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## Cause-specific sickness absence trends by occupational class and industrial sector in the context of recent labour market changes: a Finnish panel data study

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2 **Cause-specific sickness absence trends by occupational class and industrial**  
3 **sector in the context of recent labour market changes: a Finnish panel data**  
4 **study**  
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## ABSTRACT

**Objectives:** We aimed to provide previously unestablished information on population-based differences in cause-specific sickness absence trends between occupational classes and further between industrial sectors within the different occupational classes as well as on the contribution of other socioeconomic and employment factors to these trends. We focused on the period 2005–2013, during which the labour market underwent large economic and structural changes.

**Design:** Register-based panel data study.

**Setting:** Large representative data on Finnish wage-earners aged 25–59 years.

**Outcome measure:** Annual risk of sickness absence ( $\geq$ two weeks) based on repeated logistic regression.

**Results:** Between 2005 and 2013, the proportion of employees with sickness absence decreased. The change was smallest among lower non-manual employees and the overall level highest among manual workers. In musculoskeletal diseases and injuries, the level differences were particularly large, but decreased over time. In mental disorders, the level was highest among lower non-manual employees with an increasing difference over time. Sickness absence levels were generally highest in the health and social work sector. Among manual workers, however, the level in musculoskeletal diseases was highest in the manufacturing sector, where a notable temporary decrease in absences nevertheless occurred during the peak of the economic recession in 2009. Among the lower occupational classes, the decrease in absences due to musculoskeletal diseases was smallest in the trade sector. Otherwise, the differences in sickness absence between industrial sectors within the occupational classes remained relatively stable. Overall, socioeconomic and employment factors partly explained the differences in the absence levels but not in the trends.

**Conclusions:** Despite a general decreasing trend in sickness absence, non-manual employees in the health and social work sector are particularly disadvantaged in terms of work ability related to

1 mental and musculoskeletal health. Furthermore, lower grade occupations in the manufacturing and  
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4 trade sectors are worse off concerning musculoskeletal health.  
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### 10 **Strengths and limitations of this study**

- 13 • We provided novel information on occupational class differences in sickness absence by  
14 focusing on changes in the cause-specific associations over time and on further variation by  
15 industrial sector within the occupational classes.  
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- 19 • We accounted for changes in various other socioeconomic and employment factors,  
20 including education, employment sector, income, time spent in employment, and the number  
21 of employment episodes.  
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- 26 • We used longitudinal population-based register data with very good statistical power and  
27 without missing information or loss to follow-up.  
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- 31 • The sickness absence outcome was based on national data on compensated spells that  
32 typically last at least two weeks, thereby excluding shorter spells.  
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- 35 • Using register-based data, the role of factors that might further contribute to occupational  
36 and sectoral differences in sickness absence, such as changes in lifestyle, work exposures,  
37 labour market conditions, health status, illness behaviour, and health selection into  
38 employment, remained open.  
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## INTRODUCTION

The association of low occupational class with a higher likelihood of sickness absence has been established in many European countries.[1-7] The effect may vary by the diagnostic cause of work disability. For example, a study on the French GAZEL public sector employee cohort indicated that the difference in sickness absence between managers and manual workers was particularly large in musculoskeletal diseases, respiratory diseases, and injuries, and smaller but still notable in mental disorders and other diagnoses.[2] Furthermore, the association may change over time. According to a Finnish study based on a cohort employed by the City of Helsinki in the 1990s, occupational class differences in sickness absence increased particularly towards the end of the decade, i.e. at a time of declining unemployment.[8] Another study on employees of the same municipality indicated that in the more recent decades, the class differences have decreased among men and remained relatively stable among women.[9] However, little is known of occupational class differences in sickness absence trends in different disease groups or among general employed populations.

In addition to occupational class, industrial sector is closely associated with working conditions and the broader work environment, which by definition affect the ability of an individual to perform in his or her own job. A previous study from Denmark indicated that the risk of long-term sickness absence was higher than average in the health care and social services sector and lower than average in the private administration sector, but otherwise there was little variation between the sectors.[10] Accordingly, a Norwegian study indicated that the risk of long-term sickness absence was higher among women employed in health and social occupations than among the general female employed population.[11] There may also be an important interplay between occupational class and industrial sector; even within a particular occupational grade, the types of jobs may vary considerably between different sectors. Previous population-based findings from Denmark[10] and Sweden[12] have shown large differences in long-term sickness absence by particular occupational groups. Variation in sickness absence between industrial sectors within different occupational classes nevertheless remains unclear.

1 Despite the large number of studies that have investigated occupational class differences in sickness  
2 absence, very little is known of the association in terms of variation by disease group, interplay  
3 between occupational class and industrial sector, changes over time and their explanations, or  
4 generalization of the findings. We used large register data to examine cause-specific sickness  
5 absence trends in 2005–2013 by occupational class and industrial sector among the general  
6 population of Finnish wage earners while accounting for various other socioeconomic and  
7 employment factors. The study thus covers a period with various changes in the labour market in  
8 Finland as well as in other European countries, including ageing of the workforce, occupational  
9 restructuring, the onset of the recent economic recession, and increased policy efforts to lengthen  
10 working lives. The more particular research questions are listed below.

- 11 1. Do the trends in sickness absence due to all causes, musculoskeletal diseases, mental  
12 disorders, injuries, neoplasms, circulatory diseases, respiratory diseases, nervous diseases, or  
13 digestive diseases differ between occupational classes?
- 14 2. Do the trends in sickness absence due to the two largest disease groups, i.e. musculoskeletal  
15 diseases and mental disorders, vary between industrial sectors within different occupational  
16 classes?
- 17 3. Are the differences in cause-specific sickness absence trends by occupational class and  
18 industrial sector influenced by variation in socioeconomic and employment factors over the  
19 study period?

## 20 **MATERIAL AND METHODS**

### 21 **Study population**

22 We used large register data with 70% nationally representative random samples of the Finnish  
23 working aged population from three cross-sections on the last days of the years 2004, 2007 and  
24 2010. Each of the cohorts were followed up for three calendar years to cover a nine-year study  
25 period between 2005 and 2013. The data included information on compensated sickness absences  
26 and national pensions obtained from the Finnish Social Insurance Institution, on sociodemographic

1 factors obtained from the Finnish Longitudinal Employer-Employee Data (FLEED) of Statistics  
2 Finland, and on employment and earnings-related pensions from the Finnish Centre for Pensions, as  
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4 also described in our previous study on gender differences in sickness absence (Leinonen et al.,  
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6 submitted 2017).  
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10 We included individuals who were employed wage-earners according to their main economic  
11 activity and socioeconomic status and aged 25–59 at baseline, i.e. at the end of the year preceding  
12 each observation year, and who on the first day of the observation year still had an ongoing  
13 employment period in the private sector, in the public sector or in both, but not in self-employment.  
14 We allowed for non-employment and self-employment later during the observation year, adjusting  
15 for these factors in the analyses. We excluded those who already had an ongoing compensated  
16 sickness absence spell at baseline or who received full pensions (full disability pensions,  
17 unemployment pensions, special pensions for farmers, or old-age pensions), emigrated or died by  
18 the end of the observation year. In order to make the populations across the study years more  
19 comparable, we also excluded those who were not living in Finland two years before baseline. The  
20 annual study populations in the period 2005–2013 were 1 097 598, 1 100 322, 1 109 041,  
21 1 122 238, 1 117 179, 1 081 698, 1 094 294, 1 092 208, and 1 080 951 individuals.  
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### 38 **Sickness absence outcome**

39 As the outcome measure of this study, we used repeated dichotomous measures of whether a study  
40 person had a new onset of sickness absence (first occurrence of a spell lasting at least two weeks) in  
41 a particular calendar year based on spells compensated by the Finnish Social Insurance Institution.  
42 The compensated spells begin after a waiting period of ten working days typically paid by the  
43 employer, the absences therefore lasting at least two weeks by definition. Eligibility for the  
44 compensated sickness benefit requires that the claimant resides permanently in Finland and that  
45 compensation for earnings loss is not covered in other overruling statutory benefits including those  
46 related to occupational, traffic and military accidents. The outcome consists of both full and part-  
47 time sickness absence, but in Finland the first onset of work disability typically starts with a full  
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1 sickness absence. Disease groups were classified according to the tenth revision of the International  
2 Classification of Diseases (ICD-10). We examined the largest groups separately, including 1)  
3 musculoskeletal diseases (diseases of the musculoskeletal system and connective tissue, M00–  
4 M99), 2) mental disorders (mental and behavioural disorders, F00–F99), 3) injuries (injury,  
5 poisoning and certain other consequences of external causes, S00–T98), 4) neoplasms (C00–D48),  
6 5) circulatory diseases (I00–I99), 6) respiratory diseases (J00–J99), 7) nervous diseases (G00–G99),  
7 and 8) digestive diseases (K00–K93).

### 17 **Occupational class and industrial sector**

19 Occupational class and industrial sector were based on information measured in the year preceding  
20 each observation year and categorized according to classifications by Statistics Finland.[13]  
21 Occupational class consisted of categories 1) upper non-manual, 2) lower non-manual, and 3)  
22 manual. Industrial sector included the following categories: 1) manufacturing (manufacturing,  
23 mining and quarrying), 2) trade (wholesale and retail trade; repair of motor vehicles and  
24 motorcycles), 3) knowledge work (information and communication; financial and insurance  
25 activities; real estate activities; professional, scientific and technical activities), 4) human health and  
26 social work activities, and 5) other (agriculture, forestry and fishing; electricity, gas, steam and air  
27 conditioning supply; water supply; sewerage, waste management and remediation activities;  
28 construction; transportation and storage; accommodation and food service activities; administrative  
29 and support service activities; public administration and defence; compulsory social security;  
30 education; arts, entertainment and recreation; other service activities; activities of households as  
31 employers; undifferentiated goods- and services-producing activities of households for own use;  
32 activities of extraterritorial organisations and bodies; industry unknown). This classification was  
33 from year 2008. Until 2007, the classification was based on an older version from year 2002, but  
34 virtually equivalent main categories listed above could be constructed using a reclassification code  
35 provided by Statistics Finland.

## Covariates

We examined various annually measured employment and sociodemographic factors as covariates. Age was divided into 5-year groups. Education and income were based on information measured in the year preceding each observation year. Education consisted of categories 1) higher tertiary, 2) lower tertiary, 3) secondary, and 4) primary. Income consisted of both wage and capital income of the individual. It was inflation-corrected and then divided into quintiles across the observation years.

Other employment factors were measured during each observation year. Employment sector was classified as 1) private, 2) public, 3) private and public, and 4) transition to self-employment. Time spent in employment was divided into 1) full year, 2) 200–364 days, and 3) 1–199 days. The cut-point of 200 days was arbitrarily chosen to define those who had been working most of the year. The number of employment episodes was divided into 1) one, 2) two, and 3) three or more.

## Statistical methods

We used generalized estimation equations (GEE) based on repeated logistic regression to estimate the annual risk of having a new onset of compensated all-cause and cause-specific sickness absence in 2005–2013. The GEE models account for the within-individual correlation between repeated measurements in the three different samples followed up during periods 2005–2007, 2008–2010, or 2011–2013. Using margins derived from the logistic GEE model, we plotted trajectories of estimated proportions (%) of employees with sickness absence including interactions of occupational class and industrial sectors within the occupational classes with categorical year. We adjusted for the annually measured covariates holding them at their mean level when plotting the trajectories. Derived from the same models, we also calculated relative differences between industrial sectors within the different occupational classes in terms of odds ratios (OR) of sickness absence over the study years (including the interaction between industrial sector and year, with those employed in the knowledge work sector as the reference group for which the OR was held at 1.00 in each year).

1 We pooled men and women in our analyses. Even though the overall level of sickness absence in  
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4 our study population is much higher among the latter, changes over time have been relatively  
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6 similar among the genders especially after accounting for their differential occupational and sectoral  
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8 distributions (Leinonen et al., submitted 2017).  
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## 11 RESULTS

### 13 Characteristics of the study population

15 Over the study period between 2005 and 2013, the proportion of manual workers decreased  
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17 especially in the manufacturing sector, but also in the health and social work sector (Table 1). The  
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19 proportion of non-manual employees increased. Among upper non-manual employees, the increase  
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21 was largest in the knowledge work sector. Among lower non-manual employees, the increase was  
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23 largely attributable to an increase in the health and social work sector, while at the same time there  
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25 was a decrease in the manufacturing sector. Annual distributions of the study population by all  
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27 background characteristics are presented in Supplementary Table 1. Distributions over the whole  
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29 study period are also presented separately for those employed in different industrial sectors within  
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31 different occupational classes in Supplementary Table 2.  
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**Table 1.** Annual distribution (%) of the study population over the study period by industrial sectors across different occupational classes.

