Journal of Affective Disorders

Psychological distress and sickness absence: within- versus between-individual analysis

Running head: Within-individual effects of psychological distress on sickness absence

Jaana I Halonen,[1,2,3] Aapo Hiilamo,[1] Peter Butterworth,[4,5] Mark Wooden,[5] Jenni Ervasti,[1] Marianna Virtanen,[6] Børge Sivertsen,[7,8,9] Ville Aalto,[1] Tuula Oksanen,[1] Mika Kivimäki,[1,10,11] Tea Lallukka[1,10]

1 Finnish Institute of Occupational Health, Helsinki, Finland

2 Stress Research Institute, Stockholm University, Stockholm, Sweden

3 Finnish Institute for Health and Welfare, Helsinki, Finland

4 Research School of Population Health, Australian National University, Canberra, Australia

5 Melbourne Institute of Applied Economic and Social Research, The University of Melbourne, Victoria, Australia

6 School of Educational Sciences and Psychology, University of Eastern Finland, Joensuu, Finland

7 Department of Health Promotion, Norwegian Institute of Public Health, Bergen, Norway

8 Department of Mental Health, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

9 Department of Research and Innovation, Helse-Fonna HF Haugesund Hospital, Haugesund, Norway

10 Department of Public Health, University of Helsinki, Helsinki, Finland

11 Department of Epidemiology and Public Health, University College London, London, United Kingdom

Corresponding author

Jaana I. Halonen, Finnish Institute for Health and Welfare

Address: Mannerheimintie 166, 00270 Helsinki, Finland

E-mail: jaana.halonen@thl.fi Telephone: +358 50 471 5193

Words 3444

Highlights

- Psychological distress has been linked to a higher risk of sickness absence (SA)
- Most studies have failed to control for unmeasured time-invariant confounders
- A within-individual analysis takes time-invariant differences into account
- Within-individual associations were much smaller than those between-individuals
- Repeated measures for the same individuals may provide more reliable SA estimates

Abstract (248)

Background Uncertainty remains whether associations for psychological distress and sickness absence (SA) observed between and within individuals differ, and whether age, gender and work-related factors moderate these associations.

Methods We analyzed SA records of 41,184 participants of the Finnish Public Sector study with repeated survey data between 2000 and 2016 (119,024 observations). Psychological distress was measured by the General Health Questionnaire (GHQ-12), while data on SA days were from the employers' registers. We used a hybrid regression estimation approach adjusting for time-variant confounders – age, marital status, occupational class, body mass index, job contract type, months worked in the follow-up year, job demand, job control, and workplace social capital – and time-invariant gender (for between-individual analysis).

Results Higher levels of psychological distress were consistently associated with SA, both within- and between-individuals. The within-individual association (incidence rate ratio (IRR) 1.68, 95% CI 1.61–1.75 for SA at high distress), however, was substantially smaller than the between-individual association (IRR 2.53, 95% CI 2.39–2.69). High levels of psychological distress had slightly stronger within-individual associations with SA among older (>45 years) than younger employees, lower than higher occupational class, and among men than women. None of the assessed work unit related factors (e.g. job demand, job control) were consistent moderators.

Limitations These findings may not be generalizable to other working sectors or cultures with different SA policies or study populations that are male dominated.

Conclusions Focus on within-individual variation over time provides more accurate estimates of the contribution of mental health to subsequent sickness absence.

Key words between-individual; psychological distress; sickness absence; within-individual

Abbreviations

BMI = Body mass index

CI = confidence interval

GHQ = general health questionnaire

IRR = incident rate ratio

SA = sickness absence

Introduction

Mental health problems, including psychological distress, are known to be a major risk factor for sickness absence (SA) and disability retirement (Bultmann et al., 2006; Heponiemi et al., 2014; Knudsen et al., 2013; Mauramo et al., 2018; OECD, 2012; Stansfeld et al., 2011; Terluin et al., 2011; Theis et al., 2018). While these associations have been widely examined, the approaches commonly used focus on associations between individuals (i.e., comparing those with and without mental health problems). A key limitation of the between-individual approach is the inability to take into account potential unmeasured time-invariant confounders, such as personality or genetics (Wooldridge, 2015). It is possible that these unmeasured confounders between people with and without mental health problems may explain the observed associations. This means that previous studies may have (under- or) overestimated the magnitude of the association between mental health problems and SA.

A within-individual analysis takes time-invariant differences into account when both predictors and outcome vary within-individual across time (Gardiner et al., 2009), and thereby can provide estimates closer to causal inference. This approach uses each person as his/her own control (Allison, 2009) and thus all time-invariant characteristics, such as sex and personality, are controlled for by design. To date, few studies have used the within-individual regression approach to investigate determinants of SA (Ingelsrud, 2014; Milner et al., 2015; Wooden et al., 2016). Within-individual associations between mental health and SA have been, to the best of our knowledge, examined only in one Australian study (Wooden et al., 2016). The system for funding sick leave in Australia is, however, quite different from many other countries, especially most European countries. Most importantly, in Australia, provision of paid sick leave by employers is a statutory requirement that is not underpinned by any form of social insurance. Further, the level of provision is very modest –

a minimum of just 10 days of paid personal leave (which includes both sick leave and carer's leave). Therefore, studies using data from elsewhere are needed to provide evidence on these associations.

Another limitation of previous research in this field is that possible vulnerable subgroups have been under-explored. Age, for example, might act as an important moderating factor in these associations (Ervasti et al., 2017; Mattila-Holappa et al., 2017). Specific work-related factors may also moderate these associations. For example, individuals with mental health problems and mentally challenging jobs, such as care and service workers (Halonen et al., 2018), may be more vulnerable to SA than those in less mentally challenging work (Kokkinen et al., 2019). Determining potential moderators can help to identify work condition modifications that should be prioritized, and thereby help to ease the substantial economic burden related to mental health problems.

To fill some of these gaps, we examined between- and within-individual associations between psychological distress and SA days during two follow-up periods, and considered the role of age, gender and work-related factors as possible moderators of these associations. We hypothesized that the within-individual variation in psychological distress is linked to within-individual variation in SA, but that the association is weaker than that observed between individuals (Wooden et al., 2016). We also anticipated differences in the within-individual associations contingent on age and by work-related factors (work unit social capital, job demand, job control, occupational class and type of work contract).

Methods

Study population

We used data from five subsequent waves of the Finnish Public Sector (FPS) Study collected in 2000/2001, 2004, 2008, 2012 and 2016. We included employees who consented to link their survey data with data from their employer's SA register, who had no missing covariates and at least two mental health measurements while employed (Supplemental Figure S1.). This resulted in 41,184 individuals with 119,024 observations for the SA follow-up for the survey year, and 40,045 individuals with 115,157 observations for the SA follow-up for the year following the survey.

This data set is ideal for our purposes due to its repeated measurements, allowing us to consider within-individual variation in the covariates and outcome. In addition, the sample consists of persons confronted by similar SA policies but who are employed in different occupational classes, allowing us to investigate potential work-related moderators.

