimaki, M., Vahtera, J., Virtanen, M., 2017b. Predictors of Depression and Musculoskeletal Disorder Related Work Disability Among Young, Middle-Aged, and Aging Employees. J Occup Environ Med 59, 114-119.

Ewing, J.A., 1984. Detecting alcoholism: the CAGE questionnaire. Jama 252, 1905-1907.

Farrants, K., Friberg, E., Sjolund, S., Alexanderson, K., 2018. Work Disability Trajectories Among Individuals with a Sick-Leave Spell Due to Depressive Episode >/= 21 Days: A Prospective Cohort Study with 13-Month Follow Up. J Occup Rehabil.

Feldt, T., Hyvonen, K., Makikangas, A., Kinnunen, U., Kokko, K., 2009. Development trajectories of Finnish managers' work ability over a 10-year follow-up period. Scand J Work Environ Health 35, 37-47.

Ferdiana, A., Post, M.W., Hoekstra, T., van der Woude, L.H., van der Klink, J.J., Bultmann, U., 2014. Employment trajectories after spinal cord injury: results from a 5-year prospective cohort study. Arch Phys Med Rehabil 95, 2040-2046.

Finnish Centre for Pensions, 2017. Statistical yearbook of pensioners in Finland 2016.

Fishbain, D.A., Cutler, R., Rosomoff, H.L., Rosomoff, R.S., 1997. Chronic pain-associated depression: antecedent or consequence of chronic pain? A review. The Clinical journal of pain 13, 116-137.

Goldberg, D.P., Gater, R., Sartorius, N., Ustun, T.B., Piccinelli, M., Gureje, O., Rutter, C., 1997. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. Psychol Med 27, 191-197.

Halonen, J.I., Kivimaki, M., Vahtera, J., Pentti, J., Virtanen, M., Ervasti, J., Oksanen, T., Lallukka, T., 2017. Childhood adversity, adult socioeconomic status and risk of work disability: a prospective cohort study. Occup Environ Med 74, 659-666.

Harkonmaki, K., Korkeila, K., Vahtera, J., Kivimaki, M., Suominen, S., Sillanmaki, L., Koskenvuo, M., 2007. Childhood adversities as a predictor of disability retirement. J Epidemiol Community Health 61, 479-484.

Haukka, E., Ojajarvi, A., Kaila-Kangas, L., Leino-Arjas, P., 2017. Protective determinants of sickness absence among employees with multisite pain-a 7-year follow-up. Pain 158, 220-229.

Ilmarinen, J., 2009. Work ability--a comprehensive concept for occupational health research and prevention. Scand J Work Environ Health 35, 1-5.

Jane-Llopis, E., Matytsina, I., 2006. Mental health and alcohol, drugs and tobacco: a review of the comorbidity between mental disorders and the use of alcohol, tobacco and illicit drugs. Drug Alcohol Rev 25, 515-536.

Jones, B.L., Nagin, D.S., 2013. A Note on a Stata Plugin for Estimating Group-based Trajectory Models. Sociol Method Res 42, 608-613.

Järvisalo, J., Andersson, B., Boedeker, W., Houtman, I., 2005. Mental disorders as a major challenge in prevention of work disability. Experiences in Finland, Germany, the Netherlands and Sweden. Kela.

Kaila-Kangas, L., Haukka, E., Miranda, H., Kivekas, T., Ahola, K., Luukkonen, R., Shiri, R., Kaaria, S., Heliovaara, M., Leino-Arjas, P., 2014. Common mental and musculoskeletal disorders as predictors of disability retirement among Finns. J Affect Disord 165, 38-44.

Kestilä, L., Koskinen, S., Martelin, T., Rahkonen, O., Pensola, T., Aro, H., Aromaa, A., 2005. Determinants of health in early adulthood: what is the role of parental education, childhood adversities and own education? The European journal of public health 16, 305-314.

Knudsen, A.K., Harvey, S.B., Mykletun, A., Overland, S., 2013. Common mental disorders and long-term sickness absence in a general working population. The Hordaland Health Study. Acta Psychiatr Scand 127, 287-297.

Knudsen, A.K., Overland, S., Hotopf, M., Mykletun, A., 2012. Lost working years due to mental disorders: an analysis of the Norwegian disability pension registry. PLoS One 7, e42567.

Laaksonen, M., Blomgren, J., Gould, R., 2016. Sickness allowance trajectories preceding disability retirement: a register-based retrospective study. Eur J Public Health 26, 1050-1055.

Laaksonen, M., Martikainen, P., Rahkonen, O., Lahelma, E., 2008. Explanations for gender differences in sickness absence: evidence from middle-aged municipal employees from Finland. Occup Environ Med 65, 325-330.

Lahelma, E., Aittomaki, A., Laaksonen, M., Lallukka, T., Martikainen, P., Piha, K., Rahkonen, O., Saastamoinen, P., 2013. Cohort profile: the Helsinki Health Study. Int J Epidemiol 42, 722-730.

Lahelma, E., Pietilainen, O., Rahkonen, O., Lahti, J., Lallukka, T., 2016. Mental symptoms and cause-specific mortality among midlife employees. BMC Public Health 16, 1142.