Occupational class	Year								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Industrial sector									
Upper non-manual	24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Manufacturing	3.1	3.3	3.5	3.5	3.7	3.6	3.5	3.5	3.3
Trade	1.3	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.3
Knowledge work	5.4	5.6	5.8	6.0	6.2	6.3	6.3	6.4	6.2
Health & social work	2.9	2.9	2.9	2.9	3.0	3.1	3.1	3.2	3.3
Other	11.6	11.9	11.8	11.8	12.0	12.4	11.6	11.7	11.9
Lower non-manual	40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manufacturing	4.4	4.0	4.0	4.0	3.9	3.7	3.5	3.4	3.4
Trade	7.5	7.5	7.5	7.5	7.7	7.8	8.0	8.0	7.9
Knowledge work	6.0	5.8	5.7	5.9	5.8	5.8	5.9	6.0	6.2
Health & social work	11.6	11.7	11.9	12.0	12.4	12.9	12.9	13.2	13.5
Other	11.3	11.2	11.1	10.9	10.9	11.1	12.4	12.2	12.1
Manual	34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Manufacturing	12.5	12.3	12.1	11.9	11.3	10.3	10.3	10.2	9.8
Trade	2.3	2.2	2.2	2.2	2.2	2.1	2.2	2.1	2.2
Knowledge work	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.8
Health & social work	2.3	2.2	2.1	2.0	1.9	1.8	1.8	1.6	1.6
Other	16.7	16.8	16.9	16.9	16.6	16.7	16.5	16.6	16.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

### Sickness absence trends by occupational class

Upper non-manual employees had the lowest and manual workers the highest overall level of sickness absence (Table 2). Among the total study population, the age- and gender-adjusted proportion of employees with any sickness absence decreased from 127.6‰ in 2005 to 108.6‰ in 2013. The annual decrease was largest between 2008 and 2009, after which the proportion somewhat increased between 2009 and 2010, followed by continued decrease. Until 2009, the annual decrease in absences was largest among manual workers. The increase in sickness absence between 2009 and 2010 was also largest among manual workers and negligible among upper non-manual employees. After 2010, the decrease was somewhat larger among upper-non-manual employees than among the lower classes. Overall, the decrease in sickness absence was smallest among lower non-manual employees.

**Table 2.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of all-cause sickness absence (% and 95% CI) and the annual change (%) over particular years by occupational class.

Year	Occupational class			
	Upper non-manual	Lower non-manual	Manual	All
2005	80.8 (79.8–81.8)	120.4 (119.5–121.3)	168.6 (167.4–169.8)	127.6 (127.0–128.3)
2006	79.6 (78.6–80.6)	121.4 (120.5–122.3)	168.6 (167.3–169.8)	127.4 (126.8–128.1)
2007	78.6 (77.6–79.6)	118.6 (117.7–119.5)	166.0 (164.8–167.2)	124.9 (124.3–125.5)
2008	75.4 (74.4–76.3)	115.6 (114.7–116.4)	157.7 (156.5–158.9)	119.6 (119.0–120.2)
2009	72.8 (71.9–73.8)	112.2 (111.3–113.1)	146.2 (145.0–147.4)	113.5 (112.9–114.1)
2010	72.9 (71.9–73.8)	115.2 (114.3–116.1)	152.0 (150.7–153.2)	116.1 (115.5–116.7)
2011	70.8 (69.9–71.7)	112.2 (111.3–113.1)	147.6 (146.3–148.8)	112.9 (112.3–113.5)
2012	67.3 (66.4–68.2)	108.9 (108.0–109.8)	143.3 (142.1–144.5)	109.1 (108.5–109.7)
2013	67.5 (66.6–68.4)	108.8 (107.9–109.6)	142.1 (140.9–143.3)	108.6 (108.0–109.2)
Annual % change				
2005-2009	-2.5	-1.7	-3.3	-2.8
2009-2010	0.1	2.7	4.0	2.3
2010-2013	-2.5	-1.9	-2.2	-2.2

The occupational class differences varied by the diagnostic group of sickness absence in terms of both the overall level and time trends (Figure 1). In terms of the overall level, the age- and gender-adjusted differences were particularly large in musculoskeletal diseases (model 1, panel a), injuries (panel c), and nervous diseases (panel g). The differences were somewhat smaller in mental (panel b), circulatory (panel e), respiratory (panel f), and digestive diseases (panel h), and negligible in neoplasms (panel d). In mental disorders (panel b), the proportion was highest among lower non-manual employees.

In terms of trends, the decrease in absences due to musculoskeletal diseases (panel a) and injuries (panel c) was mainly restricted to manual workers, leading to decreasing class differences particularly until 2009. Among the non-manual classes, there was actually slight increase in absences due to injuries over the study period. In mental disorders (panel b), the decrease in absences was slightly smaller among lower non-manual employees than among the other classes. In circulatory diseases (panel e), absences decreased over the study period with no clear differences between the classes. In respiratory diseases (panel f), the overall decreasing trend in absences was

1 interrupted by an increasing trend between 2007 and 2011 that was more pronounced among lower  
2 non-manual employees than among the other classes. In digestive diseases (panel h), the decrease in  
3 absences over the study period was smallest among lower non-manual employees. In neoplasms  
4 (panel d) and nervous diseases (panel g), the changes over time were relatively small and the  
5 occupational class differences stable.

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8 Adjustment for socioeconomic and employment factors attenuated the occupational class  
9 differences in the absence levels, but it had little effect on the varying trends between the classes  
10 (Figure 1, model 2).

### 11 12 13 **Sickness absence trends by industrial sectors within occupational classes**

14 Further differences in sickness absence between industrial sectors within the three occupational  
15 classes were examined in the two largest disease groups, i.e. musculoskeletal diseases and mental  
16 disorders. The age- and gender-adjusted as well as the fully adjusted annual proportions of sickness  
17 absence are presented in Supplementary Figure 1 and Figure 2, respectively. Although adjustment  
18 for socioeconomic and employment factors attenuated the differences in the overall level of  
19 sickness absence particularly between the high-risk health and social work sector and other sectors,  
20 it had – similarly as in the above mentioned analyses on varying trends in sickness absence between  
21 occupational classes – little influence on the varying trends between industrial sectors (Figure 2  
22 compared to Supplementary Figure 1). All further results are thus based on the fully adjusted  
23 models.

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26 In addition to the estimated proportions in Figure 2, we show relative differences in the risk of  
27 sickness absence between the industrial sectors presented as ORs in Figure 3. In both disease  
28 groups, the overall level of sickness absence was highest in the health and social work sector among  
29 upper (Figures 2 and 3, panels a and b) and lower (panels c and d) non-manual employees. Among  
30 manual workers, the absence level in musculoskeletal diseases (panel e) was highest in the  
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1 manufacturing sector, whereas in mental disorders (panel f) there was no consistent variation  
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3 between the sectors.  
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7 In addition to the overall levels, the trends in sickness absence somewhat varied between industrial  
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9 sectors within the different occupational classes. In musculoskeletal diseases, the decrease in  
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11 absences was smaller among lower non-manual employees (Figure 2, panel c) and manual workers  
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13 (panel e) in the trade sector than in the other sectors. As a result, the excess risk in the trade sector  
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15 compared to the reference group of knowledge work increased over the study period (Figure 3,  
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17 panels c and e) and approached the levels found among lower non-manual employees in the health  
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19 and social work sector (panel c) or among manual workers in the manufacturing sector (panel e).  
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21 Furthermore, the temporary decrease in absences due to musculoskeletal diseases around year 2009  
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23 was particularly large among manual workers (Figure 2, panel e) in the manufacturing sector, which  
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25 led to a temporary decrease in the excess risk found in this sector (Figure 3, panel e). Also in mental  
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27 disorders, there were corresponding but smaller temporary decreases in the manufacturing sector  
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29 among lower non-manual employees (Figures 2 and 3, panel d) and manual workers (panel f).  
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31 Furthermore, there was no decrease over the study period in absences due to mental disorders  
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33 among upper non-manual employees (Figure 2, panel b) in the manufacturing sector. The absence  
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35 level was originally lowest among this group, but by the end of the study period the reduced risk  
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37 compared to the reference group of knowledge work disappeared (Figure 3, panel b). Otherwise, the  
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39 differences in sickness absence between industrial sectors remained relatively stable over the study  
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period.

## DISCUSSION

We used large register data on the general population of Finnish wage earners in order to provide novel information on cause-specific sickness absence trends by occupational class and industrial sector, while accounting for various other socioeconomic and employment factors. Although occupational class differences in sickness absence have been previously established,[1-9] our study is, to our knowledge, the first one to examine occupational class differences in sickness absence

1 trends by disease group or any differences in sickness absence between industrial sectors within  
2 particular occupational classes.  
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7 We found that the proportion of employees with all-cause sickness absence lasting at least two  
8 weeks decreased between 2005 and 2013 in all of the examined occupational classes. The decrease  
9 in absences over the study period was smallest among lower non-manual employees. Upper non-  
10 manual employees had the lowest and manual workers the highest overall level of sickness absence.  
11 The occupational class differences in the overall absence levels were particularly large in  
12 musculoskeletal diseases, injuries, and nervous diseases. In the former two disease groups, the class  
13 differences nevertheless decreased over time since the decreases in absences due to these causes  
14 restricted to manual workers. In mental disorders, the absence level was highest among lower non-  
15 manual employees, who also had the smallest decrease in absences, which led to increasing class  
16 differences over time. Also in respiratory and digestive diseases, the decreases over time were more  
17 limited among lower non-manual employees. In circulatory diseases, absences decreased in all  
18 occupational classes, whereas in neoplasms and nervous diseases the changes over time were  
19 altogether small.  
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36 We also found variation in sickness absence between industrial sectors within the occupational  
37 classes, which was examined in the two largest disease groups, i.e. musculoskeletal diseases and  
38 mental disorders. The overall absence levels were generally highest in the health and social work  
39 sector. Among manual workers, however, the level in musculoskeletal diseases was highest in the  
40 manufacturing sector, where a notable temporary decrease in absences nevertheless occurred during  
41 the peak of the economic recession in 2009. Among manual workers and lower non-manual  
42 employees, the decrease in absences due to musculoskeletal diseases was smallest in the trade  
43 sector.  
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54 Occupational class differences in trends in all-cause sickness absence have been previously  
55 examined among Finnish municipal employees.[8, 9] The findings indicated that class differences  
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1 in the number of sickness absence days have decreased among men since the early 2000s, but with  
2 no particular changes immediately around 2009.[9] The patterns thus somewhat differed from the  
3 ones observed in our present study based on the first onset of longer-term sickness absence among  
4 the general wage-earning population. However, an earlier study on the above mentioned municipal  
5 employees in the 1990s indicated that class differences in the number sickness absence spells  
6 lasting over three days were smaller in the recession years than in the following period of economic  
7 growth, during which absences increased more in the lower classes.[8] Accordingly, we found that  
8 the class differences were smallest in 2009, i.e. during the peak of the more recent economic  
9 recession. Moreover, we found that such changes around the time of the recession were largest in  
10 musculoskeletal diseases. We also found that the temporary sharp decline in absences in 2009 was  
11 most pronounced among manual workers employed in the manufacturing sector. This was the group  
12 in our data for which employment decreased most around the time of the recession. In addition to  
13 decreases in musculoskeletal morbidity and physically demanding work, it is thus likely that the  
14 recession itself was a driving factor behind the decline in sickness absence, especially among  
15 manual workers employed in the manufacturing sector. Employees may be less willing to be absent  
16 from work in contexts of high unemployment rates and labour market insecurity.[1, 8, 14]

17 We found that in injuries, the decrease in the occupational class differences was additionally  
18 attributable to the fact that, contrary to manual workers, the non-manual classes had slight increase  
19 in absences over the study period. However, these differences in the trends may not be  
20 representative of actual differences in the rates of injuries. Our sickness absence data are based on  
21 records from the Finnish Social Insurance Institution, while injury-related sickness absence may  
22 also be covered by other insurers, and the proportion covered by these other insurers may vary over  
23 time.

24 Our population-based finding on the higher overall level of sickness absence due to mental  
25 disorders among lower non-manual employees complements the previously unestablished  
26 information on class differences in work disability due to this common cause. Somewhat deviating