Variables

Exposure: Psychological distress

Psychological distress was examined using the 12-item version of the General Health Questionnaire (GHQ-12) (Goldberg, 1972; Pevalin, 2000). Respondents rated the extent to which they were affected by each of the 12 symptoms of distress (0 = not at all, 0 = as much as usual, 1 = slightly more than usual, 1 = much more than usual). Different levels of psychological distress were defined using the following cut-off points for the summary score of the 12 items: 0 (no distress), 1-2 (low distress), 3-6 (intermediate distress) and 7-12 (high distress). We chose to use the categorical measure as increasing GHQ-12 scores have been associated with a higher number of SA spells when using the between-individual setting (Mauramo et al., 2018).

Outcome: Sickness absence

Data on all-cause annual SA days were obtained from the employers' registers. We used two different follow-up periods for SA. First, we examined SA days during the survey year to measure immediate associations between current psychological distress and SA. Then, we examined total number of SA days the year after the survey, to measure a longer lag in the association between psychological distress and SA.

Covariates

All following covariates were time-varying: categorical survey phase, categorical age in 10-year bands (30 or younger, 31-40, 41-50, 51-60 and 61 or older), marital status (cohabiting vs. other), and two dichotomized BMI variables — overweight (25≤BMI<30) vs. non-overweight (BMI<25) and obese (BMI≥30) vs. non-overweight. The work-related factors we additionally included were: register-based number of continuous months worked during the SA follow-up (i.e., time at risk for SA), type of job contract (permanent vs. fixed-term), and occupational class (low= International Standard Classification of Occupations (ISCO) categories 4 and higher including clerical, service and manual workers, and high= ISCO classes 1-3 including managers, professionals and technicians) (Halonen et al., 2017; International Labour Organization, 2004). Self-reported work-related variables were also included as covariates. Low workplace social capital was based on an 8-item measure specifically designed to assess social capital in the workplace (e.g., "We have a 'we are together' attitude", "People feel understood and accepted by each other", "People keep each other informed about work-related issues in the work unit", and "We can trust our supervisor") (Kouvonen et al., 2006; Oksanen et al., 2013). A dummy variable of lowest

quartile indicated low workplace social capital. Job demands were measured using five questions ("I have to work very hard," "I am expected to perform excessive amounts of work," "My job requires working very fast", "My job has high tempo", and "I have enough time to get my job done") (Fransson et al., 2012), and a dummy variable of the highest quartile of the summary variable indicated high job demands. Job control was based on nine statements about decision freedom and learning at work (e.g., "I can make independent decisions," "My job requires learning new skills," and "I have a lot of say regarding my duties") (Fransson et al., 2012). A dummy of the lowest quartile of the summary variable indicated low job control. For the between- vs. within-individual estimate comparisons we additionally included gender as an important time-invariant predictor.

To assess the potential moderating effect of working conditions, due to possible bias in self-reported work-related variables, we conducted interaction models using averages calculated for work units with more than 10 employees in the data. Like the self-reported variables, lowest and highest quartiles were used as cut-off points to define low job control, low job social capital and high job demand when testing the interaction effects. For sensitivity analyses we included two measurements of physical health: 1) register-based somatic diseases, available for waves 2000-2008; and 2) self-reported chronic diseases, available for waves 2000-2012. Neither variable was available for year 2016.

Statistical analyses

There was overdispersion in the outcome variables and hence a negative binomial distribution was chosen. The associations between psychological distress and SA were examined with negative binomial hybrid-regression estimation models that can differentiate between- and within-individual associations. The hybrid model is an extension of a random

effects model with demeaning (Allison, 2009), in which both the person mean values of all predictors (capturing the between-individual effect) and the person deviation scores from their mean (capturing the within-individual effect) are both included as regressors (Schunck and Perales, 2017). The between-individual associations compare the risk of SA between different individuals with and without psychological distress after controlling for their observable differences. The within-individual approach, then, controls for all time-invariant factors, both observable and unobservable, by comparing the SA risk of an individual when reporting psychological distress to his/her SA risk at other time points when not reporting psychological distress (Allison, 2009). The difference in the between- and within-individual risk estimates illustrates the extent to which unmeasured time-invariant characteristics, such as personality or genetics, may explain the between-individual associations.

To test potential moderation effects of age group, gender and work-related factors calculated at work unit level (i.e., work unit social capital, job demand, job control, occupational class and type of work contract), stratified models were first performed by dividing the sample based on the moderated variables. Then interaction models were conducted including “age*distress”, “gender* distress” and “work-related factor* distress” interaction terms. Because age group, occupational class and gender showed some moderating effects (p for interaction <0.1), we included these interaction terms when testing the moderation of work-related factors. It is worth noting that when testing interactions with work unit working conditions, sample size was smaller (85,282 observations and 36,913 individuals when SA was measured in the survey year and 82,578 observations and 35,996 individuals when SA was measured in the year following the survey) because these scores were calculated for work units with a minimum of 11 persons responding to the working condition questions. We used work unit averages, rather than

self-reported values, when testing the moderation effect because persons with distress and on sick-leave may differ in their reporting of working conditions from those staying at work.

Stata 15 and xthybrid command (Schunck and Perales, 2017) for the within-individual estimates were used to conduct all statistical analyses. Results are presented as incidence rate ratios (IRR) with 95% confidence intervals (CI).

Results

Descriptive statistics based on the first and last observation for each participant are shown in Table 1. Most participants were female (78%) and most were married or cohabiting at the first observation (76%). Mean age was 42.9 years (SD=8.8) at the first, and 51.4 (SD=8.8) at the last, observation. For both women and men, the mean number of SA days increased in dose-response manner with higher levels of psychological distress (supplementary table S1).

Results from the negative binomial hybrid model for the associations between psychological distress and SA are shown in Figure 1. For both outcomes, there was a higher risk of SA with higher level of psychological distress. The effect estimates were larger for the between- than within-individual approach, particularly at the higher levels of distress. For example, the IRR for SA during the survey year was 2.53 (95% CI 2.39–2.69) for persons with high distress (GHQ scores 7-12) in the between-individual approach and 1.68 (95% CI 1.61–1.75) in the within-individual approach (p-value for the difference <0.001). In Supplemental Tables S2 (SA during the survey year) and S3 (SA in the year following the survey) we provide estimates for all covariates. The covariates generally showed smaller or non-significant effects when the focus was on the within- rather than between-individual variation over time. For example, IRRs for SA in the survey year in relation to self-reported low social capital were 1.20 (95% CI 1.15-1.26) in the between-individual approach and 1.09

(95% CI 1.06-1.12) in the within-individual approach (p-value for the difference <0.001). The within-individual IRR for SA in the survey year in relation to high job demands was non-significant, while the between-individual estimate indicated a positive association (p-value for the difference <0.0001). For low job control, an association was observed for SA during the survey year (IRR 1.11, 95% 1.08–1.15 for within-individual approach), and the magnitude of the effect estimates did not differ between the approaches (p-value for the difference 0.83).