Lahelma, E., Pietilainen, O., Rahkonen, O., Lallukka, T., 2015. Common mental disorders and cause-specific disability retirement. Occup Environ Med 72, 181-187.

Lahti, J., Rahkonen, O., Lahelma, E., Laaksonen, M., 2013. Leisure-time physical activity and disability retirement: a prospective cohort study. J Phys Act Health 10, 669-675.

Lee, H., Hubscher, M., Moseley, G.L., Kamper, S.J., Traeger, A.C., Mansell, G., McAuley, J.H., 2015. How does pain lead to disability? A systematic review and meta-analysis of mediation studies in people with back and neck pain. Pain 156, 988-997.

Lorant, V., Deliege, D., Eaton, W., Robert, A., Philippot, P., Ansseau, M., 2003. Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol 157, 98-112.

Luppino, F.S., de Wit, L.M., Bouvy, P.F., Stijnen, T., Cuijpers, P., Penninx, B.W., Zitman, F.G., 2010. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry 67, 220-229.

Makinen, T., Laaksonen, M., Lahelma, E., Rahkonen, O., 2006. Associations of childhood circumstances with physical and mental functioning in adulthood. Soc Sci Med 62, 1831-1839.

Mattila-Holappa, P., Ervasti, J., Joensuu, M., Ahola, K., Pentti, J., Oksanen, T., Vahtera, J., KivimAki, M., Virtanen, M., 2017. Do predictors of return to work and recurrence of work disability due to mental disorders vary by age? A cohort study. Scand J Public Health 45, 178-184.

Mauramo, E., Lallukka, T., Lahelma, E., Pietilainen, O., Rahkonen, O., 2018. Common mental disorders and sickness absence: a register-linkage follow-up study among Finnish municipal employees. J Occup Environ Med.

Molarius, A., Berglund, K., Eriksson, C., Eriksson, H.G., Linden-Bostrom, M., Nordstrom, E., Persson, C., Sahlqvist, L., Starrin, B., Ydreborg, B., 2009. Mental health symptoms in relation to socio-economic conditions and lifestyle factors--a population-based study in Sweden. BMC Public Health 9, 302.

Nagin, D., 2005. Group-based modeling of development. Harvard University Press.

Nagin, D.S., Odgers, C.L., 2010. Group-based trajectory modeling in clinical research. Annu Rev Clin Psychol 6, 109-138.

Ormel, J., VonKorff, M., Ustun, T.B., Pini, S., Korten, A., Oldehinkel, T., 1994. Common mental disorders and disability across cultures. Results from the WHO Collaborative Study on Psychological Problems in General Health Care. JAMA 272, 1741-1748.

Pevalin, D.J., 2000. Multiple applications of the GHQ-12 in a general population sample: an investigation of long-term retest effects. Soc Psychiatry Psychiatr Epidemiol 35, 508-512.

Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., Viikari-Juntura, E., 2009. The association between obesity and low back pain: a meta-analysis. American journal of epidemiology 171, 135-154.

The Social Insurance Institution of Finland, 2017. Statistical Yearbook of the Social Insurance Institution.

van Rijn, R.M., Robroek, S.J., Brouwer, S., Burdorf, A., 2014. Influence of poor health on exit from paid employment: a systematic review. Occup Environ Med 71, 295-301.

Virtanen, M., Kivimaki, M., Zins, M., Dray-Spira, R., Oksanen, T., Ferrie, J.E., Okuloff, A., Pentti, J., Head, J., Goldberg, M., Vahtera, J., 2015. Lifestyle-related risk factors and trajectories of work disability over 5 years in employees with diabetes: findings from two prospective cohort studies. Diabet Med 32, 1335-1341.

Virtanen, P., Siukola, A., Lipiainen, L., Liukkonen, V., Pentti, J., Vahtera, J., 2017. Trajectory analyses of sickness absence among industrial and municipal employees. Occup Med (Lond) 67, 109-113.

TABLES

Table 1. Characteristics of the three work disability trajectory groups.

		Work disability trajectories (%)			
	N	**None**	**Stable/low**	**High/increasing**	P-value for chi2
Overall	2,350	59	31	10	
Group N		1379	738	233	
Gender					
Men	438	74	21	6	<0.001
Women	1,912	55	34	11	
Common mental disorders					
Yes	604	47	37	16	<0.001
No	1,734	63	29	8	
Childhood adversity					
Yes	1126	54	33	13	<0.001
No	1195	63	30	7	
Occupational status					
Managers or professionals	744	74	22	4	<0.001
Semi-professionals	500	63	28	9	
Routine non-manual workers	800	45	41	14	
Manual workers	306	50	36	14	
Limiting long-standing illness					
Yes	831	46	36	18	<0.001
No	1,462	67	28	5	
Smoking					
Never	1,195	64	28	9	<0.001
Past	589	61	29	10	
Current	550	45	42	13	
Body mass index					
Healthy weight	1,187	66	26	8	<0.001
Overweight	775	56	35	9	
Obesity	371	41	41	18	
Leisure time physical activity					
Inactive	483	58	31	11	<0.001
Moderate	1266	52	37	12	
Vigorous	585	66	28	6	
Drinking problem					
Yes	569	55	35	10	0.320
No	1,730	60	30	10	