1 from our findings, those based on French and Finnish public sector employee cohorts indicated that  
2 sickness absence[2] or any long-term ( $\geq 90$  days) work disability[15] due to mental disorders was  
3 more common or at a similar level among manual workers than among lower non-manual groups.  
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5 The differences nevertheless remain somewhat unclear due to a lack of statistical power in these  
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7 studies. Findings based on the general Finnish population during the 2000s indicated that the risk of  
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9 disability retirement, i.e. more permanent type of work disability typically succeeding sickness  
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11 absence lasting for about one year, was consistently higher among manual workers in all of the  
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13 large disease groups, including mental disorders.[16] Among a cohort of Finnish municipal  
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15 employees, nevertheless, the number of all-cause sickness absence days has in recent years actually  
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17 become higher among routine non-manual employees compared to the other classes, especially  
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19 among employees under 35 years old.[9] Since mental disorders are particularly common causes of  
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21 work disability among the young, this finding appears to be compatible with ours. All in all, it  
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23 appears that in mental disorders, the class differences somewhat differ between shorter and longer-  
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25 term work disability.  
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32 Our finding on the more limited decrease among lower non-manual employees in sickness absence  
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34 due to mental, respiratory, and digestive diseases may be related to unfavourable changes in the  
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36 work environment in lower non-manual occupations such as increase in psychosocial demands  
37  
38 during the period of economic downturn. It may also be related to changes in the labour market that  
39  
40 reduce sickness absence in the other two occupational classes. For example, manual workers may  
41  
42 be less willing to seek medical advice and be absent from work due to job insecurity, while upper  
43  
44 non-manual employees may have become more able to perform distant work while being ill.  
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46 However, according to previous findings from Finland, trends in job quality appear to have been  
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48 relatively similar between occupational classes over our study period.[17]  
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53 The generally higher absence levels that we found in the health and social work sector is in  
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55 accordance with previous studies.[10, 11] Findings from Norway indicated that the higher risk of  
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57 sickness absence among those employed in health and social occupations was largely explained by  
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1 their unfavourable psychosocial and physical working conditions.[11] A Finnish study has also  
2 shown that compared to employees in other sectors, those in the combined sector of education,  
3 health and social work had poorer health in terms of a higher risk of hospitalization due to various  
4 disease groups including musculoskeletal diseases and mental disorders. Furthermore, the risk of  
5 hospitalization at least due to musculoskeletal diseases was higher in the manufacturing sector than  
6 in the trade and knowledge work -related sectors.[18] The present study adds to the literature by  
7 indicating that also in sickness absence, the difference between the health and social work sector  
8 and other sectors was generally found in both musculoskeletal diseases and mental disorders.  
9 However, our novel findings further indicated that this difference was only found among non-  
10 manual employees. Among manual workers, the absence level in musculoskeletal diseases was  
11 highest in the manufacturing sector.  
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26 The present study also suggests that the differences in sickness absence between industrial sectors  
27 within the occupational classes have been relatively stable since the mid-2000s, except for the  
28 above discussed temporary fluctuations around 2009 and for the smaller decrease in absences due to  
29 musculoskeletal diseases in the trade sector compared to other ones within the lower classes. Since  
30 the more unfavourable trends of the trade sector were not explained by changes in  
31 sociodemographic and employment factors, changes in working conditions or types of jobs within  
32 the sector may have contributed.  
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42 Overall, our findings indicate that the trend differences between occupational classes and industrial  
43 sectors largely depend on the disease causing work disability. In musculoskeletal diseases, the  
44 changes over time varied most. Musculoskeletal diseases may easily be considered as work-related  
45 and their diagnoses are often symptom-based. Such factors may increase the sensitivity of sickness  
46 absence occurrence to changes in the work or economic conditions among particular groups of  
47 employees. In other causes such as circulatory diseases, the decrease in absences has been more  
48 consistent across the classes, which may be related to equality in terms of decreased morbidity and  
49 improved treatment.  
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1 The strengths of this study include nationally representative samples of the population, register-  
2 based data without missing information or loss to follow-up, and longitudinal information on  
3 employment and sociodemographic factors as well as on sickness absence and its diagnostic cause.  
4  
5 Furthermore, the very large data set allowed us to examine cause-specific sickness absence between  
6 industrial sectors within different occupational classes, thereby capturing occupational groups with  
7 relatively similar types of jobs. Our findings may be generalizable to other countries that have  
8 experienced similar labour market changes and have relatively generous sickness benefit systems.  
9

10 There are nevertheless also certain limitations. Our findings are based on national data on  
11 compensated sickness absence, and thus cover spells that typically last at least two weeks. Variation  
12 between the groups may be different in shorter spells that reflect less severe morbidity. Although  
13 our results indicated that socioeconomic and employment factors partly explained the differences by  
14 occupational class and industrial sector in the overall level of cause-specific sickness absence, they  
15 did not appear to explain the varying trends. Factors that could not be measured in this study, such  
16 as changes in health, lifestyle, work exposures, and labour market conditions, are therefore likely to  
17 contribute to the differences in the trends. They may also be influenced by changes in the variation  
18 between different groups in ill-health-related selection out of work through other routes than  
19 sickness absence. Moreover, sickness absence trends may have been affected by changes in national  
20 sickness insurance legislation aiming at enhancing work participation.[19-21]  
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## 41 **CONCLUSIONS**

42 The proportion of employees with sickness absence exceeding two weeks decreased in Finland  
43 between 2005 and 2013. The change was smallest among lower non-manual employees.  
44  
45 Occupational class differences in sickness absence trends nevertheless varied by disease group, and  
46 there was further variation between industrial sectors within the occupational classes. The findings  
47 indicate that certain groups of employees are particularly disadvantaged in terms of either a high  
48 overall level of sickness absence or limited decrease in sickness absence over time: preventive  
49 measures should be targeted especially at work ability related to mental and musculoskeletal health  
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1 among non-manual employees in the health and social work sector and at work ability related to  
2 musculoskeletal health among those with lower grade occupations in the manufacturing and trade  
3 sectors.  
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14  
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17

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19 study. SS and TL prepared the data for analyses. TL conducted the statistical analyses. All authors  
20 contributed to interpretation of the results. TL wrote the first drafts of the article. All authors  
21 discussed and revised the drafts and prepared the final manuscript.  
22  
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28 **Competing interests:** None declared.  
29  
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31

32 **Data sharing statement:** Due to data protection regulations of the administrative sources providing  
33 the register data, the authors do not have the permission to share the data. Permissions to use the  
34 register data can be applied from the Social Insurance Institution of Finland  
35 (<http://www.kela.fi/web/en/research-data-requests>), the Finnish Centre for Pensions  
36 (<http://www.etk.fi/en/statistics-2/statistics/producer-of-statistics/>), and Statistics Finland  
37 ([http://www.stat.fi/meta/tietosuojakayttolupa\\_en.html](http://www.stat.fi/meta/tietosuojakayttolupa_en.html)).  
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For peer review only



## Figure captions

**Figure 1.** Estimated annual proportion of employees with a new onset of cause-specific (A-H) sickness absence (%) by occupational class. The panels are presented in different scales; Model 1 (M1): Adjusted for age and gender; Model 2 (M2): Adjusted for age, gender, education, industrial sector, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between occupational class and year: A) M1: 0.000, M2: 0.000, B) M1: 0.000, M2: 0.000, C) M1: 0.000, M2: 0.000, D) M1: 0.099, M2: 0.100, E) M1: 0.035, M2: 0.041, F) M1: 0.000, M2: 0.000, G) M1: 0.449, M2: 0.568, H) M1: 0.021, M2: 0.165.

**Figure 2.** Estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

**Figure 3.** Annual risk (ORs and their 95% confidence intervals) of having a new onset of sickness absence due to musculoskeletal diseases and mental disorders by industrial sector (OR=1.00 for the knowledge work sector in each year) among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

## Supplementary material captions

**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

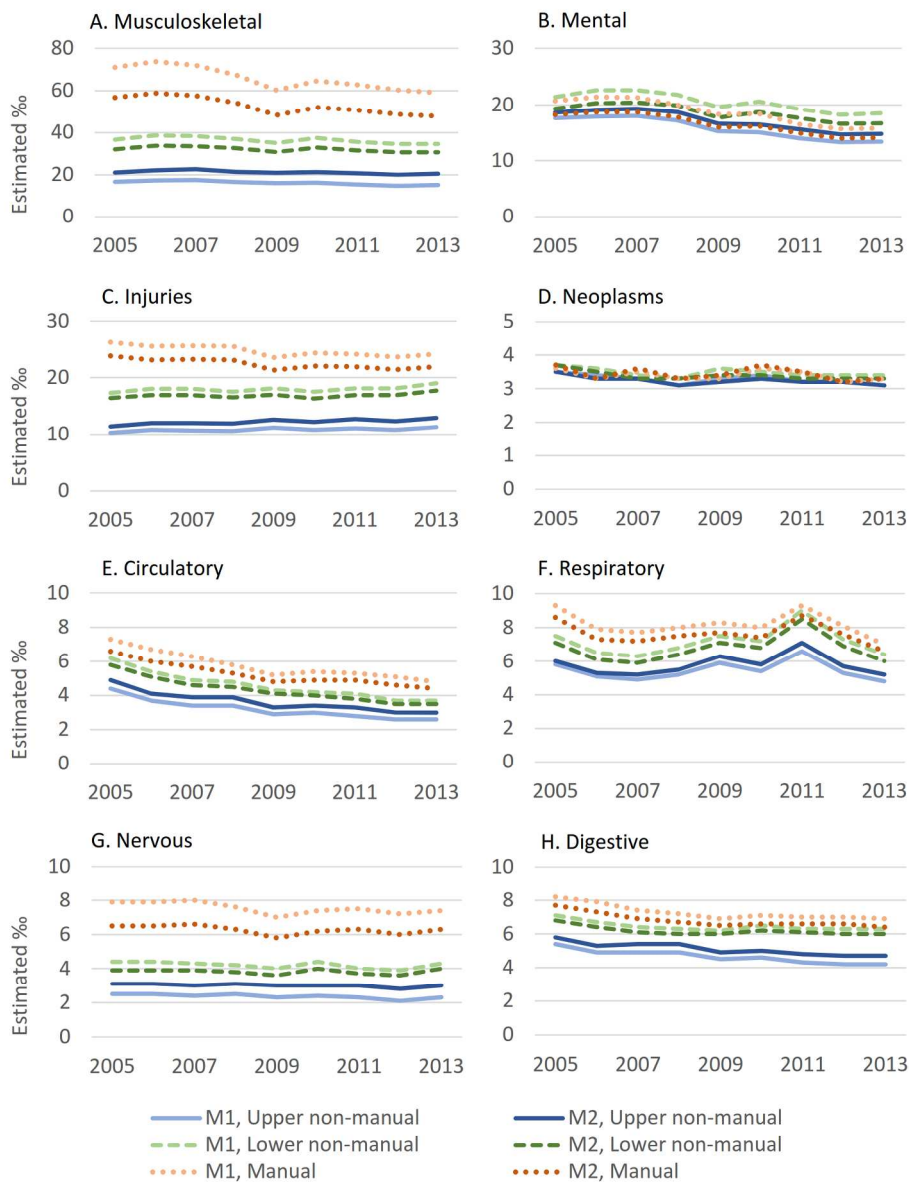


Figure 1

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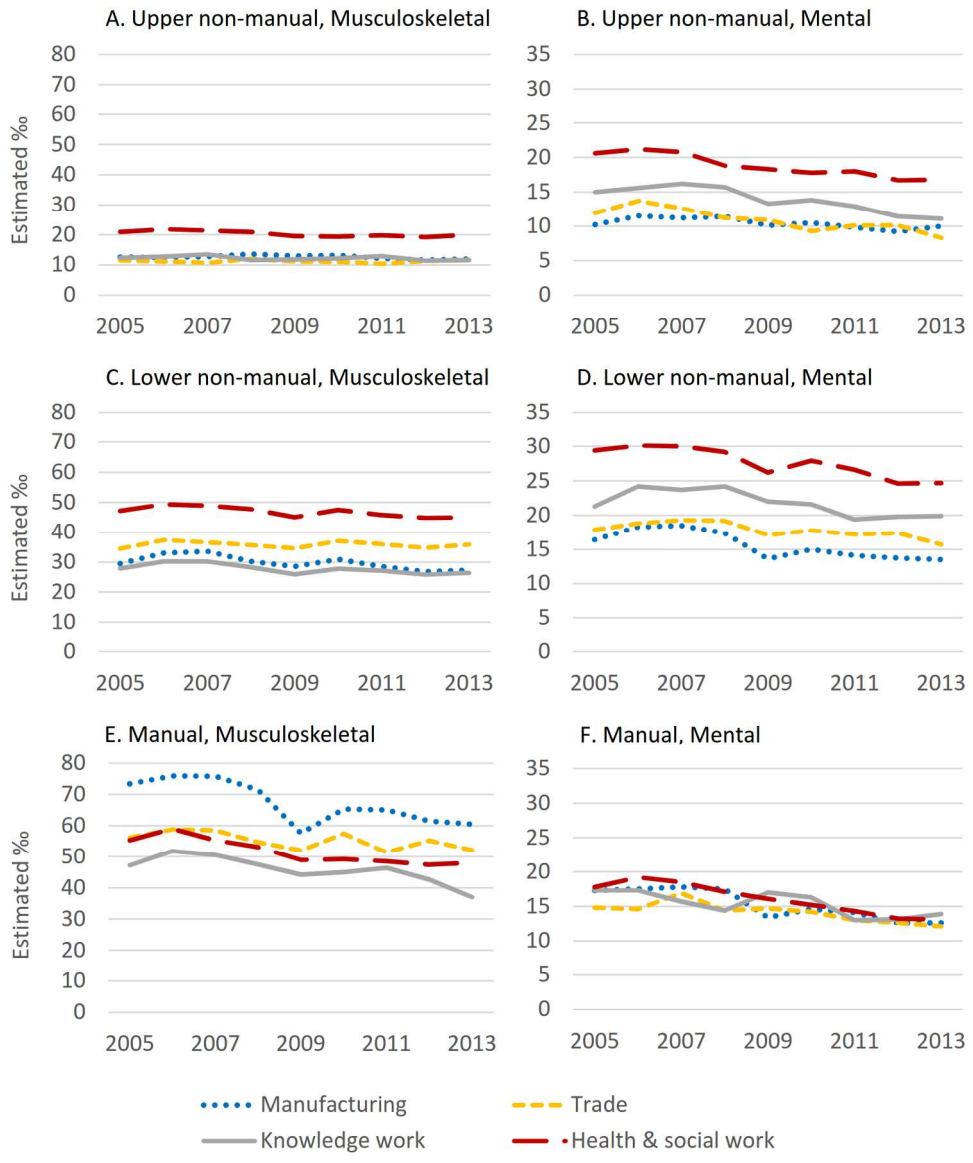