Age stratified within-individual estimates for SA in relation to psychological distress are shown in Figure 2 (employees ≤45 years: 23,701 individuals with 46,852 observations, and employees >45 years: 30,852 individuals with 72,172 observations in the survey year). In both outcome groups, at higher levels of distress there was an indication of stronger associations with SA among those aged >45 vs. ≤45 years (interaction p-values for age group*distress [categories: low, intermediate and high] for the SA in the survey year were 0.166, 0.006, <0.001, respectively, and for the SA in the year following the survey 0.917, 0.115, <0.001). For SA during the survey year the IRR for those in high distress was 1.79 (95% CI 1.69–1.90) among those >45 years old and 1.49 (95% CI 1.40–1.59) among those aged ≤45.

Gender-stratified results from within-individual analyses are presented in Figure 3 (SA in the survey year: 9,075 men with 25,697 observations and 32,109 women with 93,327 observations; SA year following the survey: 8,830 men with 24,881 observations, and 31,215 women with 90,276 observations). Interaction between gender and psychological distress indicated some difference at the higher levels of psychological distress (interaction p-values for gender*distress [categories: low, intermediate and high] for the SA in the survey year were 0.353, 0.651, 0.016, respectively, and for SA the year

following the survey 0.215, 0.027, 0.049, respectively). At the highest level of distress, the IRR for SA in the survey year was 1.92 (95% CI 1.72–2.14) for men and 1.63 (95% CI 1.57–1.71) for women.

None of the included work-related factors showed consistent or significant interactions with psychological distress (Supplemental Figures 2 and 3). There was a weak indication that the association between psychological distress and SA was stronger for those in the lower occupational class for the SA in the following year at the lower levels of distress (interaction p-value for occupational class*distress (low, intermediate and high) 0.054, 0.04, 0.348, respectively, after accounting for the gender and age group interactions).

In the sensitivity analysis, adjusting for somatic health attenuated the between-individual effect estimates, but the within-individual estimates remained similar to the models without this adjustment (Supplemental Figure S4). Comparison between self-reported and work-unit level working conditions indicated no differences in the distress estimates (Supplemental Figure S5).

Discussion

We examined associations between psychological distress and incidence of SA in a large cohort of Finnish municipal employees. We observed a dose-response between distress and SA in the year when distress was reported, as well as in the following year. Importantly, we compared the effect estimates obtained from the between- and within-individual approaches and showed that the within-individual approach produced weaker associations, suggesting that unmeasured time-invariant factors have a meaningful effect on the magnitude of the association between psychological distress and SA. Furthermore, the observed associations were stronger among older than younger employees, and among

men than women, but work-related factors did not moderate the associations in any consistent way.

Almost all previous studies examining determinants of SA have used between-individual approaches or relied on only one measurement point for the examined determinants, but some exceptions exist. In one longitudinal study psychosocial job quality – was associated with a higher risk of SA (Milner et al., 2015), and another study using a fixed effects approach has reported associations between organisational changes and SA (Ingelsrud, 2014). These findings are in line with our finding for low workplace social capital and low job control, but the earlier studies did not examine association between own mental health and SA. To the best of our knowledge, only one study from Australia has reported between- and within-individual associations for mental health status and SA (Wooden et al., 2016). The effect estimates in that study were lower than what we observed; within-individual IRRs 1.13 for men and 1.10 for women vs. 1.92 and 1.61, respectively, in our study. This is possibly because sickness absence entitlements in Australia vary from Scandinavia; provision of paid sick leave by Australian employers is a statutory requirement that is not subsidized by any form of social insurance, and there is only modest level of provision – a minimum of just 10 days of paid personal leave – which explains why the levels as well as risk of SA were lower than in our study. The exposure (SF36 mental health inventory) and outcome (self-reported SA) measures were also different from ours. However, they also observed that accounting for the unmeasured time-invariant confounders attenuated the associations between poor mental health and SA. Together these findings suggest that researchers should be careful when making final conclusions and recommendations from the studies using between-individual comparison approaches because these may lead to overestimated associations.

Of the tested potential moderators, we observed relative interaction of age with psychological distress, particularly at higher levels of distress. We observed stronger associations among employees over 45 years when compared to younger employees. This may indicate that older employees are more vulnerable to psychological distress, that their job tasks may be different causing more distress, or that their job tasks are such that they cannot work when they have psychological symptoms. Work-related variables did not consistently moderate the observed associations, though some had a direct within-individual association with SA, suggesting that modifications of working conditions (workplace social capital in particular) are needed to reduce SA.

We also observed stronger associations among men than women, which is in agreement with prior studies on psychological distress and all-cause SA (Bultmann et al., 2006; Stansfeld et al., 2011; Wooden et al., 2016). This may reflect differences in the determinants of SA between genders; women are generally are absent from work more often than men (Laaksonen et al., 2010; Mastekaasa, 2014) and a greater variety of causes for their sickness absences could reduce the relative importance of psychological distress as a determinant. In addition, gender differences in the association between psychological distress and all-cause SA can also be due to differences in reporting psychological distress if men scoring above a certain threshold on the GHQ scale have more severe and disabling distress than women.. Furthermore, it is also possible that we were not able to control for all gender-specific covariates, artificially creating differences in associations between men and women.

The current study has several strengths including the large study population with repeated measurements enabling the application of the within-individual approach and the possibility to adjust models for several time-varying confounders. Our outcome data

were complete and were derived from employers' registers that included both short self-certified and longer doctor-certified absence periods. However, some important study limitations should be noted. One is that the study population was derived from the public sector, which is female dominated due to the types of jobs in the public sector in Finland (most common occupations such as nurses and teachers are female dominated). Thus, the findings may not be generalizable to other working sectors or cultures with different SA policies or study populations that are male dominated. Another potential weakness is the self-reported nature of the exposure variable and hence the potential for reporting bias, however, our outcome measure was objective. The GHQ-12 also does not distinguish between different types of mental disorders (for example, for depression or anxiety). Nevertheless, this measure has been used in epidemiological studies and has been shown to have high reliability and good validity in relation to diagnosed affective disorders (Cano et al., 2001; Goldberg et al., 1997; Makowska et al., 2002). It has also been suggested to be a useful screening tool for mental distress (Romppel et al., 2013). As the shortest absence spells are often self-certified and not recorded by cause, we could not perform cause-specific analyses. Finally, although we did control for many possible time-variant confounders, it is possible that some confounders affected shorter and longer absence spells differently (Nielsen et al., 2006), and some yet unmeasured time-varying confounding may have affected the effect estimates.

Our findings have three key implications. First, they indicated robust risk estimates for the associations between psychological distress and all-cause SA while controlling for all time-invariant factors in the models comparing individuals to themselves at different time points. Second, our findings suggest that older employees may be more vulnerable to SA when experiencing psychological distress than younger employees, and

that men are more vulnerable than women. Third, these findings contribute to the scientific evidence indicating the extent to which unmeasured time-invariant characteristics are relevant in associations between psychological distress and SA. This suggests that using longitudinal settings including repeated measurements from the same individuals is essential for providing reliable evidence on the determinants of SA.

Conflicts of interest None declared

Funding: This work was supported by the Academy of Finland (JIH, AH and TL grant numbers 287488 and 319200) and the Finnish Work Environment Fund (TL grant number 117308).