Table 2: Characteristics of the employees with common mental disorders (CMD) by different work disability (WD) trajectory groups

	Work disability trajectory group		
	No WD	Stable/low WD	High/increasing WD
	Col %	Col %	Col %
Gender			
Men	23	12	8
Women	77	88	92
Total	100	100	100
Childhood adversity			
No	46	45	30
Yes	54	55	70
Total	100	100	100
Occupational status			
Managers or professionals	51	31	18
Semi-professionals	19	19	19
Routine non-manual workers	21	40	47
Manual workers	9	11	16
Total	100	100	100
Limiting long-standing illness			
No	68	49	24
Yes	32	51	76
Total	100	100	100
Smoking			
No	56	48	41
Past Smoking	24	21	29
Smoking	21	31	30
Total	100	100	100
Obesity			
Healthy weight	61	42	41
Overweight	29	36	22
Obesity	10	22	36
Total	100	100	100
Physical activity			
Moderate	49	51	56
Inactive	28	27	34
Vigorous	23	22	10
Total	100	100	100
Problems with alcohol drinking			
No	69	62	70
Yes	31	38	30
Total	100	100	100

Table 3. Results from multinomial logistic regression on trajectory group memberships (None, Stable/low or High/increasing) among employees with common mental disorders (CMD) (model 1), employees without CMD (model 2) and all employees (model 3). All models adjusted for the start year of the follow-up.[a]

	Model 1: Employees with CMD (n=559)		**Model 2: Employees without CMD (n=1620)**		**Model 3: All employees (n=2179)**	
	No WD vs. stable/low WD	No WD vs. high/increasing WD	No WD vs. stable/low WD	No WD vs. high/increasing WD	No WD vs. stable/low WD	No WD vs. high/increasing WD
Common mental disorders	-	-	-	-	1.73	2.55
					[1.37,2.18]	[1.81,3.59]
Female gender	2.67	2.39	2.67	2.42	2.70	2.50
	[1.48,4.82]	[0.97,5.86]	[1.87,3.82]	[1.29,4.54]	[2.00,3.66]	[1.50,4.17]
Childhood adversity	0.84	1.43	1.12	1.90	1.03	1.75
	[0.56,1.26]	[0.79,2.59]	[0.88,1.41]	[1.26,2.85]	[0.84,1.26]	[1.25,2.43]
Occupational status (ref: professionals/managers)						
Semi-professionals	1.54	3.37	1.50	2.46	1.49	2.80
	[0.89,2.67]	[1.44,7.91]	[1.06,2.14]	[1.26,4.84]	[1.11,1.99]	[1.67,4.70]
Routine non-manual workers	2.19	4.74	2.62	4.00	2.44	4.29
	[1.34,3.59]	[2.20,10.19]	[1.92,3.58]	[2.16,7.42]	[1.88,3.15]	[2.68,6.86]
Manual workers	1.49	3.57	2.66	3.90	2.35	4.03
	[0.72,3.07]	[1.35,9.42]	[1.78,3.96]	[1.88,8.09]	[1.67,3.31]	[2.28,7.13]
Limiting long-standing illness	2.18	5.94	1.80	4.46	1.86	4.77
	[1.44,3.29]	[3.23,10.90]	[1.39,2.32]	[2.93,6.78]	[1.50,2.31]	[3.39,6.69]
Smoking (ref: never)						
Past	1.02	1.46	1.06	0.87	1.05	1.07
	[0.62,1.70]	[0.73,2.93]	[0.79,1.42]	[0.53,1.42]	[0.82,1.35]	[0.72,1.58]
Current	1.66	1.83	2.16	1.55	1.98	1.62
	[1.00,2.75]	[0.91,3.69]	[1.61,2.89]	[0.94,2.54]	[1.54,2.54]	[1.09,2.40]
Body mass index (ref: healthy weight)						
Overweight	1.86	0.95	1.70	1.49	1.76	1.30
	[1.19,2.93]	[0.48,1.88]	[1.31,2.22]	[0.94,2.36]	[1.41,2.21]	[0.89,1.89]
Obesity	3.77	4.63	1.90	1.94	2.25	2.50
	[2.06,6.90]	[2.19,9.79]	[1.34,2.70]	[1.12,3.35]	[1.67,3.02]	[1.64,3.82]
Leisure time physical activity (ref: moderate)						
Inactive	0.78	0.92	1.33	0.86	1.12	0.94
	[0.48,1.26]	[0.49,1.71]	[0.98,1.81]	[0.50,1.48]	[0.87,1.45]	[0.64,1.40]
Vigorous	1.34	0.52	0.95	0.75	1.05	0.69
	[0.80,2.24]	[0.21,1.32]	[0.71,1.27]	[0.45,1.25]	[0.82,1.34]	[0.44,1.08]
Drinking problem	1.48	1.09	1.26	1.13	1.29	1.07
	[0.95,2.29]	[0.58,2.04]	[0.93,1.69]	[0.68,1.88]	[1.01,1.64]	[0.72,1.57]

[a] Notes: Odds ratios and their 95 % confidence intervals are presented in the table.