Figure 2

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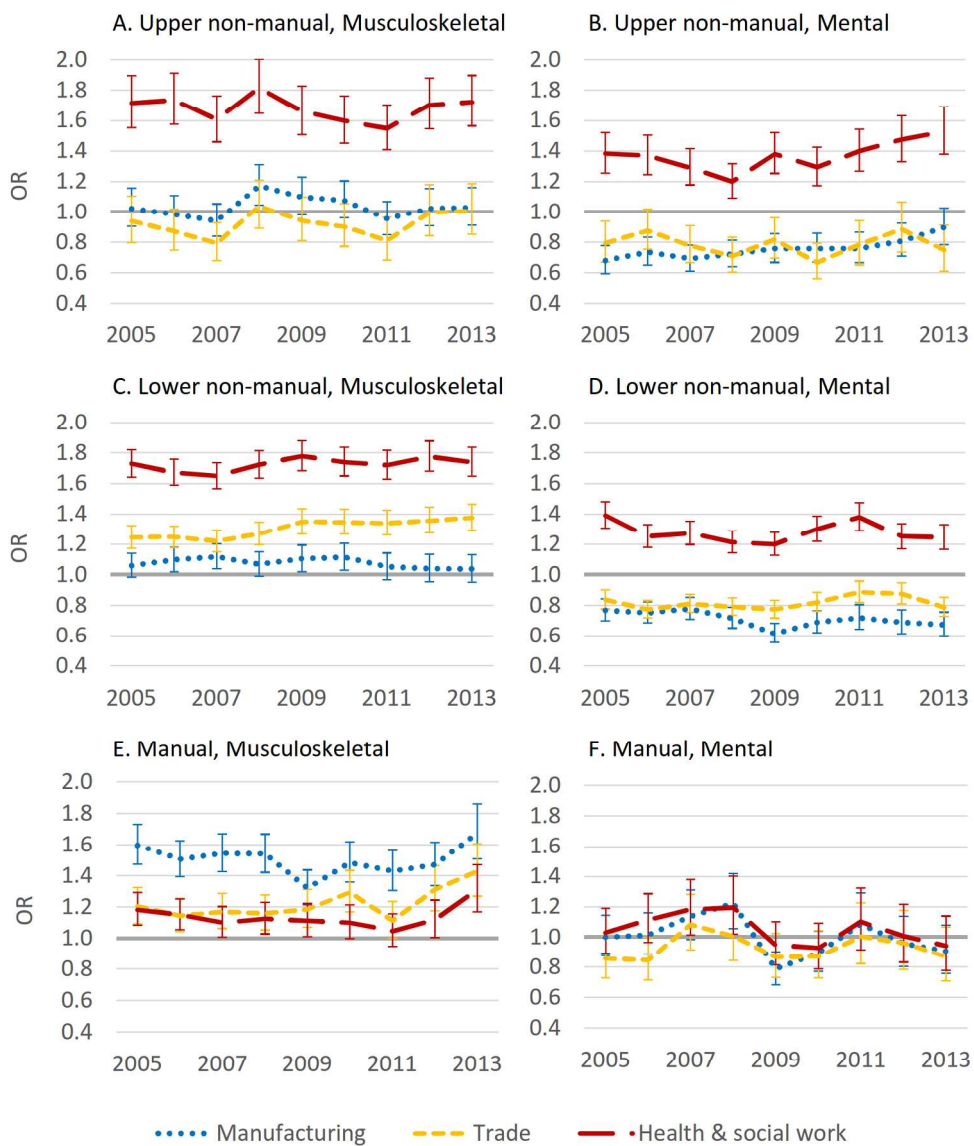


Figure 3

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**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

	Year								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Age									
25-29	12.8	12.9	12.9	13.2	13.3	13.2	13.5	13.4	13.1
30-34	12.8	13.0	13.3	13.7	14.2	14.3	14.5	14.4	14.5
35-39	15.0	14.7	14.3	13.8	13.3	13.4	13.5	13.8	14.2
40-44	16.0	16.0	15.9	15.8	15.6	15.3	14.8	14.5	14.0
45-49	15.8	15.8	15.7	15.6	15.7	15.8	15.7	15.7	15.7
50-54	15.1	15.1	15.3	15.2	15.0	15.0	14.9	14.9	15.0
55-59	12.5	12.6	12.7	12.8	12.9	13.1	13.1	13.4	13.5
Gender									
Men	49.3	49.3	49.3	49.2	48.6	47.9	48.2	48.2	47.9
Women	50.7	50.7	50.7	50.8	51.4	52.1	51.9	51.8	52.1
Education									
Higher tertiary	12.7	13.1	13.3	13.7	14.5	15.0	15.4	15.7	16.1
Lower tertiary	29.7	29.8	29.8	29.8	30.0	30.4	30.4	30.4	30.5
Secondary	41.8	42.2	42.7	43.1	42.8	42.8	43.0	43.2	43.2
Primary	15.9	14.9	14.2	13.5	12.7	11.8	11.3	10.8	10.2
Occupational class									
Upper non-manual	24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Lower non-manual	40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manual	34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Industrial sector									
Manufacturing	20.1	19.6	19.5	19.4	18.8	17.5	17.2	17.0	16.4
Trade	11.2	11.2	11.2	11.2	11.3	11.4	11.4	11.4	11.4
Knowledge work	12.4	12.5	12.5	12.9	13.0	13.1	13.1	13.2	13.2
Health & social work	16.7	16.8	17.0	16.9	17.3	17.8	17.8	18.0	18.5
Other	39.6	39.8	39.8	39.6	39.5	40.2	40.4	40.4	40.5

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2 Employment sector

3 Private	62.4	62.6	62.6	63.1	63.1	62.8	62.7	62.9	62.6
4 Public	32.2	31.8	30.4	29.7	30.2	30.6	30.1	30.3	30.6
5 Private and public	4.9	5.1	6.5	6.6	6.3	6.1	6.3	6.1	6.2
6 Transition to self-employment	0.5	0.5	0.6	0.6	0.6	0.6	0.9	0.7	0.6

## 8 Income

9 Quintile 1 (highest)	17.1	17.7	18.8	19.8	20.2	21.0	21.9	21.8	21.7
10 Quintile 2	17.9	18.9	19.2	19.5	20.0	20.8	21.3	21.1	21.4
11 Quintile 3	19.2	19.9	19.7	19.6	19.8	20.5	20.5	20.3	20.5
12 Quintile 4	22.5	21.9	21.2	20.5	19.9	19.2	18.1	18.4	18.3
13 Quintile 5 (lowest)	23.3	21.6	21.1	20.6	20.1	18.4	18.3	18.5	18.1

## 16 Employed time

17 Full year	90.5	90.4	90.6	90.8	90.5	91.5	91.4	91.2	91.3
18 200-364 days	6.8	7.0	7.1	6.9	6.5	6.1	6.4	6.5	6.3
19 1-199 days	2.7	2.6	2.4	2.2	3.0	2.4	2.2	2.3	2.4

## 21 Employment episodes

22 1	90.0	89.5	88.2	88.3	89.2	89.3	88.5	88.9	89.1
23 2	7.0	7.4	8.5	8.5	7.8	7.7	8.5	8.2	8.0
24 3+	3.0	3.0	3.4	3.2	3.1	2.9	3.0	2.9	2.9

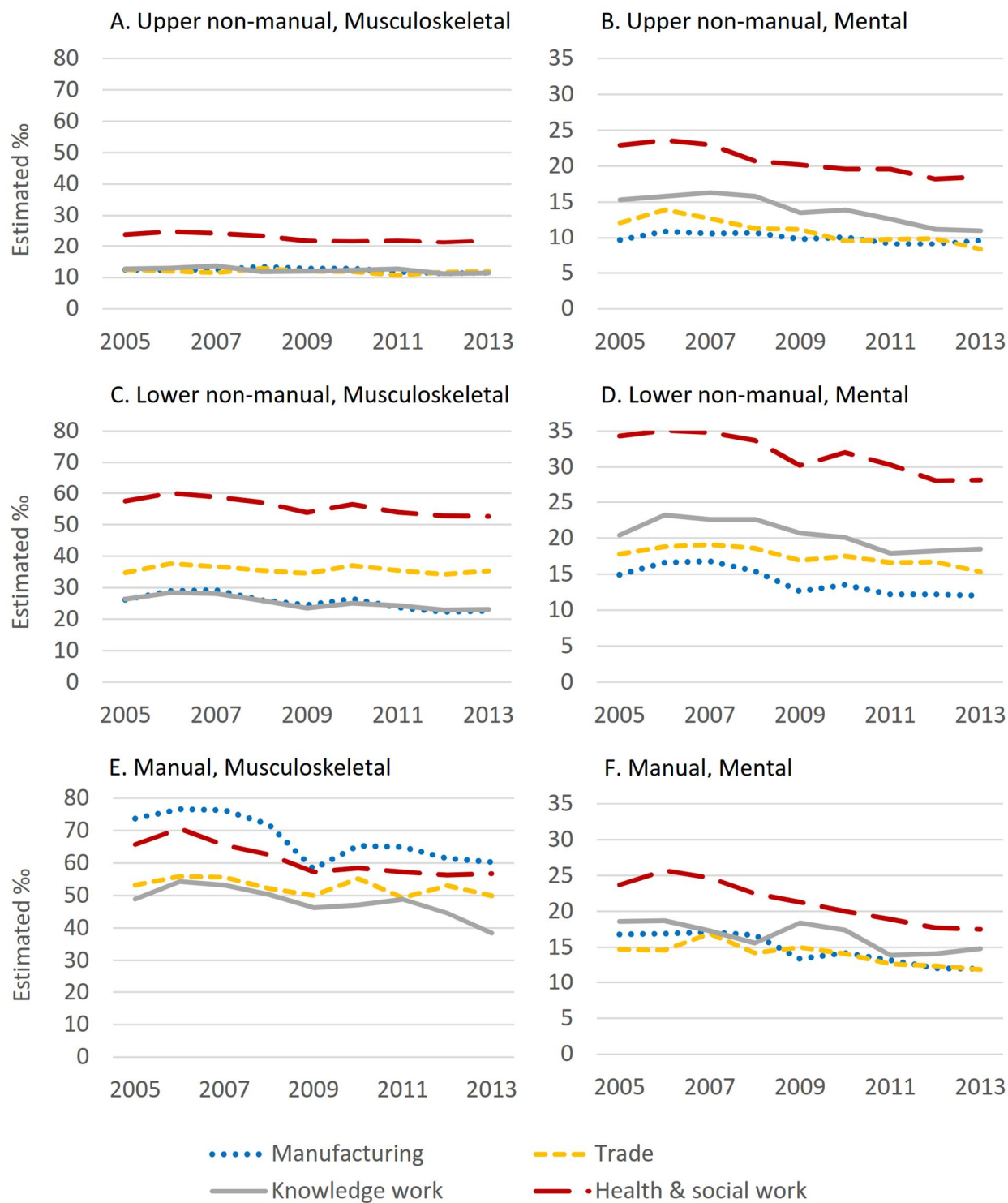
25 Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
26 N	1 097 598	1 100 322	1 109 041	1 122 238	1 117 179	1 081 698	1 094 294	1 092 208	1 080 951

**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

	Upper non-manual					Lower non-manual					Manual				
	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All
Age															
25-29	7.7	9.0	12.9	9.5	10.1	12.4	18.3	15.1	11.1	13.7	13.6	21.3	14.2	7.1	14.8
30-34	15.5	14.6	18.6	12.4	15.0	16.5	16.1	14.5	12.2	13.9	13.6	16.4	10.9	7.7	12.9
35-39	19.2	17.1	16.7	13.6	15.7	15.5	15.2	12.7	13.1	13.7	14.0	14.7	11.1	10.3	13.1
40-44	18.9	18.9	15.4	15.6	16.4	15.4	15.2	14.6	15.2	15.2	14.9	14.4	13.5	1.4	14.7
45-49	15.9	17.1	14.5	17.5	16.0	14.3	13.4	15.3	17.2	15.8	15.2	12.8	16.1	17.6	15.5
50-54	12.7	13.3	12.1	17.4	14.5	13.6	11.5	14.7	17.1	15.0	15.5	11.2	17.6	20.9	15.6
55-59	10.3	10.1	9.7	14.0	12.4	12.2	10.2	13.1	14.1	12.9	13.1	9.3	16.6	22.3	13.5
Gender															
Men	78.5	68.5	65.0	18.2	52.0	56.1	37.6	37.9	7.6	30.3	77.8	79.1	65.0	15.4	69.1
Women	21.5	31.6	35.0	81.8	48.0	43.9	62.4	62.1	92.4	69.7	22.2	20.9	35.0	84.6	30.9
Education															
Higher tertiary	38.2	25.2	42.4	45.0	47.7	10.9	3.0	9.1	1.2	4.7	0.4	0.4	1.6	0.6	0.5
Lower tertiary	46.4	46.7	37.6	48.4	37.0	54.2	32.6	51.2	43.4	44.2	6.5	7.8	11.0	6.7	6.9
Secondary	11.2	21.5	16.7	5.8	12.4	27.0	47.2	31.0	49.9	41.6	70.3	68.7	63.9	69.3	67.9
Primary	4.1	6.7	3.4	0.7	3.0	7.9	17.2	8.7	5.5	9.5	22.9	23.0	23.4	23.3	24.7
Employment sector															
Private	96.2	95.6	81.4	14.0	49.0	97.1	96.1	86.2	17.4	56.9	97.6	95.6	66.3	20.4	80.8
Public	0.1	0.2	12.1	72.3	41.4	0.2	0.2	9.9	73.3	36.7	0.1	1.3	27.4	71.2	14.7
Private and public	3.1	3.1	5.6	12.9	8.8	2.4	3.0	3.4	9.0	6.0	1.9	2.3	5.7	8.2	3.8
Transition to self-employment	0.6	1.1	0.9	0.9	0.8	0.4	0.7	0.5	0.3	0.5	0.4	0.8	0.6	0.2	0.7