Figure legends

Figure 1. Within- and between-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of psychological distress.
Figure 2. Within-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of pshychological distress stratified by age.
Figure 3. Within-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of psychological distress stratified by gender.

REFERENCES

Allison, P.D., 2009. Fixed Effects Regression Models. SAGE Publications, Inc
Bultmann, U., Rugulies, R., Lund, T., Christensen, K.B., Labriola, M., Burr, H., 2006. Depressive symptoms and the risk of long-term sickness absence: a prospective study among 4747 employees in Denmark. Soc Psychiatry Psychiatr Epidemiol 41, 875-880.
Cano, A., Sprafkin, R.P., Scaturo, D.J., Lantinga, L.J., Fiese, B.H., Brand, F., 2001. Mental Health Screening in Primary Care: A Comparison of 3 Brief Measures of Psychological Distress. Primary care companion to the Journal of clinical psychiatry 3, 206-210.
Ervasti, J., Mattila-Holappa, P., Joensuu, M., Pentti, J., Lallukka, T., Kivimaki, M., Vahtera, J., Virtanen, M., 2017. Predictors of Depression and Musculoskeletal Disorder Related Work Disability Among Young, Middle-Aged, and Aging Employees. J Occup Environ Med 59, 114-119.
Fransson, E.I., Nyberg, S.T., Heikkila, K., Alfredsson, L., Bacquer de, D., Batty, G.D., Bonenfant, S., Casini, A., Clays, E., Goldberg, M., Kittel, F., Koskenvuo, M., Knutsson, A., Leineweber, C., Magnusson Hanson, L.L., Nordin, M., Singh-Manoux, A., Suominen, S., Vahtera, J., Westerholm, P., Westerlund, H., Zins, M., Theorell, T., Kivimaki, M., 2012. Comparison of alternative versions of the job demand-control scales in 17 European cohort studies: the IPD-Work consortium. BMC Public Health 12, 62.
Gardiner, J.C., Luo, Z., Roman, L.A., 2009. Fixed effects, random effects and GEE: what are the differences? Stat Med 28, 221-239.
Goldberg, D.P., 1972. The detection of psychiatric illness by questionnaire. University Press, London.
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.
Halonen, J.I., Koskinen, A., Varje, P., Kouvonen, A., Hakanen, J.J., Vaananen, A., 2018. Mental health by gender-specific occupational groups: Profiles, risks and dominance of predictors. Journal of affective disorders 238, 311-316.
Heponiemi, T., Elovainio, M., Presseau, J., Eccles, M.P., 2014. General practitioners' psychosocial resources, distress, and sickness absence: a study comparing the UK and Finland. Family practice 31, 319-324.
Ingelsrud, M.H., 2014. Reorganization increases long-term sickness absence at all levels of hospital staff: panel data analysis of employees of Norwegian public hospitals. BMC health services research 14, 411.
International Labour Organization, 2004. International Standard Classification of Occupations, ISCO-88.
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 psychiatrica Scandinavica 127, 287-297.
Kokkinen, L., Kouvonen, A., Buscariolli, A., Koskinen, A., Varje, P., Vaananen, A., 2019. Human service work and long-term sickness absence due to mental disorders: a prospective study of gender-specific patterns in 1,466,100 employees. Ann Epidemiol 31, 57-61.e51.
Kouvonen, A., Kivimaki, M., Vahtera, J., Oksanen, T., Elovainio, M., Cox, T., Virtanen, M., Pentti, J., Cox, S.J., Wilkinson, R.G., 2006. Psychometric evaluation of a short measure of social capital at work. BMC Public Health 6, 251.
Laaksonen, M., Mastekaasa, A., Martikainen, P., Rahkonen, O., Piha, K., Lahelma, E., 2010. Gender differences in sickness absence--the contribution of occupation and workplace. Scand J Work Environ Health 36, 394-403.

Makowska, Z., Merecz, D., Moscicka, A., Kolasa, W., 2002. The validity of general health questionnaires, GHQ-12 and GHQ-28, in mental health studies of working people. Int J Occup Med Environ Health 15, 353-362.
Mastekaasa, A., 2014. The gender gap in sickness absence: long-term trends in eight European countries. Eur J Public Health 24, 656-662.
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 60, 569-575.
Milner, A., Butterworth, P., Bentley, R., Kavanagh, A.M., LaMontagne, A.D., 2015. Sickness absence and psychosocial job quality: an analysis from a longitudinal survey of working Australians, 2005-2012. Am J Epidemiol 181, 781-788.
Nielsen, M.L., Rugulies, R., Christensen, K.B., Smith-Hansen, L., Kristensen, T.S., 2006. Psychosocial work environment predictors of short and long spells of registered sickness absence during a 2-year follow up. J Occup Environ Med 48, 591-598.
OECD, 2012. Sick on the Job?: Myths and Realities about Mental Health and Work. OECD Publishing, Paris.
Oksanen, T., Kawachi, I., Kouvonen, A., Takao, S., Suzuki, E., Virtanen, M., Pentti, J., Kivimaki, M., Vahtera, J., 2013. Workplace determinants of social capital: cross-sectional and longitudinal evidence from a Finnish cohort study. PLoS One 8, e65846.
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.
Romppel, M., Braehler, E., Roth, M., Glaesmer, H., 2013. What is the General Health Questionnaire-12 assessing? Dimensionality and psychometric properties of the General Health Questionnaire-12 in a large scale German population sample. Comprehensive psychiatry 54, 406-413.
Schunck, R., Perales, F., 2017. Within-and between-cluster effects in generalized linear mixed models: A discussion of approaches and the xthybrid command. Stata Journal 17, 89-115.
Stansfeld, S.A., Fuhrer, R., Head, J., 2011. Impact of common mental disorders on sickness absence in an occupational cohort study. Occup Environ Med 68, 408-413.
Terluin, B., van Rhenen, W., Anema, J.R., Taris, T.W., 2011. Psychological symptoms and subsequent sickness absence. Int Arch Occup Environ Health 84, 825-837.
Theis, K.A., Roblin, D.W., Helmick, C.G., Luo, R., 2018. Prevalence and causes of work disability among working-age U.S. adults, 2011-2013, NHIS. Disability and health journal 11, 108-115.
Wooden, M., Bubonya, M., Cobb-Clark, D., 2016. Sickness absence and mental health: evidence from a nationally representative longitudinal survey. Scand J Work Environ Health 42, 201-208.
Wooldridge, J.M., 2015. Introductory econometrics: A modern approach. Nelson Education.

Table 1. Descriptive statistics of the study population.