FIGURES

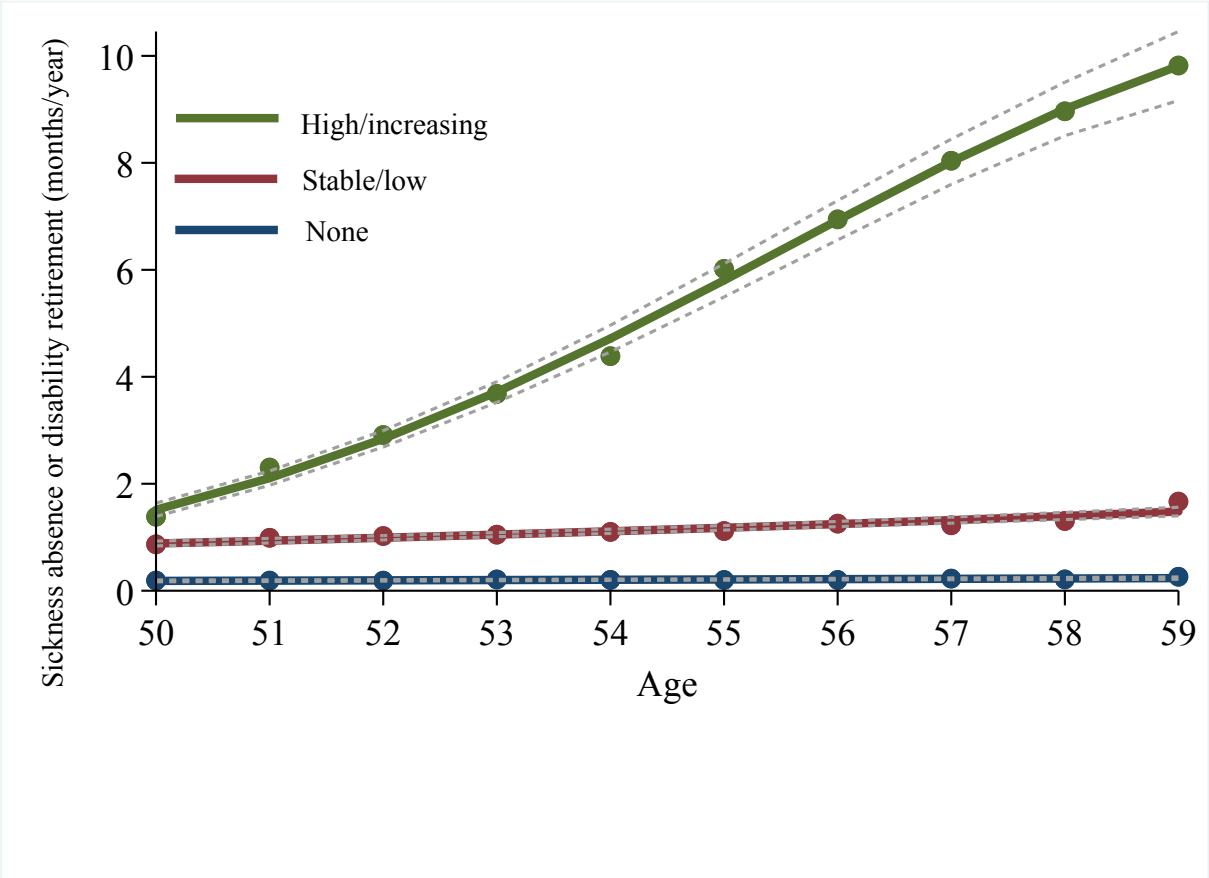


Figure 1. Work disability trajectories identified in the group-based trajectory analysis (N=2350). Group means and fitted lines.