1																
2	Income															
3	Quintile 1 (highest)	73.3	66.4	56.7	32.6	48.7	28.8	13.0	19.8	2.0	11.7	13.1	5.0	5.5	0.9	8.1
4	Quintile 2	15.7	16.1	22.4	21.0	24.0	33.7	14.0	24.6	12.3	18.5	25.6	15.3	15.2	2.5	18.7
5	Quintile 3	5.5	7.2	9.5	21.0	12.1	19.4	15.2	24.1	29.5	23.0	27.5	22.9	22.7	8.7	22.5
6	Quintile 4	2.6	4.4	5.1	15.3	7.4	10.9	22.3	17.8	33.6	24.9	21.3	28.0	25.8	36.0	23.7
7	Quintile 5 (lowest)	3.0	5.9	6.3	10.2	7.9	7.2	35.5	13.6	22.7	21.9	12.5	28.8	30.9	51.9	27.1
8	Employed time															
9	Full year	94.9	93.2	93.6	93.2	93.3	94.3	90.9	93.1	91.5	91.8	92.9	89.8	89.1	81.6	87.9
10	200-364 days	3.6	5.0	4.9	5.3	5.2	4.0	6.7	5.0	6.3	5.9	4.9	7.3	7.4	11.0	8.7
11	1-199 days	1.5	1.8	1.5	1.5	1.5	1.7	2.4	1.9	2.2	2.3	2.2	2.9	3.5	7.4	3.4
12	Employment episodes															
13	1	94.3	92.9	90.6	82.7	87.2	95.2	92.2	93.1	86.5	89.9	95.0	92.2	88.7	83.0	89.3
14	2	4.9	5.8	7.4	12.5	9.3	4.0	6.1	5.6	8.2	7.1	4.2	6.4	8.3	9.0	8.0
15	3+	0.8	1.3	2.0	4.8	3.5	0.8	1.7	1.3	5.4	3.0	0.8	1.5	3.1	8.0	2.7
16	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
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**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies***

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-9
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-9
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-9
Bias	9	Describe any efforts to address potential sources of bias	18
Study size	10	Explain how the study size was arrived at	5, 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8, 9
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	na
		(d) If applicable, explain how loss to follow-up was addressed	na
		(e) Describe any sensitivity analyses	na
<b>Results</b>			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5, 6
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10
		(b) Indicate number of participants with missing data for each variable of interest	na
		(c) Summarise follow-up time (eg, average and total amount)	na
Outcome data	15*	Report numbers of outcome events or summary measures over time	10, 11
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-13
		(b) Report category boundaries when continuous variables were categorized	8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	10-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-13
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	13, 14
<b>Limitations</b>			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Cause-specific sickness absence trends by occupational class and industrial sector in the context of recent labour market changes: a Finnish panel data study

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# Cause-specific sickness absence trends by occupational class and industrial sector in the context of recent labour market changes: a Finnish panel data study

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## ABSTRACT

**Objectives:** We aimed to provide previously unestablished information on population-based differences in cause-specific sickness absence trends between occupational classes and further between four large industrial sectors within the different occupational classes while controlling for other socioeconomic factors and employment patterns. We focused on the period 2005–2013, during which the labour market underwent large economic and structural changes in many countries.

**Design:** Register-based panel data study.

**Setting:** Large representative data sets on Finnish wage earners aged 25–59 years.

**Outcome measure:** Annual risk of sickness absence (> ten working days) based on repeated logistic regression.

**Results:** Between 2005 and 2013, the proportion of employees with sickness absence decreased. Occupational class differences in sickness absence trends varied by disease group. Overall, the decrease in absences was smallest among lower non-manual employees. Sickness absence levels were highest in the health and social work sector and in the manufacturing sector within the non-manual and manual classes, respectively. Absences due to musculoskeletal diseases decreased temporarily during the peak of the economic recession in 2009, particularly in the manufacturing sector within the manual class. The decrease in absences due to musculoskeletal diseases was smallest in the trade sector within the lower occupational classes. Overall, education, income, and employment patterns partly explained the differences in the absence levels, but not in the trends.

**Conclusions:** We found a complex interplay between the associations of occupational class and industrial sector with sickness absence trends. During the economic recession, absences due to musculoskeletal diseases decreased temporarily in a segment of wage earners that are known to have been hit hard by the recession. However, the trend differences were not explained by the

1 measured structural changes in the characteristics of the study population. Both occupational class  
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3  
4 and industrial sector should be taken into account when tackling problems of work disability.  
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### 10 **Strengths and limitations of this study**

- 13 • The large register-based data sets were representative of Finnish wage earners and did not  
14 have the problem of missing information due to non-response.
- 17 • The data had sufficient statistical power for examining cause-specific sickness absence  
18 trends by large industrial sectors within different occupational classes.
- 21 • The rich data included information on various covariates, including education, employment  
22 sector, income, time spent in employment, and the number of employment episodes.
- 26 • The data lacked information on some potentially important covariates such as health status,  
27 lifestyle factors, work exposures, and labour market conditions.
- 30 • The sickness absence outcome was based on national data on compensated spells that begin  
31 after a period of ten working days, thereby excluding shorter spells.  
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## INTRODUCTION

The association of low occupational class with a higher likelihood of sickness absence has been established in many European countries.[1-11] The occupational class differences have been particularly large in absences due to musculoskeletal diseases, and smaller but still notable in most other disease groups. In mental disorders, the absence levels have been similar or even higher among lower non-manual employees than among manual workers.[2, 10]

In addition to occupational class, industrial sector is closely associated with working conditions and the broader work environment, which affect the ability of an individual to perform in his or her own job. A previous study from Denmark indicated that the risk of long-term sickness absence was higher than average in the health care and social services sector and lower than average in the private administration sector, but otherwise the differences between the sectors were small.[12]

Accordingly, a Norwegian study indicated that the risk of long-term sickness absence was higher among women employed in health and social occupations than among the general female employed population.[13] There may also be an important interplay between occupational class and industrial sector; even within a particular occupational class, the types of jobs may vary considerably between different sectors. Previous population-based findings from Denmark[12] and Sweden[14] have shown large differences in long-term sickness absence between particular occupational groups. Variation in sickness absence between industrial sectors within different occupational classes nevertheless remains unclear.

From the start of the millennium, Finland and other European countries have experienced two key labour market changes that may have had varying consequences for the health, work ability, and illness behaviour of individuals in different occupational classes and industrial sectors. Firstly, particular sectors including manufacturing and construction were hit hard by the economic recession of the late 2000s, whereas other sectors such health and social services were less affected.[15] In Finland, the economic recession peaked in 2009. This was the only year in which the change in the GDP was negative (-6.5%). A specific feature for Finland was that there was



1 another decline in the GDP after 2011. The manufacturing sector was affected the most: the number  
2 of wage earners employed in this sector decreased by 9.4% between 2008 and 2009, while the  
3 corresponding decrease in the total wage-earner population was 3.8%.[16] Secondly, the labour  
4 market has undergone longer-term structural changes through which employment in non-manual  
5 occupations as well as in the knowledge work and service sectors has increased.[16, 17] These  
6 economic and structural changes are likely to have been associated with changes in the types of jobs  
7 as well as in the work, employment and social conditions of individuals within particular  
8 occupational classes and industrial sectors.  
9

10 Recent economic and structural changes in the labor market may have led to changes in the  
11 associations of occupational class and industrial sector with sickness absence. Previous studies from  
12 Finland indicated that during recent decades, the overall level as well as occupational class  
13 differences in sickness absence have mainly decreased.[9-11] However, the contribution of the  
14 recession of the late 2000s to changes in the occupational class differences in sickness absence  
15 remains unclear. Moreover, information on trends in sickness absence by industrial sector are  
16 altogether lacking. Further, little is known of whether occupational class and industrial sector  
17 differences in sickness absence trends can be attributed to longer-term structural changes in the  
18 labour market, such as those related to educational attainment, income, private versus public sector  
19 employment, or other employment patterns. Information on sickness absence trends and their  
20 explanations would help identify vulnerable groups in order to prevent work disability and extend  
21 working careers.  
22

23 We used large register-based data sets to examine cause-specific sickness absence trends in 2005–  
24 2013 by occupational class and further by industrial sector among the general population of Finnish  
25 wage earners while accounting for other socioeconomic factors and employment patterns. We  
26 thereby aimed to explore whether occupational class and industrial sector differences in cause-  
27 specific sickness absence trends were influenced by changes in the characteristics of the wage-  
28

1 earner population over a period of major economic fluctuations. The more particular research  
2 questions are listed below.  
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7 1. Do the trends in sickness absence due to all causes, musculoskeletal diseases, mental  
8 disorders, injuries, neoplasms, circulatory diseases, respiratory diseases, nervous diseases, or  
9 digestive diseases differ between occupational classes?  
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- 12  
13 2. Do the trends in sickness absence due to the two largest disease groups, i.e. musculoskeletal  
14 diseases and mental disorders, vary between four large industrial sectors within different  
15 occupational classes?  
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- 18  
19 3. Are the occupational class and industrial sector differences in cause-specific sickness  
20 absence trends influenced by changes over the study period in education, employment  
21 sector, income, time spent in employment, and the number of employment episodes?  
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## 27 **MATERIAL AND METHODS**

### 28 **Study population**

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31 We used large register-based data sets with 70% nationally representative random samples of the  
32 Finnish working aged population from three cross-sections on the last days of the years 2004, 2007,  
33 and 2010. Each of the cohorts were followed up for three calendar years to cover a nine-year study  
34 period between 2005 and 2013. The data included information on compensated sickness absences  
35 and national pensions obtained from the Social Insurance Institution of Finland, on  
36 sociodemographic factors obtained from the Finnish Longitudinal Employer-Employee Data  
37 (FLEED) of Statistics Finland, and on employment and earnings-related pensions from the Finnish  
38 Centre for Pensions, as also described in our previous study on gender differences in sickness  
39 absence.[18]  
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52 Criteria for being included in the study population were applied separately to each study year. An  
53 individual could thus be excluded in one year and included in others. We restricted the study  
54 population to those aged 25–59 on the last day of the year preceding the study year. We included  
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1 individuals who were employed wage earners according to their main economic activity and  
2 socioeconomic status and did not receive full pensions (full disability pensions, unemployment  
3 pensions, special pensions for farmers, or old-age pensions) before the study year. We also required  
4 that the study person had an ongoing employment period (in the private sector, in the public sector,  
5 or in both, but not in self-employment) and did not have an ongoing compensated sickness absence  
6 spell at the beginning of the study year. The excluded were subsequently either self-employed  
7 (8.7% of the original study population), unemployed (8.0%), retired (14.1%), otherwise non-  
8 employed (9.9%), or on sick leave (0.8%). We allowed for non-employment and self-employment  
9 later during the study year, adjusting for these factors in the analyses. We nevertheless excluded  
10 those who started receiving full pensions (0.2%), emigrated (0.1%), or died (0.05%) during the  
11 study year. Finally, we excluded those who did not live in Finland two years before the end of the  
12 year preceding the study year (0.2%). We did this because we used the population samples from the  
13 end of years 2004, 2007, and 2010 to form the study population in years 2005–2007, 2008–2010,  
14 and 2011–2013, respectively; since the study population in years 2007, 2010, and 2013 by design  
15 lived in Finland two years before, we applied the same inclusion criteria for all of the years.

16 After all exclusions, 74.0% of the remaining individuals were included in the study population in  
17 each of the three consecutive years (calculated among those who fit the age range 25–59 in all three  
18 years). The final study population consisted of around 1.1 million individuals per study year  
19 (Supplementary Table 1).

### 20 **Sickness absence outcome**

21 In Finland, sickness absence is compensated by the Social Insurance Institution of Finland after a  
22 period of ten working days that are typically paid by the employer.[19] Only sickness absence spells  
23 compensated by the Social Insurance Institution are registered at the national level and included in  
24 our data. The outcome of this study was therefore based on sickness absence that by definition  
25 lasted around two calendar weeks or more. We used repeated dichotomous measures of whether a  
26 study person had a new onset of compensated sickness absence in a particular calendar year. The

1 outcome included both full and part-time sickness absence, but in Finland the first onset of work  
2 disability typically starts with full sickness absence. Eligibility for the compensated sickness benefit  
3 requires that the claimant resides permanently in Finland and that compensation for earnings loss is  
4 not covered in other overruling statutory benefits including those related to occupational, traffic and  
5 military accidents.  
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13 Cause-specific sickness absence was classified according to the tenth revision of the International  
14 Classification of Diseases (ICD-10). We examined the largest groups separately, including 1)  
15 musculoskeletal diseases (diseases of the musculoskeletal system and connective tissue, M00–  
16 M99), 2) mental disorders (mental and behavioural disorders, F00–F99), 3) injuries (injury,  
17 poisoning and certain other consequences of external causes, S00–T98), 4) neoplasms (C00–D48),  
18 5) circulatory diseases (I00–I99), 6) respiratory diseases (J00–J99), 7) nervous diseases (G00–G99),  
19 and 8) digestive diseases (K00–K93).  
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### 29 **Occupational class and industrial sector**

30 Occupational class and industrial sector were based on information measured in the year preceding  
31 each study year and categorized according to classifications by Statistics Finland.[20] Occupational  
32 class consisted of categories 1) upper non-manual, 2) lower non-manual, and 3) manual.  
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38 Industrial sector included the following categories: 1) manufacturing (manufacturing, mining and  
39 quarrying), 2) trade (wholesale and retail trade; repair of motor vehicles and motorcycles), 3)  
40 knowledge work (information and communication; financial and insurance activities; real estate  
41 activities; professional, scientific and technical activities), 4) human health and social work  
42 activities, and 5) other (agriculture, forestry and fishing; electricity, gas, steam and air conditioning  
43 supply; water supply; sewerage, waste management and remediation activities; construction;  
44 transportation and storage; accommodation and food service activities; administrative and support  
45 service activities; public administration and defence; compulsory social security; education; arts,  
46 entertainment and recreation; other service activities; activities of households as employers;  
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1 undifferentiated goods- and services-producing activities of households for own use; activities of  
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4 extraterritorial organisations and bodies; industry unknown). This classification was from year  
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6 2008. Until 2007, the classification was based on an older version from year 2002, but virtually  
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8 equivalent main categories listed above could be constructed using a reclassification code provided  
9  
10 by Statistics Finland.