	N (first observation)	First observation % / mean (sd)	Last observation % / mean (sd)
Age		42.9 (8.8)	51.4 (8.8)
Psychological distress (GHQ-12)			
No	18,196	44	45
Low	10,356	25	24
Intermediate	7,938	19	18
High	4,694	11	13
Gender			
Women	32,109	78	
Men	9,075	22	
Occupational class			
High (ISCO 1-3)	22,394	54	58
Low (ISCO 4-9)	18,790	46	42
Marital status			
Other	9,904	24	26
Married or cohabiting	31,280	76	74
Self-reported low workplace social capital			
No	29,553	72	73
Yes (lowest 25%)	11,631	28	27
Self-reported high job demands			
No	34,471	84	81
Yes (highest 25%)	6,713	16	19
Self-reported low job control			
No	29,339	71	71
Yes (lowest 25%)	11,845	29	29
Job contract type			
Permanent	34,283	83	94
Fixed-term	6,901	17	6
Body weight			
Under or normal weight (BMI<25)	22,714	55	45
Overweight (25<BMI<30)	13,178	32	36
Obesity (BMI≥30)	5,292	13	19
Number of observations			
2	18,726	45	
3	11,899	29	
4	6,920	17	
5	3,639	9	
First and last survey wave	First	First	Last
2000	20,336	49	011
2004	7,789	19	1117
2008	7,646	19	1721
2012	5,413	13	21
2016	0	0	51

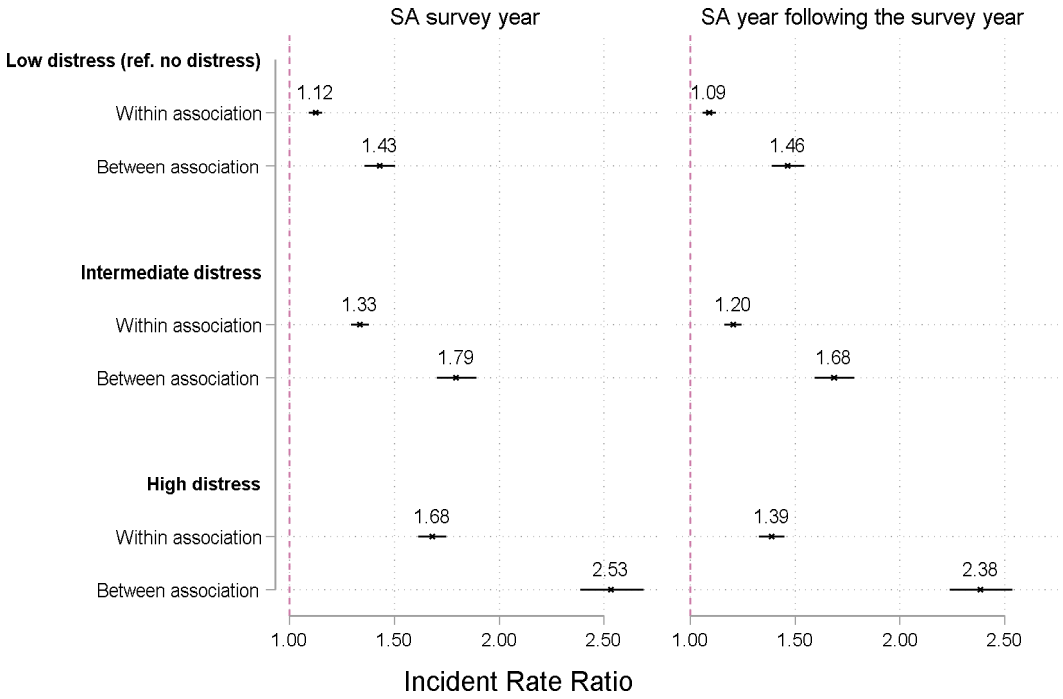


Figure 1. Within- and between-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of psychological distress.

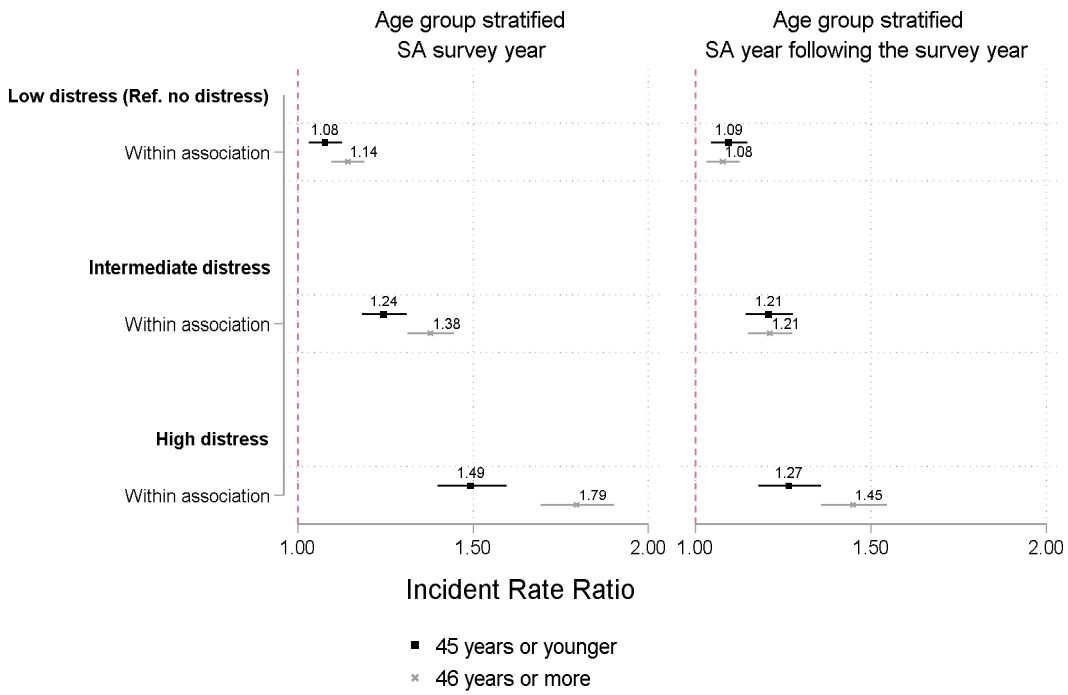


Figure 2. Within-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of pshychological distress stratified by age.