SUPPLEMENTARY MATERIALS

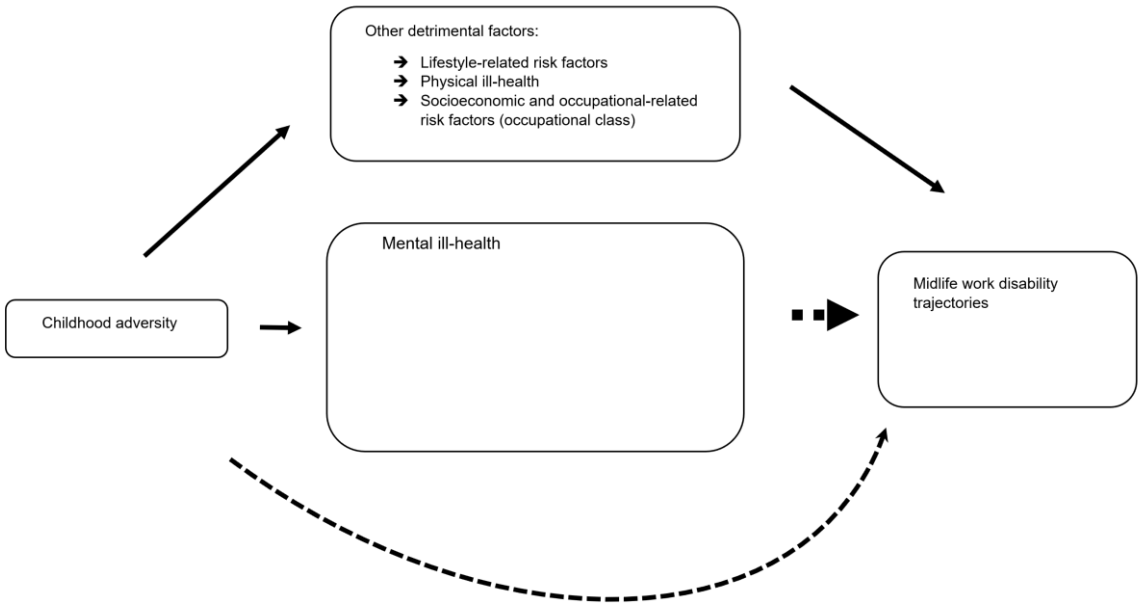


Figure S1. Conceptual framework

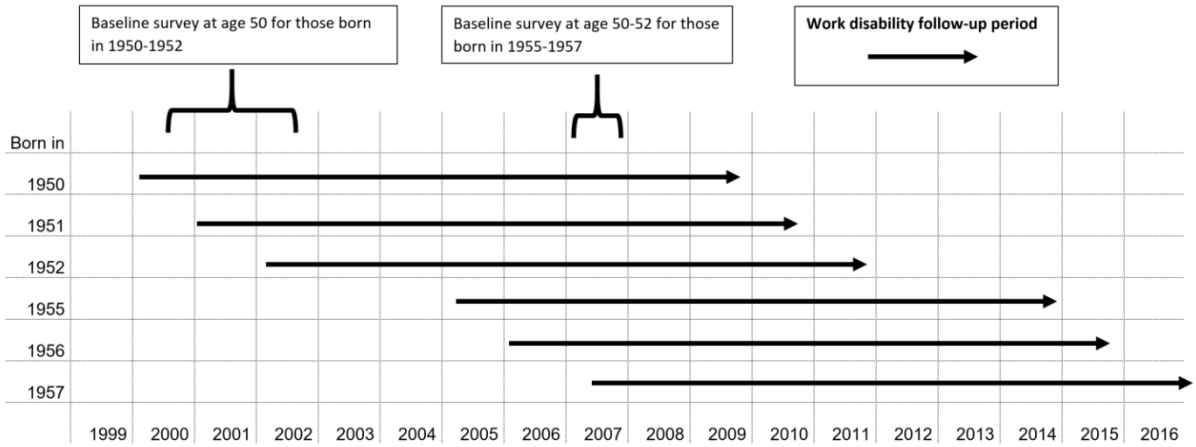


Figure S2. Description of the study design

Table S1. Optimal number of trajectory groups and the trajectory shapes. Bayesian information criteterion (BIC), and the group sizes. Optimal model in bold.

Number of groups	Trajectory shapes[a]	BIC[b] (N=21092)	BIC[c] (N=2337)	Group 1 n	Group 2 n	Group 3 n	Group 4 n
2	0 0	-28170	-28167	2019	331		
2	0 1	-26915	-26911	2024	326		
2	0 2	-26885	-26879	2026	324		
2	1 1	-26872	-26866	2027	323		
2	1 2	-26842	-26835	2027	323		
2	2 2	-26847	-26839	2028	322		
3	0 0 0	-26290	-26285	1362	770	218	
3	0 0 1	-24958	-24952	1358	751	241	
3	0 1 1	-24875	-24867	1375	737	238	
3	1 1 1	-24874	-24865	1368	745	237	
3	0 1 2	-24831	-24822	1378	739	233	
3	0 2 2	-24832	-24822	1382	735	233	
3	**1 1 2**	**-24830**	**-24820**	**1379**	**738**	**233**	
3	1 2 2	-24831	-24820	1386	731	233	
3	2 2 2	-24835	-24823	1384	733	233	
4	0 0 0 0	-25871	-25863	1236	798	195	121
4	1 1 1 1	-24187	-24175	1354	731	164	101[d]

[a]Trajectory shapes: 0 = intercept, 1 = linear and 2 = quadratic
[b]Bayesian information criteterion (BIC) in longitudinal level
[c]Bayesian information criteterion (BIC) in subject level
[d]Less than 5% of the total sample

Table S2. Results from multinomial logistic regression on work disability (WD) trajectory group membership with common mental disorders (CMD) interaction terms. Only interaction terms shown. All models adjusted for the start year of the follow-up.