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13 When examining industrial sectors within the three occupational classes, we only show results for  
14  
15 the four large industrial sectors 1–4. The category “other” consisted of heterogeneous smaller  
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17 sectors which could not be examined separately due to small number of events.  
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### 20 **Covariates**

21 We examined sociodemographic factors and employment patterns as covariates. Age was divided  
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23 into 5-year groups. Education and income were based on information measured in the year  
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25 preceding each study year. Education consisted of categories 1) higher tertiary (Master's or  
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27 equivalent level, or higher), 2) lower tertiary (Bachelor's or equivalent level), 3) secondary, and 4)  
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29 primary. Tertiary education was divided into two levels, because the proportion of those with higher  
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31 tertiary education in particular increased during the study period (Supplementary Table 1). Income  
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33 consisted of both wage and capital income of the individual. It was inflation-corrected and then  
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35 divided into quintiles across the study years.  
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41 Employment patterns were measured during each study year. Employment sector was classified as  
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43 1) private, 2) public, 3) private and public, and 4) transition to self-employment. Time spent in  
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45 employment was divided into 1) full year, 2) 200–364 days, and 3) 1–199 days. The cut-point of  
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47 200 days was arbitrarily chosen to define those who were employed most of the year. The number  
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49 of employment episodes was divided into 1) one, 2) two, and 3) three or more.  
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### 52 **Statistical methods**

53 We used generalized estimation equations (GEE) based on repeated logistic regression to estimate  
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55 the annual risk of having a new onset of compensated all-cause and cause-specific sickness absence  
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1 in 2005–2013. The GEE models account for the within-individual correlation between repeated  
2  
3 measurements in the three different samples followed up during periods 2005–2007, 2008–2010, or  
4  
5 2011–2013.  
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7  
8 Using margins derived from the logistic GEE models, we plotted trajectories of estimated  
9  
10 proportions (%) of employees with sickness absence including interactions of occupational class  
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12 and industrial sectors within the occupational classes with categorical year. Estimated proportions  
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14 demonstrate the magnitude and direction of changes in the level of sickness absence among  
15  
16 different groups, which would not be revealed solely on the basis of information on changes in the  
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18 differences between the groups. Analyses of occupational class differences were performed in each  
19  
20 of the eight disease groups. Analyses of differences between industrial sectors within the different  
21  
22 occupational classes were performed in the two largest disease groups, i.e. musculoskeletal diseases  
23  
24 and mental disorders. We adjusted for the annually measured covariates holding them at their mean  
25  
26 level when plotting the trajectories.  
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29

30  
31 Derived from the same GEE models, we also calculated relative differences between industrial  
32  
33 sectors within the different occupational classes. We used those employed in the knowledge work  
34  
35 sector as the reference group, for which the odds ratio (OR) of sickness absence was held at 1.00 in  
36  
37 each year.  
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41 We pooled men and women, adjusting for gender in the analyses. Even though the overall level of  
42  
43 sickness absence was much higher among the female than the male study population, changes over  
44  
45 time were relatively similar among the genders especially after accounting for their differential  
46  
47 occupational and sectoral distributions.[18]  
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49

## 50 **RESULTS**

### 51 **Characteristics of the study population**

52  
53 Over the study period between 2005 and 2013, the proportion of manual workers decreased  
54  
55 especially in the manufacturing sector, but also in the health and social work sector (Table 1). The  
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proportion of non-manual employees increased. Among upper non-manual employees, the increase was largest in the knowledge work sector. Among lower non-manual employees, the proportion increased in the health and social work sector and decreased in the manufacturing sector. Annual distributions of the study population by all background characteristics are presented in Supplementary Table 1. Average distributions over the whole study period are presented also separately for those employed in different industrial sectors within different occupational classes in Supplementary Table 2.

**Table 1.** Annual distribution (%) of the study population over the study period by industrial sectors across different occupational classes.

Occupational class	Year									
	Industrial sector	2005	2006	2007	2008	2009	2010	2011	2012	2013
Upper non-manual		24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Manufacturing		3.1	3.3	3.5	3.5	3.7	3.6	3.5	3.5	3.3
Trade		1.3	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.3
Knowledge work		5.4	5.6	5.8	6.0	6.2	6.3	6.3	6.4	6.2
Health & social work		2.9	2.9	2.9	2.9	3.0	3.1	3.1	3.2	3.3
Other		11.6	11.9	11.8	11.8	12.0	12.4	11.6	11.7	11.9
Lower non-manual		40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manufacturing		4.4	4.0	4.0	4.0	3.9	3.7	3.5	3.4	3.4
Trade		7.5	7.5	7.5	7.5	7.7	7.8	8.0	8.0	7.9
Knowledge work		6.0	5.8	5.7	5.9	5.8	5.8	5.9	6.0	6.2
Health & social work		11.6	11.7	11.9	12.0	12.4	12.9	12.9	13.2	13.5
Other		11.3	11.2	11.1	10.9	10.9	11.1	12.4	12.2	12.1
Manual		34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Manufacturing		12.5	12.3	12.1	11.9	11.3	10.3	10.3	10.2	9.8
Trade		2.3	2.2	2.2	2.2	2.2	2.1	2.2	2.1	2.2
Knowledge work		1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.8
Health & social work		2.3	2.2	2.1	2.0	1.9	1.8	1.8	1.6	1.6
Other		16.7	16.8	16.9	16.9	16.6	16.7	16.5	16.6	16.5
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

### Sickness absence trends by occupational class

Upper non-manual employees had the lowest and manual workers the highest overall level of sickness absence (Table 2). Among the total study population, the age- and gender-adjusted proportion of employees with any sickness absence decreased from 127.6‰ in 2005 to 108.6‰ in 2013. Until 2009, the annual decrease was largest among manual workers. Between 2009 and 2010,

sickness absence increased, but only among manual workers and lower non-manual employees.

After 2010, the decrease in sickness absence continued. Overall, the decrease in sickness absence was smallest among lower non-manual employees.

**Table 2.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of all-cause sickness absence (‰ and 95% CI) and the annual change (%) over particular years by occupational class.

Year	Occupational class			
	Upper non-manual	Lower non-manual	Manual	All
2005	80.8 (79.8–81.8)	120.4 (119.5–121.3)	168.6 (167.4–169.8)	127.6 (127.0–128.3)
2006	79.6 (78.6–80.6)	121.4 (120.5–122.3)	168.6 (167.3–169.8)	127.4 (126.8–128.1)
2007	78.6 (77.6–79.6)	118.6 (117.7–119.5)	166.0 (164.8–167.2)	124.9 (124.3–125.5)
2008	75.4 (74.4–76.3)	115.6 (114.7–116.4)	157.7 (156.5–158.9)	119.6 (119.0–120.2)
2009	72.8 (71.9–73.8)	112.2 (111.3–113.1)	146.2 (145.0–147.4)	113.5 (112.9–114.1)
2010	72.9 (71.9–73.8)	115.2 (114.3–116.1)	152.0 (150.7–153.2)	116.1 (115.5–116.7)
2011	70.8 (69.9–71.7)	112.2 (111.3–113.1)	147.6 (146.3–148.8)	112.9 (112.3–113.5)
2012	67.3 (66.4–68.2)	108.9 (108.0–109.8)	143.3 (142.1–144.5)	109.1 (108.5–109.7)
2013	67.5 (66.6–68.4)	108.8 (107.9–109.6)	142.1 (140.9–143.3)	108.6 (108.0–109.2)
Annual % change				
2005-2009	-2.5	-1.7	-3.3	-2.8
2009-2010	0.1	2.7	4.0	2.3
2010-2013	-2.5	-1.9	-2.2	-2.2

The occupational class differences in sickness absence varied by disease group in terms of both the overall level and time trends (Figure 1). In terms of the overall level, the differences were particularly large in musculoskeletal diseases (panel A), injuries (panel C), and nervous diseases (panel G), and negligible in neoplasms (panel D). In mental disorders (panel B), the level was highest among lower non-manual employees.

In terms of trends, the decrease in absences due to musculoskeletal diseases (panel A) and injuries (panel C) was mainly restricted to manual workers, leading to decreasing class differences particularly until 2009. In mental disorders (panel B) and digestive diseases (panel H), the decrease in absences was slightly smaller among lower non-manual employees than among the other classes. In respiratory diseases (panel F), the overall decreasing trend was interrupted by an increase in



1 absences between 2007 and 2011, most notably so among lower non-manual employees. In  
2  
3  
4 circulatory diseases (panel E), absences decreased over the study period with no clear differences  
5  
6 between the classes. In neoplasms (panel D) and nervous diseases (panel G), the changes over time  
7  
8 were relatively small and the occupational class differences stable.  
9

10  
11 Adjustment for other socioeconomic factors and employment patterns attenuated the occupational  
12  
13 class differences in sickness absence levels, but it had little effect on the varying trends between the  
14  
15 classes (Figure 1, model 2 compared to model 1).  
16

### 17 18 **Sickness absence trends by industrial sectors within occupational classes**

19  
20 We examined age- and gender-adjusted (Supplementary Figure 1) as well as fully adjusted (Figure  
21  
22 2) annual proportions of cause-specific sickness absence by industrial sectors within the three  
23  
24 occupational classes. Although adjustment for socioeconomic factors and employment patterns  
25  
26 attenuated the industrial sector differences in the overall absence levels, it had little influence on the  
27  
28 varying trends (Figure 2 compared to Supplementary Figure 1). All further results are therefore  
29  
30 based on the fully adjusted models.  
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33  
34 Among upper (Figures 2 and 3, panels A and B) and lower (panels C and D) non-manual  
35  
36 employees, the overall level of sickness absence due to both musculoskeletal diseases and mental  
37  
38 disorders was highest in the health and social work sector. Among manual workers, the absence  
39  
40 level in musculoskeletal diseases (panel E) was highest in the manufacturing sector, whereas in  
41  
42 mental disorders (panel F) there was no consistent variation between the sectors.  
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45  
46 Among lower non-manual employees (Figure 2, panel C) and manual workers (panel E), the  
47  
48 decrease in absences due to musculoskeletal diseases was smaller in the trade sector than in the  
49  
50 other sectors. As a result, the excess risk in the trade sector compared to the reference group of  
51  
52 knowledge work increased over the study period (Figure 3, panels C and E). The temporary  
53  
54 decrease in absences due to musculoskeletal diseases around year 2009 was particularly large  
55  
56 among manual workers (Figure 2, panel E) in the manufacturing sector, which led to a temporary  
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1 decrease in the excess risk found in this sector (Figure 3, panel E). Also in mental disorders, there  
2 were corresponding but smaller temporary decreases around year 2009 in the manufacturing sector  
3 among lower non-manual employees (Figures 2 and 3, panel D) and manual workers (panel F).  
4  
5 Furthermore, there was no decrease over the study period in absences due to mental disorders  
6 among upper non-manual employees (Figure 2, panel B) in the manufacturing sector. The absence  
7 level was originally lowest in this sector, but by the end of the study period, the reduced risk  
8 compared to the reference group of knowledge work disappeared (Figure 3, panel D). Otherwise,  
9 the differences in sickness absence between industrial sectors remained relatively stable over the  
10 study period.  
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## 22 **DISCUSSION**

23  
24 We used large register-based data sets on the general population of Finnish wage earners in order to  
25 provide novel information on occupational class and industrial sector differences in cause-specific  
26 sickness absence trends. We accounted for the potential influence of changes in other  
27 socioeconomic factors and employment patterns on the varying trends. Although both occupational  
28 and sectoral differences in sickness absence have been previously examined,[1-14] our study is, to  
29 our knowledge, the first one to examine differences in sickness absence between industrial sectors  
30 within particular occupational classes.  
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40 We found that the proportion of employees with sickness absence lasting more than ten working  
41 days generally decreased between 2005 and 2013 in all of the examined occupational classes. All in  
42 all, the change was smallest among lower non-manual employees. Upper non-manual employees  
43 had the lowest and manual workers the highest overall level of sickness absence. The occupational  
44 class differences in the overall absence levels were particularly large in musculoskeletal diseases,  
45 injuries, and nervous diseases. In the former two disease groups, the decrease in absences  
46 nevertheless restricted to manual workers, leading to a reduction in the class differences over time.  
47 In mental disorders, in contrast, the absence level was highest and the decrease over time smallest  
48 among lower non-manual employees. This led to increasing class differences over time. Also in  
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1 respiratory and digestive diseases, the decreases over time were smaller among lower non-manual  
2 employees. In circulatory diseases, absences decreased in all occupational classes, whereas in  
3  
4 neoplasms and nervous diseases, the changes over time were altogether small.  
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9 Looking at the two largest disease groups, i.e. musculoskeletal diseases and mental disorders, we  
10 found further variation in sickness absence between four large industrial sectors despite the fact that  
11 these were examined within particular occupational classes. Among non-manual employees, the  
12 overall absence levels were highest in the health and social work sector. Among manual workers,  
13 the level in musculoskeletal diseases was highest in the manufacturing sector, where a notable  
14 temporary decrease in absences nevertheless occurred during the peak of the economic recession in  
15 2009. Among manual workers and lower non-manual employees, the decrease in absences due to  
16 musculoskeletal diseases was smallest in the trade sector.  
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27 The contribution of the recession of the late 2000s to changes in the occupational class differences  
28 in sickness absence has not been clear. A previous study on municipal employees in the 1990s  
29 indicated that occupational class differences in the number of new all-cause sickness absence spells  
30 lasting over three days were smaller in the recession years than in the following period of economic  
31 growth.[3] Accordingly, we found that the class differences were smallest in 2009, i.e. during the  
32 peak of the more recent economic recession. Moreover, we found that changes in the class  
33 differences around the time of the recession were largest in musculoskeletal diseases. We also  
34 found that the temporary sharp decline in absences in 2009 was most pronounced among manual  
35 workers employed in the manufacturing sector. This was the group in our data for which  
36 employment decreased most around the time of the recession. In addition to decreases in  
37 musculoskeletal morbidity and physically demanding work, it is thus likely that the recession itself  
38 was a driving factor behind the decline in sickness absence, especially among manual workers  
39 employed in the manufacturing sector. Employees who were strongly affected by labour market  
40 insecurity and the threat of unemployment may have been less willing to be absent from work  
41 despite their health problems.[1, 3, 21-23] It is also possible that during the recession, affected  
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1 groups of employees had stronger ill-health-related selection out of employment.[24-26] The  
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3 decline in sickness absence during the recession could thus have been attributable to excess  
4  
5 employment exit among individuals with a higher likelihood of sickness absence.[27]  
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9 We found that occupational class differences decreased also in sickness absence due to injuries.