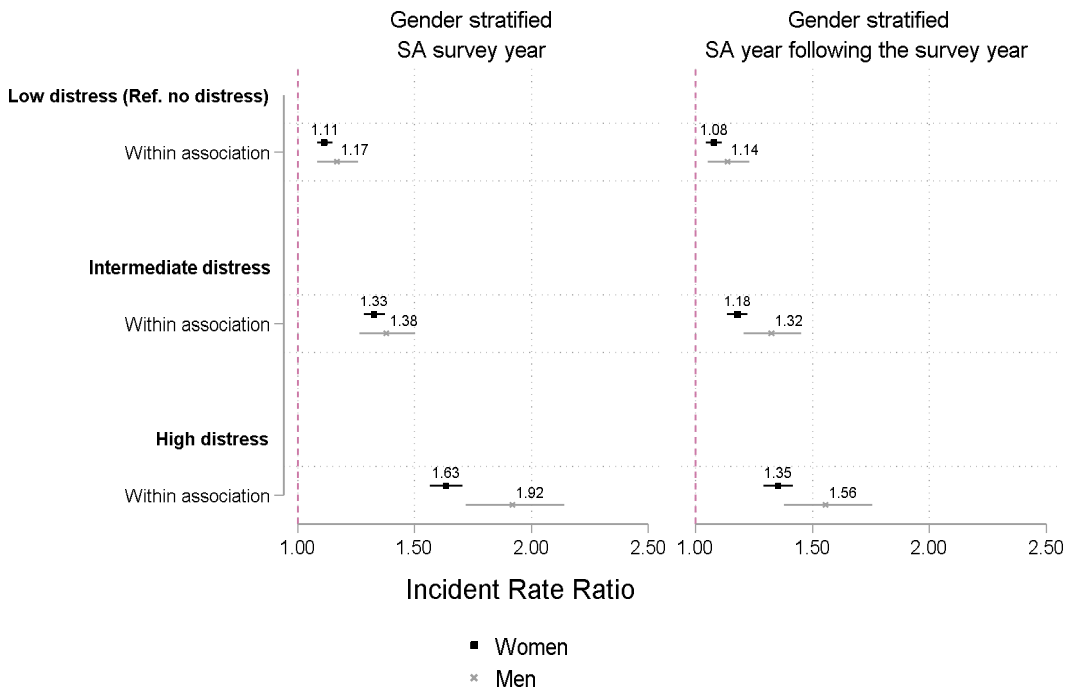


Figure 3. Within-individual incidence rate ratios with 95% confidence intervals for sickness absence (SA) by different levels of psychological distress stratified by gender.

Supplemental Material

Psychological distress and sickness absence: within- versus between-individual analysis

Jaana I Halonen, Aapo Hiilamo, Peter Butterworth, Mark Wooden, Jenni Ervasti, Marianna Virtanen, Børge Sivertsen, Ville Aalto, Tuula Oksanen, Mika Kivimäki, Tea Lallukka

Supplemental Table S1. Mean, standard deviation, median and inter-quartile range of SA days by different levels of psychological distress (all observations*).

		All SA days in the survey year			
	% (all observations)	Mean	SD	Median	Inter-quartile range
All	100	12.7	23.9	4	14
Psychological distress					
No	46	9.9	19.9	3	10
Low	24	12.2	21.7	4	12
Intermediate	18	15.2	25.7	6	17
High	12	21.2	35.1	8	23
Women	100	13.5	24.4	5	14
Psychological distress					
No	44	10.6	20.3	4	11
Low	25	12.8	22.0	5	13
Intermediate	19	15.7	25.9	6	17
High	12	21.9	35.4	9	24
Men	100	10.0	21.9	2	9
Psychological distress					
No	52	7.8	18.2	2	7
Low	22	9.5	20.3	3	9
Intermediate	16	12.6	24.7	3	13
High	10	18.0	33.5	5	20

*Same individual is more than once in the data

Supplemental Table S2. Within- and between-individual incident rate ratios (IRR) with 95% confidence intervals (CI) for SA during the survey year by all covariates ($N_{individuals}$=41,184, $N_{observations}$=119,024).

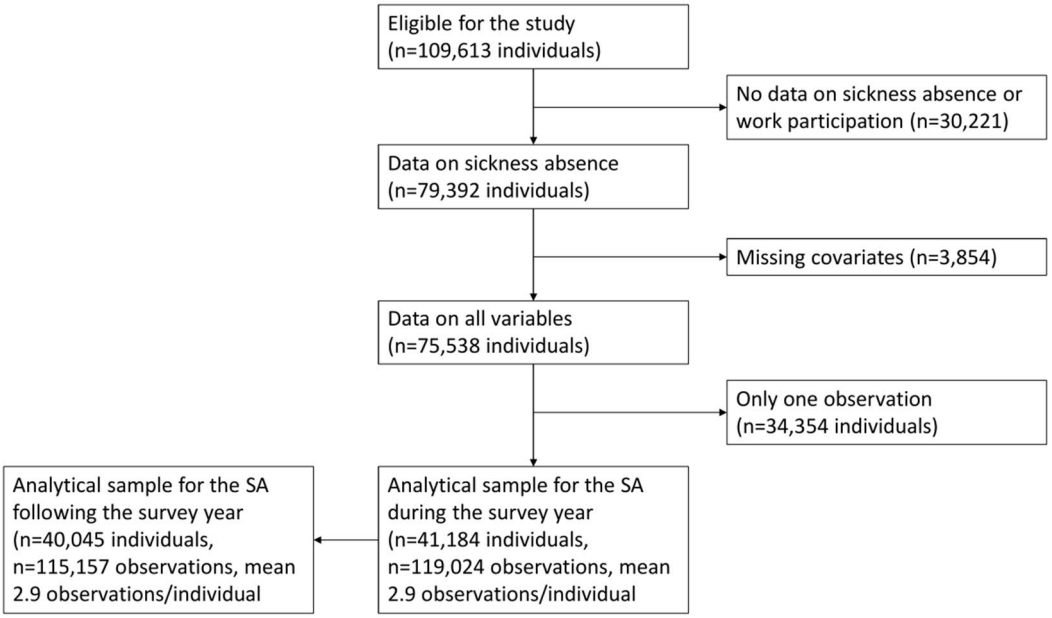
	Within-individual IRR [95% CI]	Between-individual IRR [95% CI]	Difference P-value
Male gender (vs. female)	Time-invariant	0.61*** [0.58,0.63]	
Low distress (vs. no distress)	1.12*** [1.09,1.16]	1.43*** [1.36,1.50]	p<0.0001
Intermediate distress (vs. no distress)	1.33*** [1.29,1.38]	1.79*** [1.70,1.89]	p<0.0001
High distress (vs. no distress)	1.68*** [1.61,1.75]	2.53*** [2.39,2.69]	p<0.0001
Wave 2004 (vs. wave 2000)	1.04* [1.01,1.07]	1.10 [0.97,1.24]	0.4356
Wave 2008 (vs. wave 2000)	1.30*** [1.25,1.35]	1.17** [1.06,1.30]	0.0599
wave 2012 (vs. wave 2000)	1.28*** [1.22,1.34]	1.15** [1.04,1.27]	0.0655
Wave 2016 (vs. wave 2000)	1.34*** [1.26,1.43]	1.02 [0.92,1.13]	p<0.0001
Low occupation class (vs. high)	1.05 [0.99,1.12]	1.97*** [1.92,2.04]	p<0.0001
Married (vs. no)	0.99 [0.95,1.03]	0.92*** [0.89,0.95]	0.0036
Fixed-term contract (vs. continuing)	0.79*** [0.76,0.82]	0.92* [0.87,0.98]	0.0001
Overweight (vs. BMI<25)	1.05* [1.01,1.09]	1.30*** [1.26,1.35]	p<0.0001
Obese (vs. BMI<25)	1.12*** [1.05,1.19]	1.70*** [1.64,1.77]	p<0.0001
Age 31-40 (vs. <31)	0.93* [0.87,0.98]	0.86*** [0.79,0.94]	0.2052
Age 41-50 (vs. <31)	0.82*** [0.75,0.89]	0.87*** [0.81,0.93]	0.2753
Age 51-60 (vs. <31)	0.87** [0.79,0.97]	0.85*** [0.79,0.92]	0.6939
Age >60 (vs. <31)	1.03 [0.90,1.18]	0.54*** [0.47,0.61]	p<0.0001
Low workplace social capital (lowest quartile)	1.09*** [1.06,1.12]	1.20*** [1.15,1.26]	0.0001
High job demand (highest quartile)	1.01 [0.98,1.04]	1.12*** [1.07,1.17]	0.0003
Low job control (lowest quartile)	1.11*** [1.08,1.15]	1.10*** [1.06,1.15]	0.8291
Months worked in the SA follow-up time	1.11*** [1.10,1.11]	1.03*** [1.02,1.04]	p<0.0001