	No WD vs. stable/low WD			No WD vs. high/increasing WD		
	Interaction odds ratio	95 % CI	P-value	Interaction odds ratio	95 % CI	P-value
Female gender # Common mental disorders	1.07	[0.54,2.12]	0.851	1.00	[0.34,2.97]	1.000
Childhood adversity # Common mental disorders	0.76	[0.48,1.21]	0.248	0.77	[0.37,1.58]	0.476
Semi-professionals # Common mental disorders	1.07	[0.56,2.04]	0.839	1.35	[0.46,3.95]	0.588
Routine non-manual workers # Common mental disorders	0.83	[0.46,1.48]	0.526	1.16	[0.44,3.09]	0.764
Manual workers # Common mental disorders	0.56	[0.25,1.29]	0.175	0.91	[0.27,3.04]	0.875
Limiting long-standing illness # Common mental disorders	1.28	[1.36,2.27]	0.306	1.36	[2.94,6.75]	0.409
Past Smoking # Common mental disorders	0.95	[0.53,1.71]	0.875	1.71	[0.73,3.99]	0.216
Smoking # Common mental disorders	0.75	[0.42,1.33]	0.322	1.20	[0.51,2.81]	0.676
Overweight # Common mental disorders	1.12	[0.66,1.89]	0.672	0.63	[0.28,1.44]	0.273
Obesity # Common mental disorders	2.02	[1.01,4.04]	0.045	2.28	[0.92,5.69]	0.076
Physical inactivity # Common mental disorders	0.59	[0.33,1.04]	0.068	1.08	[0.47,2.48]	0.848
Vigorous activity # Common mental disorders	1.50	[0.84,2.69]	0.174	0.73	[0.25,2.08]	0.551
Problems with alcohol drinking # Common mental disorders	1.18	[0.70,2.00]	0.530	0.94	[0.42,2.10]	0.882

Table S3. Results from multinomial logistic regression on trajectory group memberships among employees with common mental disorders (CMD) (model 1), employees without CMD (model 2) and all employees (model 3). All models adjusted for the start year of the follow-up. Missing item responses imputed using multiple imputations by chained equations[a]

	Model 1: Employees with CMD (n=604)		**Model 2: Employees without CMD (n=1734)**		**Model 3: All employees (n=2350)**	
	No WD vs. stable/low WD	No WD vs. high/increasing WD	No WD vs. stable/low WD	No WD vs. high/increasing WD	No WD vs. stable/low WD	No WD vs. high/increasing WD
Common mental disorders	-	-	-	-	1.73	2.61
					[1.38,2.17]	[1.87,3.64]
Female gender	2.34	3.09	2.49	2.52	2.44	2.69
	[1.34,4.10]	[1.27,7.53]	[1.76,3.50]	[1.37,4.62]	[1.83,3.26]	[1.65,4.40]
Childhood adversity	0.91	1.57	1.11	1.75	1.07	1.72
	[0.61,1.34]	[0.89,2.79]	[0.88,1.40]	[1.18,2.61]	[0.87,1.30]	[1.25,2.36]
Occupational status (ref: professionals/managers)						
Semi-professionals	1.55	2.88	1.53	2.52	1.51	2.65
	[0.91,2.63]	[1.26,6.55]	[1.09,2.15]	[1.32,4.82]	[1.14,2.00]	[1.61,4.35]
Routine non-manual workers	2.38	4.29	2.72	3.98	2.58	4.09
	[1.48,3.83]	[2.09,8.82]	[2.01,3.69]	[2.19,7.22]	[2.01,3.31]	[2.62,6.38]
Manual workers	1.68	3.75	2.53	3.67	2.32	4.01
	[0.84,3.35]	[1.49,9.46]	[1.72,3.70]	[1.82,7.38]	[1.67,3.22]	[2.35,6.85]
Limiting long-standing illness	2.06	6.08	1.78	4.56	1.81	4.82
	[1.37,3.10]	[3.26,11.35]	[1.38,2.29]	[2.98,6.96]	[1.47,2.24]	[3.41,6.83]
Smoking (ref: never)						
Past	1.03	1.54	1.05	0.83	1.05	1.04
	[0.63,1.69]	[0.78,3.01]	[0.80,1.39]	[0.51,1.34]	[0.83,1.34]	[0.71,1.52]
Current	1.82	2.02	2.03	1.62	1.92	1.68
	[1.11,2.98]	[1.01,4.04]	[1.53,2.69]	[1.01,2.61]	[1.50,2.45]	[1.15,2.46]
Body mass index (ref: healthy weight)						
Overweight	1.73	0.93	1.65	1.51	1.68	1.28
	[1.12,2.67]	[0.48,1.80]	[1.28,2.12]	[0.97,2.35]	[1.35,2.10]	[0.89,1.84]
Obesity	3.59	5.43	1.95	2.15	2.29	2.83
	[2.00,6.44]	[2.60,11.31]	[1.39,2.72]	[1.27,3.64]	[1.72,3.04]	[1.89,4.25]
Leisure time physical activity (ref: moderate)						
Inactive	0.82	0.94	1.30	0.83	1.14	0.95
	[0.52,1.30]	[0.51,1.73]	[0.97,1.75]	[0.49,1.39]	[0.89,1.46]	[0.65,1.39]
Vigorous	1.30	0.71	0.94	0.78	1.04	0.77
	[0.79,2.13]	[0.31,1.62]	[0.71,1.24]	[0.48,1.28]	[0.82,1.32]	[0.51,1.18]
Drinking problem	1.35	1.00	1.32	1.17	1.31	1.11
	[0.89,2.05]	[0.55,1.85]	[0.99,1.75]	[0.72,1.92]	[1.03,1.65]	[0.76,1.62]

[a] Notes: odds ratios and their 95 % confidence intervals are presented in the table. Item missingness (7% of the full analytical sample) were imputed using multiple imputations by chained equations. Mi chained command in STATA and five data sets were used. All variables including the outcome used in the analyses were included in the imputation process. Gender, occupational status and trajectory group membership variables did not include any missing values.