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11 However, a corresponding change may not necessarily have occurred in actual injury rates.

12  
13 Absences due to some injuries such as occupational accidents were not included in our data,  
14  
15 because these are covered by other insurers than the Social Insurance Institution of Finland (see the  
16  
17 Material and methods section for more details). The proportion covered by these other insurers may  
18  
19 vary over time and by occupational class. Making interpretations of trends in sickness absence due  
20  
21 to injuries is therefore difficult.  
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24  
25 Our finding on the smaller decrease among lower non-manual employees in sickness absence due to  
26  
27 mental, respiratory, and digestive diseases was not explained by changes in the distribution of  
28  
29 factors that were measured in this study, including education, income, and employment patterns.

30  
31 The smaller decrease in sickness absence among lower non-manual employees may therefore have  
32  
33 been related to unobserved unfavourable changes in their work environment such as increased  
34  
35 psychosocial demands during the period of economic downturn. It may also have been related to  
36  
37 labour market changes that reduced sickness absence in the other two occupational classes.

38  
39 However, according to previous findings from Finland, trends in job quality appear to have been  
40  
41 relatively similar between occupational classes over our study period.[28] Other findings

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43 nevertheless indicated polarization in the labour market of Finland and other Nordic countries  
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45 between the mid-1990s and mid-2000s, which was interpreted as partly relating to technological  
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47 advances in the period. The proportion of occupations at both the top and the bottom ends of the  
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49 wage distribution increased: engineering professionals and other professionals at the top level and

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51 personal and protective services at the bottom level became more common. Accordingly, the  
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53 proportion of occupations at the intermediate level of the wage distribution decreased mainly due to  
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55 a reduction in office clerks, i.e. routine non-manual employees.[29]. Corresponding changes may  
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1 have occurred in our study period and affected the job distributions within the occupational classes.

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4 A further notable change in the Finnish labour market is that the proportion of employees  
5  
6 performing distant work increased from 10% in 2003 to 20% in 2013.[30] This may have  
7  
8 contributed to the decrease in sickness absence among particular groups of employees. It is likely  
9  
10 that upper non-manual employees are more able to perform distant work while being ill than lower  
11  
12 non-manual employees or manual workers.  
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14  
15 The generally higher absence levels that we found in the health and social work sector are in  
16  
17 accordance with previous studies.[12, 13] Findings from Norway indicated that the higher risk of  
18  
19 sickness absence among those employed in health and social occupations was largely explained by  
20  
21 their unfavourable psychosocial and physical working conditions.[13] A Finnish study also showed  
22  
23 that employees in the combined sector of education, health and social work had poorer health in  
24  
25 terms of a higher risk of hospitalization compared to those in other sectors. This applied to various  
26  
27 disease groups, including musculoskeletal diseases and mental disorders. Furthermore, the risk of  
28  
29 hospitalization at least due to musculoskeletal diseases was higher in the manufacturing sector than  
30  
31 in the trade and knowledge work -related sectors.[31] The present study adds to the literature by  
32  
33 indicating that the higher level of sickness absence in the health and social work sector compared to  
34  
35 other sectors was generally found in both musculoskeletal diseases and mental disorders. However,  
36  
37 our novel findings further indicated that this sector difference was only found among non-manual  
38  
39 employees. Among manual workers, the absence level in musculoskeletal diseases was highest in  
40  
41 the manufacturing sector.  
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47 Our study also indicated that the differences in sickness absence between industrial sectors within  
48  
49 the occupational classes were relatively stable since the mid-2000s. Exceptions included the above  
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51 discussed temporary fluctuations around 2009 and the smaller decrease in absences due to  
52  
53 musculoskeletal diseases in the trade sector compared to other ones within the lower classes. The  
54  
55 more unfavourable trends of the trade sector were not explained by changes in the distribution of  
56  
57 any of the measured socioeconomic factors and employment patterns. More research is needed to  
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1 determine whether e.g. changes in working conditions or types of jobs within the trade sector  
2 contributed to the trends.  
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5  
6 Overall, our findings indicated that the occupational class and industrial sector differences in  
7 sickness absence trends largely depended on the disease causing work disability. In musculoskeletal  
8 diseases, the changes over time varied most. Musculoskeletal diseases may be considered as work-  
9 related and their diagnoses are often symptom-based. Changes in the work or economic conditions  
10 may have affected how particular groups of employees cope with their symptoms and behave while  
11 being ill. In other causes such as circulatory diseases, the decrease in absences was more consistent  
12 across the classes, which may have been related to equality in terms of decreased morbidity and  
13 improved treatment.  
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25 The strengths of this study included nationally representative samples of the Finnish population and  
26 register-based data sets that did not have the problem of missing information due to non-response.  
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28  
29 The rich data comprised longitudinal information on employment and sociodemographic factors as  
30 well as on sickness absence and its diagnostic cause. Furthermore, the very large samples allowed  
31 us to examine cause-specific sickness absence between industrial sectors within different  
32 occupational classes, thereby capturing occupational groups with relatively similar types of jobs.  
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37 Our findings may be generalizable to countries in which the manufacturing sector in particular was  
38 affected by the recession of the late 2000s and in which also the sickness benefit system is relatively  
39 generous.  
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46 There were nevertheless also certain limitations. Our outcome measure was based on national data  
47 on compensated sickness absence spells that begin after a period of ten working days. Sickness  
48 absence spells that did not exceed ten working days were therefore not covered. Moreover, our  
49 outcome measure was based on new onset of sickness absence. The predictors of sickness absence  
50 might be different when examining e.g. the occurrence of short-term spells, the number of spells of  
51 different lengths, or the total number of absence days.[32-36]  
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1 Although our results indicated that other socioeconomic factors and employment patterns partly  
2 explained the occupational class and industrial sector differences in the overall level of cause-  
3 specific sickness absence, they did not appear to explain the varying trends. Factors that were not  
4 measured in this study, such as changes in health, lifestyle, work exposures, and labour market  
5 conditions, were therefore likely to have contributed to the differences in the trends. Sickness  
6 absence trends may have been affected also by changes in national sickness insurance legislation  
7 aiming at enhancing work participation.[37-39]

8 It should be noted that the recession might have led to a larger health inequality between the  
9 employed and non-employed populations than between the different socioeconomic groups among  
10 the employed. Focusing on sickness absence among an employed population may therefore not  
11 have revealed some of the potential effects of the recent economic recession on health and health  
12 inequalities.[40-44]

## 29 CONCLUSIONS

31 The proportion of wage earners with sickness absence lasting more than ten working days decreased  
32 in Finland between 2005 and 2013 in all occupational classes. Overall, the change was smallest  
33 among lower non-manual employees. Occupational class differences in sickness absence trends  
34 nevertheless varied by disease group. There were notable and relatively stable differences in  
35 sickness absence between industrial sectors even when these were examined within particular  
36 occupational classes. Moreover, the association between industrial sector and sickness absence  
37 varied across the occupational classes. At the time of the economic recession of the late 2000s, there  
38 was a temporary decrease in sickness absence due to musculoskeletal diseases specifically among  
39 manual workers employed in the manufacturing sector, i.e. in a segment of wage earners that are  
40 known to have been hit hard by the recession. However, differences in the trends amongst  
41 occupational classes and industrial sectors were not explained by the measured structural changes in  
42 other socioeconomic factors or employment patterns. The complex interplay between occupational  
43 class and industrial sector should be taken into account when tackling problems of work disability.

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10

11  
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13  
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15  
16 contributed to interpretation of the results. TL wrote the first drafts of the article. All authors  
17  
18 discussed and revised the drafts and prepared the final manuscript.  
19  
20

21  
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23  
24

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26  
27 the register data, the authors do not have the permission to share the data. Permissions to use the  
28  
29 register data can be applied from the Social Insurance Institution of Finland  
30  
31 (<http://www.kela.fi/web/en/research-data-requests>), the Finnish Centre for Pensions  
32  
33 (<http://www.etk.fi/en/statistics-2/statistics/producer-of-statistics/>), and Statistics Finland  
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35 ([http://www.stat.fi/meta/tietosuoja/kayttolupa\\_en.html](http://www.stat.fi/meta/tietosuoja/kayttolupa_en.html)).  
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## Figure captions

**Figure 1.** Estimated annual proportion of employees with a new onset of cause-specific (A-H) sickness absence (‰) by occupational class. The panels are presented in different scales; Model 1 (M1): Adjusted for age and gender; Model 2 (M2): Adjusted for age, gender, education, industrial sector, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between occupational class and year: A) M1: 0.000, M2: 0.000, B) M1: 0.000, M2: 0.000, C) M1: 0.000, M2: 0.000, D) M1: 0.099, M2: 0.100, E) M1: 0.035, M2: 0.041, F) M1: 0.000, M2: 0.000, G) M1: 0.449, M2: 0.568, H) M1: 0.021, M2: 0.165.

**Figure 2.** Estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (‰) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

**Figure 3.** Annual risk (ORs and their 95% confidence intervals) of having a new onset of sickness absence due to musculoskeletal diseases and mental disorders by industrial sector (OR=1.00 for the knowledge work sector in each year) among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