*p-value <0.05
** p-value <0.01
*** p-value <0.001

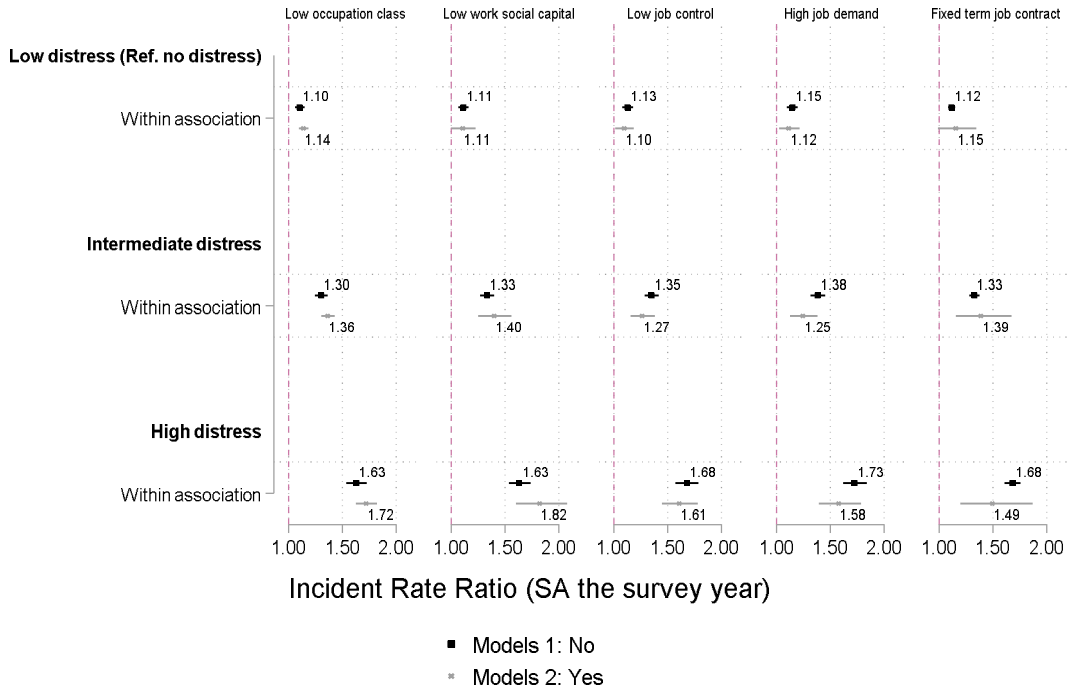
Supplemental Table S3. Within- and between-individual incident rate ratios (IRR) with 95% confidence intervals (CI) for SA following the survey year by all covariates ($N_{individuals}$=40,045, $N_{observations}$=115,157).

	Within-individual IRR [95% CI]	Between-individual IRR [95% CI]	Difference P-value
Male gender (vs. female)	Time-invariant	0.61*** [0.59,0.64]	
Low distress (vs. no distress)	1.09*** [1.06,1.12]	1.46*** [1.39,1.54]	p<0.0001
Intermediate distress (vs. no distress)	1.20*** [1.16,1.25]	1.68*** [1.59,1.78]	p<0.0001
High distress (vs. no distress)	1.39*** [1.33,1.45]	2.38*** [2.24,2.54]	p<0.0001
Wave 2004 (vs. wave 2000)	1.28*** [1.24,1.32]	1.13 [0.99,1.29]	0.0671
Wave 2008 (vs. wave 2000)	1.37*** [1.31,1.43]	1.07 [0.97,1.19]	p<0.0001
wave 2012 (vs. wave 2000)	1.26*** [1.20,1.33]	1.01 [0.91,1.12]	0.0002
Wave 2016 (vs. wave 2000)	1.43*** [1.33,1.52]	0.90 [0.81,1.00]	p<0.0001
Low occupation class (vs. high)	1.03 [0.96,1.11]	1.97*** [1.91,2.03]	p<0.0001
Married (vs. no)	1.07** [1.02,1.11]	0.90*** [0.87,0.93]	p<0.0001
Fixed-term contract (vs. continuing)	0.86*** [0.82,0.90]	0.95 [0.89,1.02]	0.0149
Overweight (vs. BMI<25)	1.01 [0.97,1.06]	1.34*** [1.29,1.39]	p<0.0001
Obese (vs. BMI<25)	1.05 [0.98,1.12]	1.75*** [1.67,1.82]	p<0.0001
Age 31-40 (vs. <31)	0.81*** [0.76,0.87]	0.84*** [0.77,0.92]	0.5867
Age 41-50 (vs. <31)	0.68*** [0.62,0.74]	0.83*** [0.77,0.90]	0.0009
Age 51-60 (vs. <31)	0.74*** [0.66,0.83]	0.80*** [0.74,0.87]	0.2623
Age >60 (vs. <31)	0.78*** [0.67,0.90]	0.40*** [0.35,0.46]	p<0.0001
Low workplace social capital (lowest quartile)	1.07*** [1.04,1.11]	1.23*** [1.18,1.29]	p<0.0001
High job demand (highest quartile)	1.04* [1.01,1.08]	1.10*** [1.05,1.16]	0.0848
Low job control (lowest quartile)	1.09*** [1.06,1.13]	1.10*** [1.05,1.14]	0.8799
Months worked in the SA follow-up time	1.11*** [1.10,1.12]	1.05*** [1.03,1.06]	p<0.0001