Table S4. Results from multinomial logistic regression on work disability (WD) trajectory group membership with common mental disorders (CMD) interaction terms. Only interaction terms shown. All models adjusted for the start year of the follow-up. Missing item responses imputed using multiple imputations by chained equations (N=2350)[a]

	No WD vs. stable/low WD			No WD vs. high/increasing WD		
	Interaction odds ratio	95 % CI	P-value	Interaction odds ratio	95 % CI	P-value
Female gender # Common mental disorders	0.93	[0.48,1.82]	0.842	1.17	[0.39,3.45]	0.779
Childhood adversity # Common mental disorders	0.82	[0.52,1.29]	0.386	0.90	[0.45,1.81]	0.766
Semi-professionals # Common mental disorders	1.01	[0.54,1.89]	0.982	1.15	[0.41,3.27]	0.791
Routine non-manual workers # Common mental disorders	0.87	[0.50,1.53]	0.637	1.09	[0.43,2.78]	0.858
Manual workers # Common mental disorders	0.67	[0.30,1.48]	0.318	1.05	[0.33,3.33]	0.940
Limiting long-standing illness # Common mental disorders	1.14	[0.71,1.85]	0.585	1.28	[0.63,2.62]	0.493
Past Smoking # Common mental disorders	0.99	[0.56,1.74]	0.963	1.83	[0.80,4.15]	0.150
Smoking # Common mental disorders	0.89	[0.51,1.57]	0.693	1.20	[0.52,2.77]	0.665
Overweight # Common mental disorders	1.06	[0.64,1.76]	0.810	0.62	[0.28,1.37]	0.236
Obesity # Common mental disorders	1.84	[0.94,3.60]	0.077	2.55	[1.02,6.39]	0.045
Physical inactivity # Common mental disorders	0.63	[0.36,1.09]	0.099	1.15	[0.52,2.58]	0.729
Vigorous activity # Common mental disorders	1.39	[0.79,2.46]	0.251	0.91	[0.35,2.38]	0.849
Problems with alcohol drinking # Common mental disorders	1.04	[0.62,1.75]	0.869	0.89	[0.41,1.92]	0.762

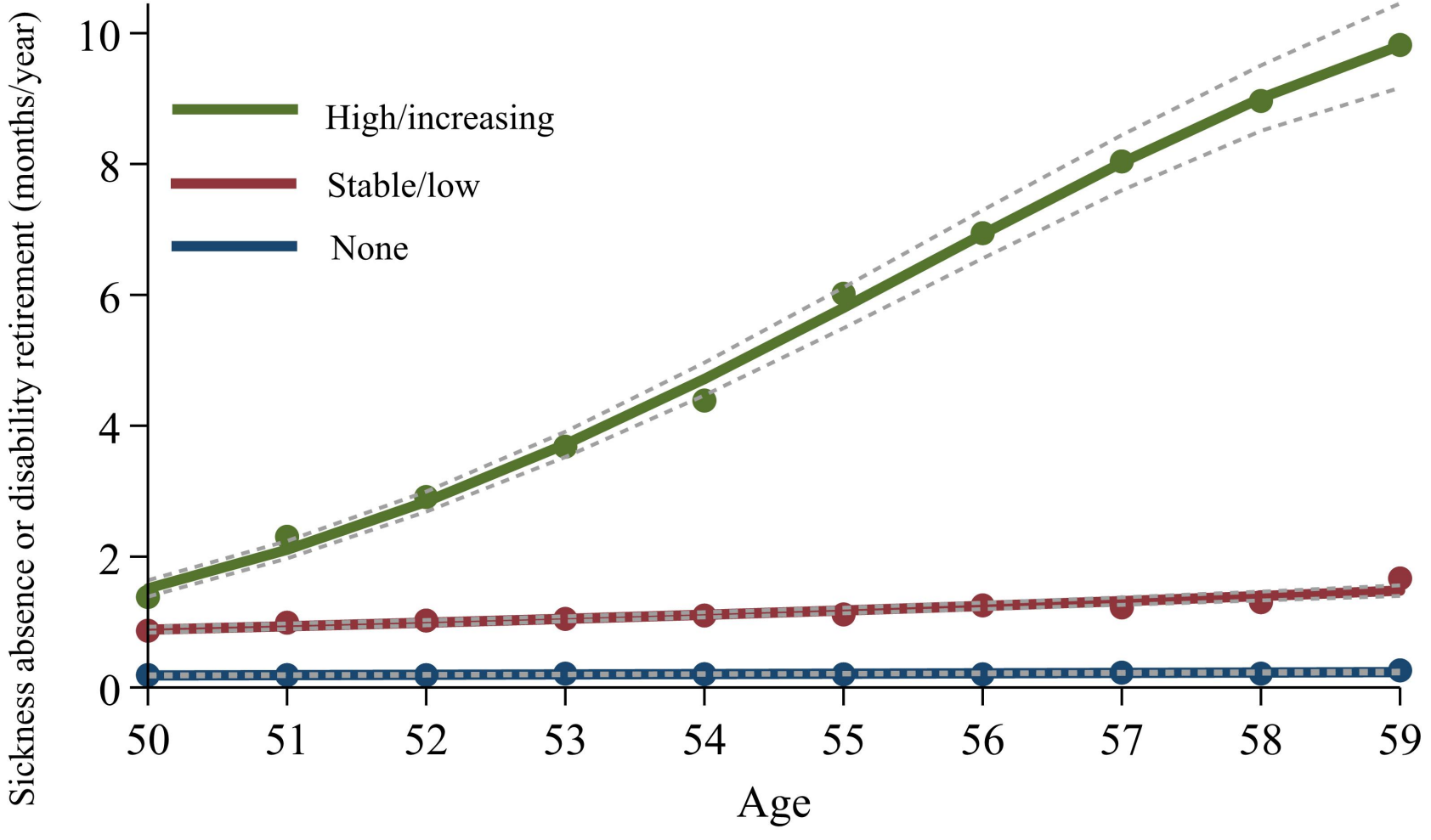
Table S5: Descriptive statistics of the study population by mental ill-health status