* p-value <0.05
** p-value <0.01
*** p-value <0.001

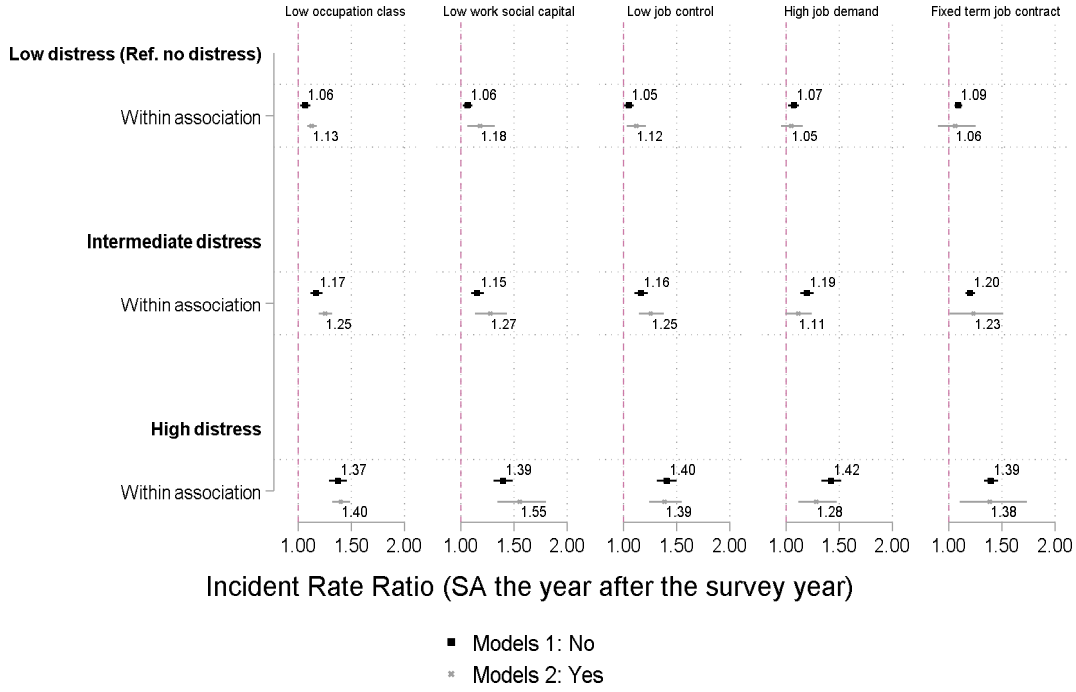


Supplemental Figure S1. Flowchart for the selection of the study population.



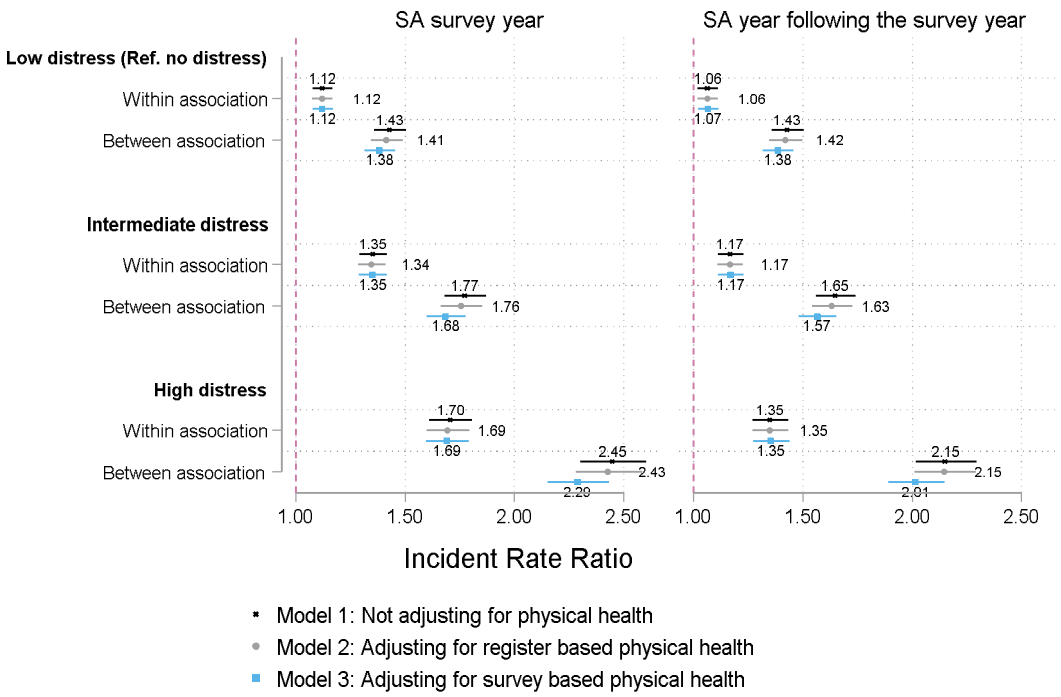
Supplemental Figure S2. Within-individual incidence rate ratios for sickness absence (SA) on the survey year by different levels of psychological distress stratified by workplace social capital, job control, job demands, occupational class, and type of job contract.

85,282 observations from 36,913 individuals in the work unit level working conditions models.

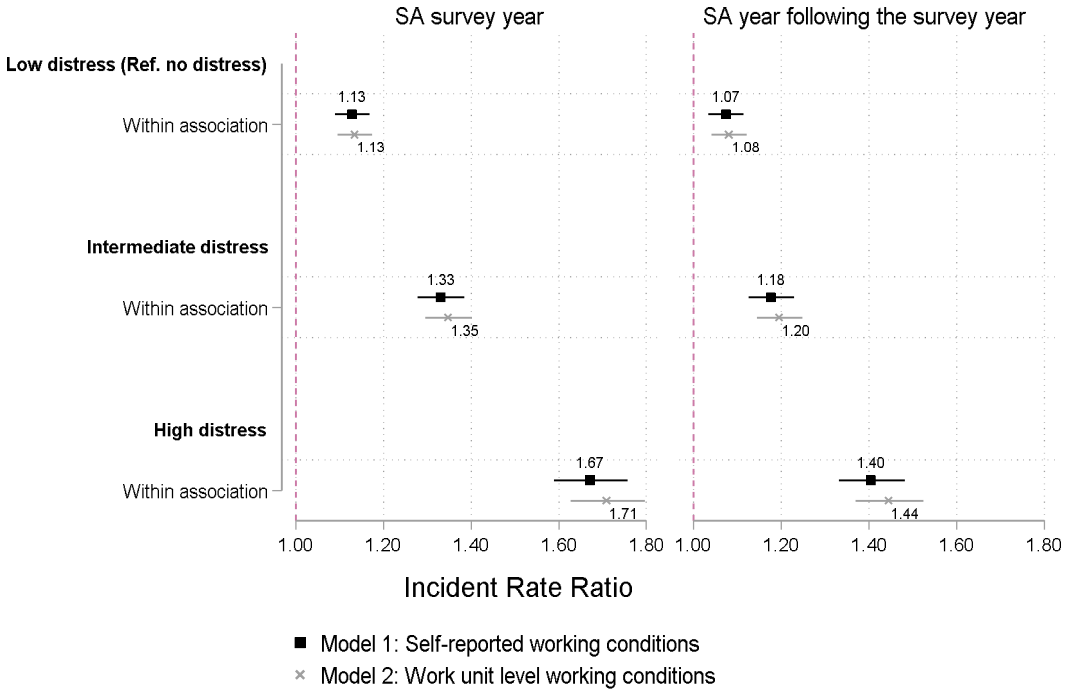


Supplemental Figure S3. Within-individual incidence rate ratios for sickness absence (SA) on the year following survey by different levels of psychological distress stratified by work unit social capital, job control, job demands, occupational class, and type of job contract.

82,578 observations from 35,996 individuals in the work unit working conditions models.



Supplemental Figure S4. Within- and between-individual incidence rate ratios for sickness absence (SA) by different levels of psychological distress while adjusting for register-based and self-reported physical health. Only waves 2000-2008 included.



Supplemental Figure S5. Within-individual incidence rate ratios for sickness absence (SA) by different levels of psychological distress and using self-reported and work unit-level variables.

85,282 observations from 36,913 individuals for SA in the survey year and 82,578 observations from 35,996 individuals for SA on the year following the survey year.