	Common mental disorders No (n=1734)		Yes (n=604)		Total (n=2350)[a]		Sample size	Chi2
	Col %	Row %	Col %	Row %	Col %	Row %		p-value
Baseline survey in								
2007	43	74	42	26	43	100	1,001	
2000-2002	57	73	58	26	57	100	1,349	0.187
Total	100	74	100	26	100	100	2,350	
Gender								
Men	19	76	17	23	19	100	438	
Women	81	73	83	26	81	100	1,912	0.276
Total	100	74	100	26	100	100	2,350	
Childhood adversity								
No	54	78	43	22	51	100	1,195	
Yes	45	69	57	30	48	100	1,126	<0.001
Item missing	1	83	1	14	1	100	29	
Total	100	74	100	26	100	100	2,350	
Occupational status								
Managers or professionals	29	69	38	31	32	100	744	
Semi-professionals	22	77	19	23	21	100	500	0.008
Routine non-manual workers	35	75	32	25	34	100	800	
Manual workers	14	78	11	21	13	100	306	
Total	100	74	100	26	100	100	2,350	
Limiting long-standing illness								
No	66	78	52	22	62	100	1,462	
Yes	32	67	45	32	35	100	831	<0.001
Item missing	2	67	3	33	2	100	57	
Total	100	74	100	26	100	100	2,350	
Smoking								
No	51	74	50	25	51	100	1,195	
Past Smoking	26	76	23	24	25	100	589	0.026
Smoking	23	71	26	28	23	100	550	
Item missing	1	63	1	31	1	100	16	
Total	100	74	100	26	100	100	2,350	
Obesity								
Healthy weight	51	74	50	26	51	100	1,187	
Overweight	34	76	30	24	33	100	775	<0.001
Obesity	15	70	18	30	16	100	371	
Item missing	0	41	1	35	1	100	17	
Total	100	74	100	26	100	100	2,350	
Physical activity								
Moderate	55	75	51	24	54	100	1,266	
Inactivity	18	64	28	35	21	100	483	<0.001
Vigorous	27	79	20	21	25	100	585	
Item missing	1	69	1	25	1	100	16	
Total	100	74	100	26	100	100	2,350	
Problems with alcohol drinking								
No	77	77	65	23	74	100	1,730	
Yes	21	64	33	35	24	100	569	<0.001
Item missing	2	71	2	27	2	100	51	
Total	100	74	100	26	100	100	2,350	

a) Employees with item missing in CMD also included

Table S6: Mental ill-health and adjusted odds ratios (OR) of the work disability trajectory group membership while adjusting for different measures of physical ill-health. All adjustments.

	No WD vs. stable/low WD	No WD vs. high/increasing WD
	OR	OR
Common mental disorders	1.50	1.95
While adjusted for less than good self-rated health (n=2212)	[1.18,1.91]	[1.37,2.77]


Sickness absence or disability retirement (months/year)
10
8
6
4
2
0
High/increasing
Stable/low
None
50
51
52
53
54
55
56
57
58
59
Age

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

AUTHOR STATEMENT

All the authors have contributed to the planning of the analysis, commented on the manuscript text, and approved the submission of the final version. Therefore, the requirements for authorship have been met. Each author believes that the manuscript represents honest work.

AUTHOR CONTRIBUTIONS

AH and TL had the original idea for the present paper. AH conducted all phases of the statistical analyses and wrote the first draft of the manuscript and the later versions. RS, AK, MM, PB, OP, EL, OR and TL interpreted the results, reviewed and revised the manuscript. All the authors approved the final manuscript for submission to this journal.