## Supplementary material captions

**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (‰) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

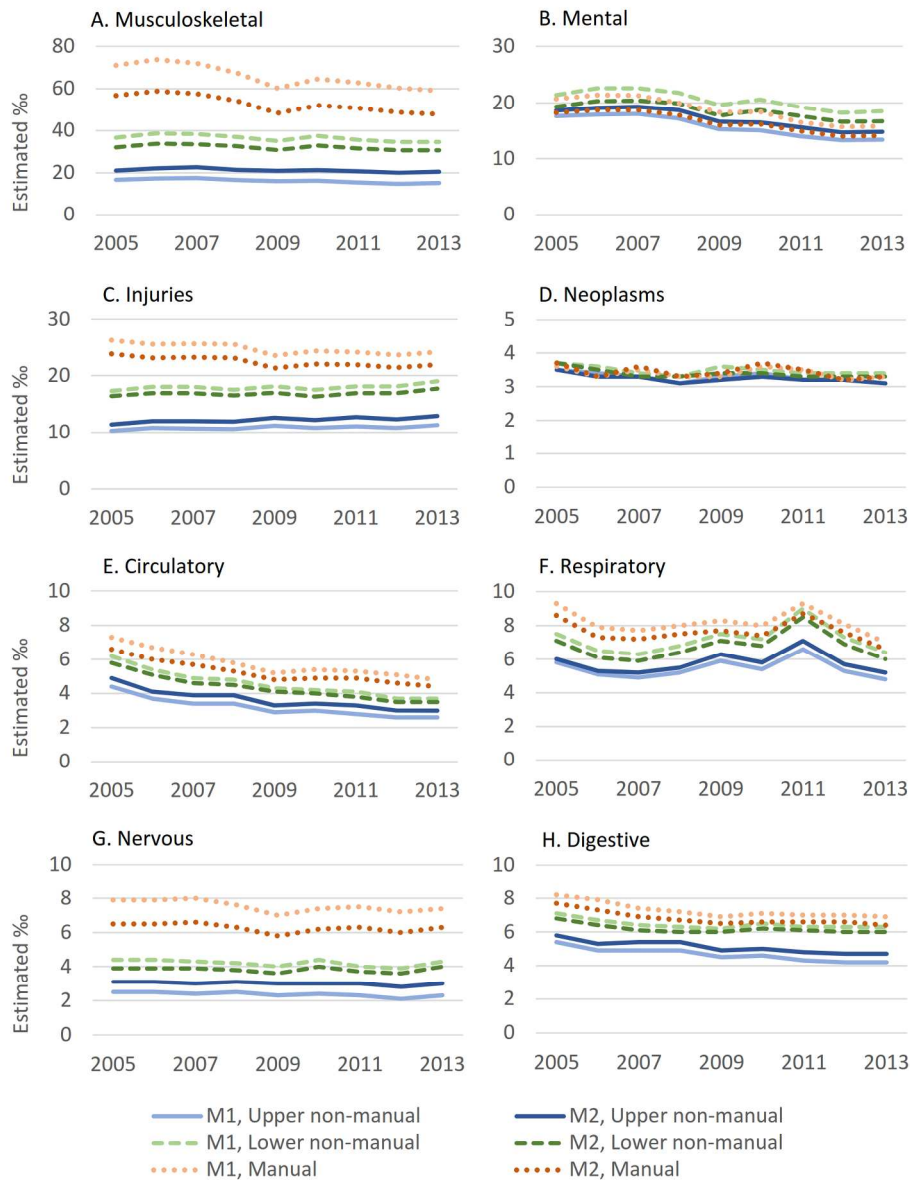


Figure 1

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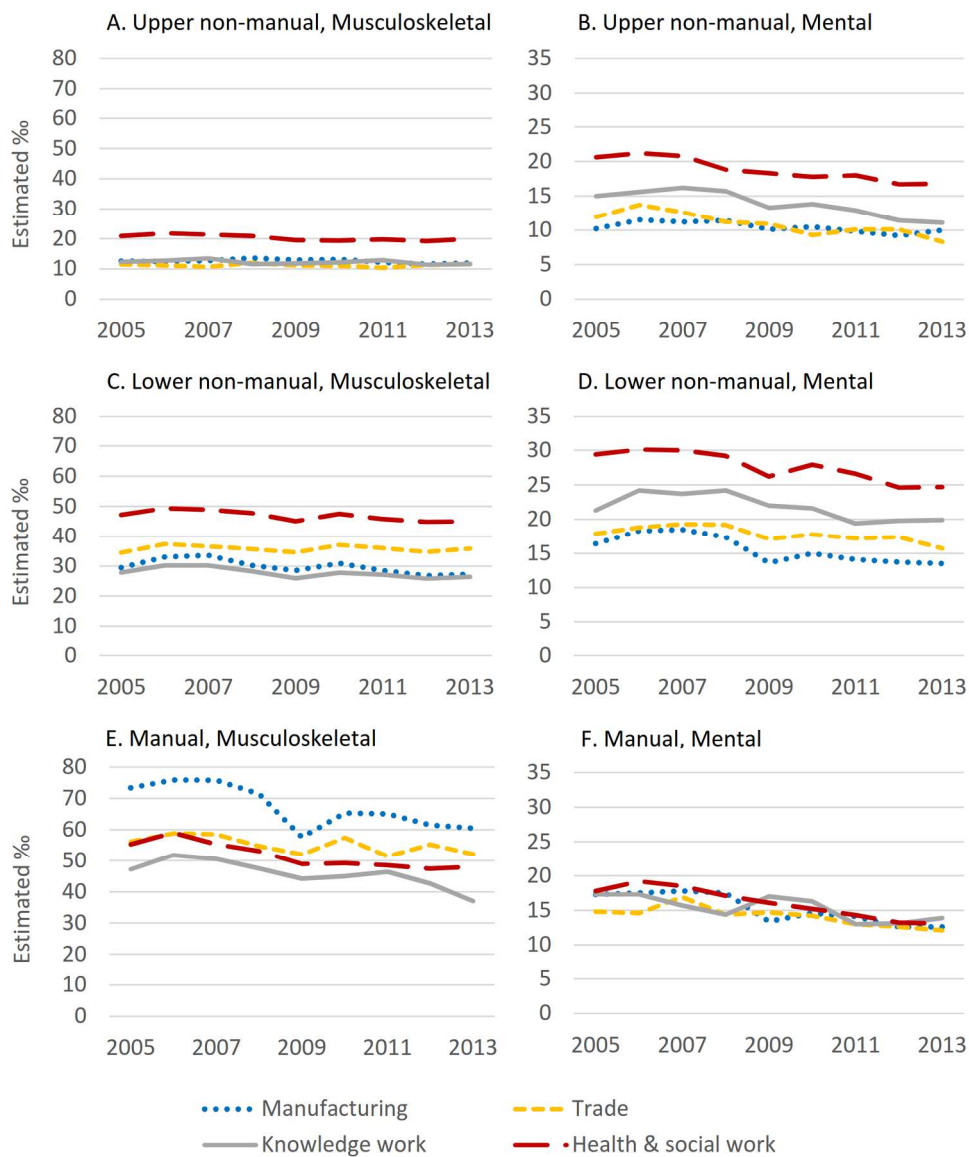


Figure 2

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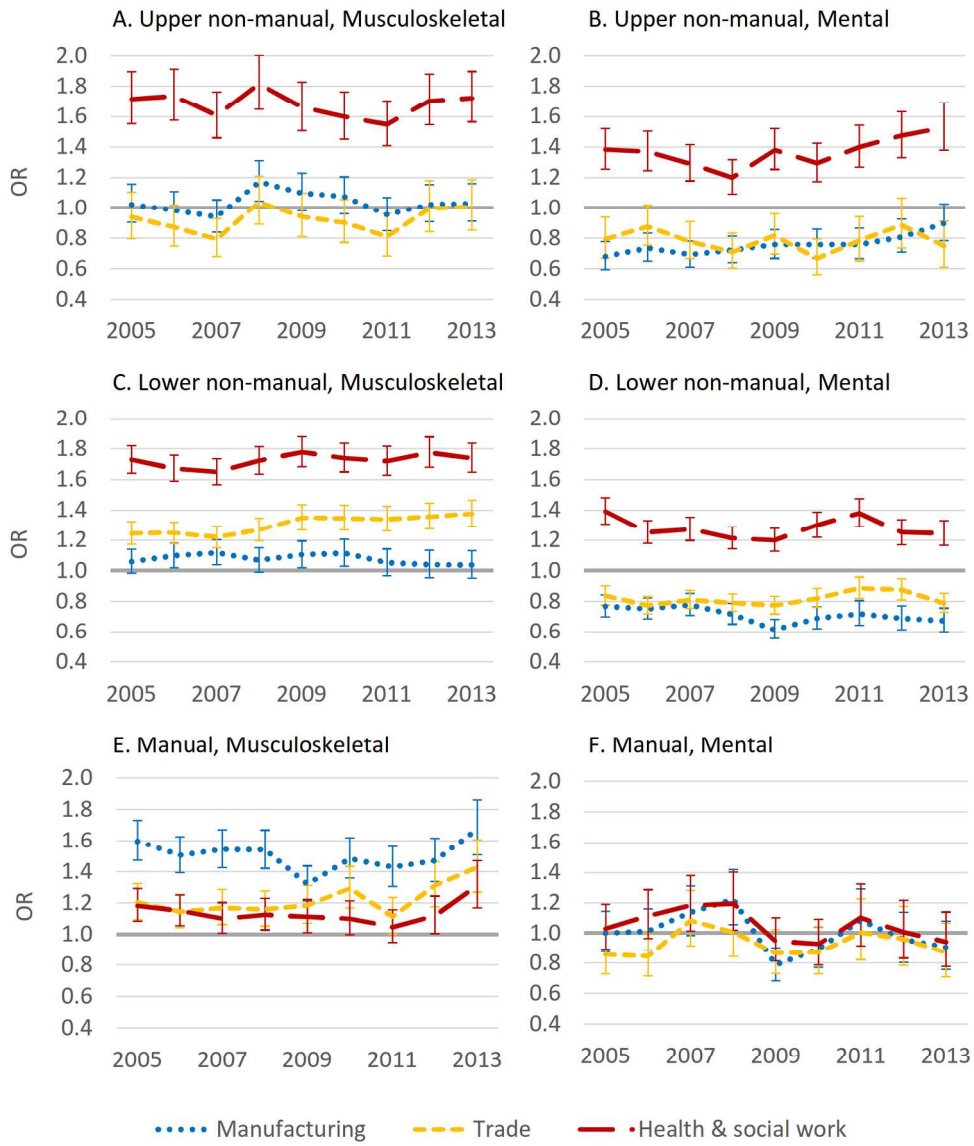


Figure 3

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**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

	Year								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Age									
25-29	12.8	12.9	12.9	13.2	13.3	13.2	13.5	13.4	13.1
30-34	12.8	13.0	13.3	13.7	14.2	14.3	14.5	14.4	14.5
35-39	15.0	14.7	14.3	13.8	13.3	13.4	13.5	13.8	14.2
40-44	16.0	16.0	15.9	15.8	15.6	15.3	14.8	14.5	14.0
45-49	15.8	15.8	15.7	15.6	15.7	15.8	15.7	15.7	15.7
50-54	15.1	15.1	15.3	15.2	15.0	15.0	14.9	14.9	15.0
55-59	12.5	12.6	12.7	12.8	12.9	13.1	13.1	13.4	13.5
Gender									
Men	49.3	49.3	49.3	49.2	48.6	47.9	48.2	48.2	47.9
Women	50.7	50.7	50.7	50.8	51.4	52.1	51.9	51.8	52.1
Education									
Higher tertiary	12.7	13.1	13.3	13.7	14.5	15.0	15.4	15.7	16.1
Lower tertiary	29.7	29.8	29.8	29.8	30.0	30.4	30.4	30.4	30.5
Secondary	41.8	42.2	42.7	43.1	42.8	42.8	43.0	43.2	43.2
Primary	15.9	14.9	14.2	13.5	12.7	11.8	11.3	10.8	10.2
Occupational class									
Upper non-manual	24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Lower non-manual	40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manual	34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Industrial sector									
Manufacturing	20.1	19.6	19.5	19.4	18.8	17.5	17.2	17.0	16.4
Trade	11.2	11.2	11.2	11.2	11.3	11.4	11.4	11.4	11.4
Knowledge work	12.4	12.5	12.5	12.9	13.0	13.1	13.1	13.2	13.2
Health & social work	16.7	16.8	17.0	16.9	17.3	17.8	17.8	18.0	18.5
Other	39.6	39.8	39.8	39.6	39.5	40.2	40.4	40.4	40.5

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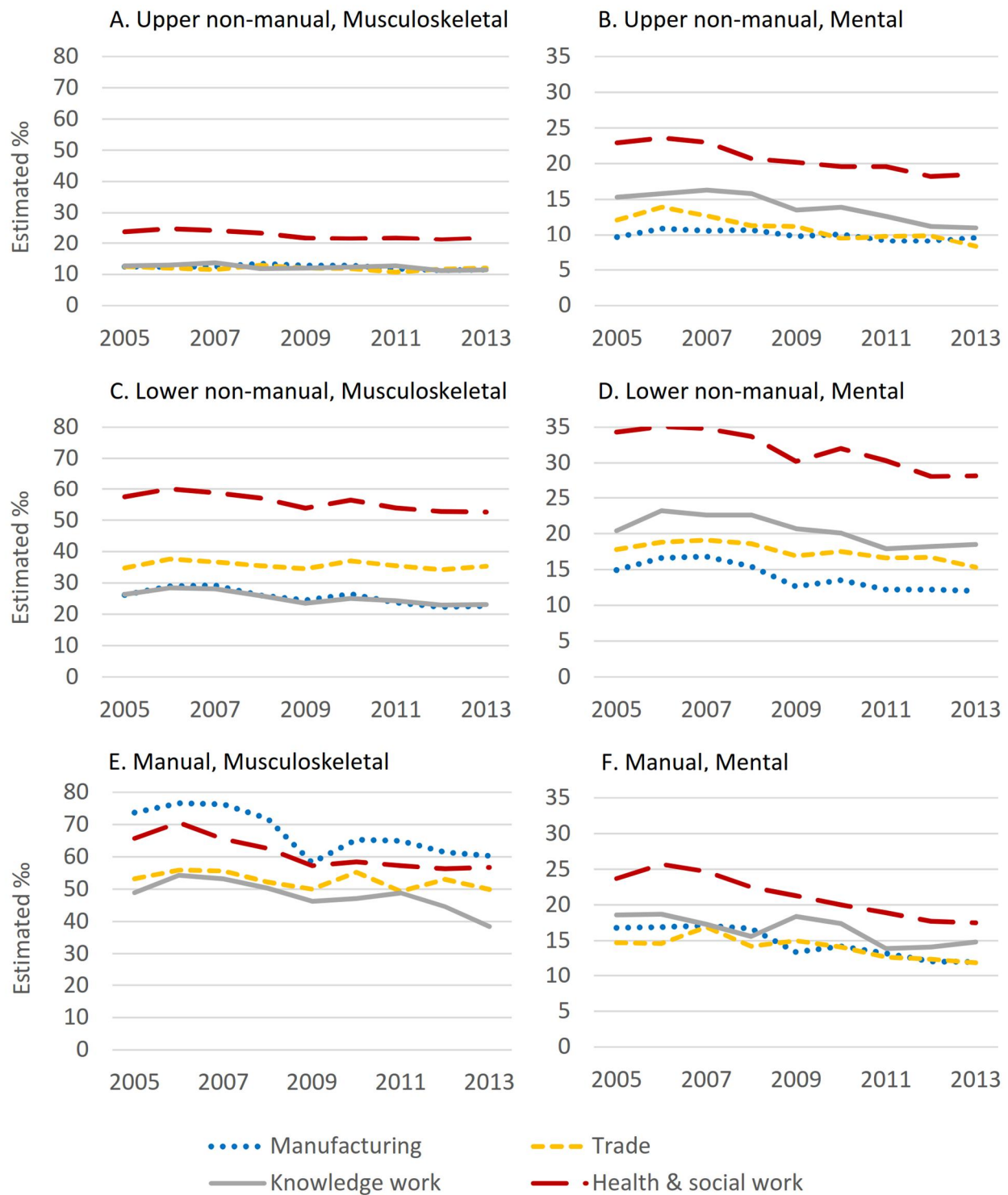
Employment sector										
Private	62.4	62.6	62.6	63.1	63.1	62.8	62.7	62.9	62.6	
Public	32.2	31.8	30.4	29.7	30.2	30.6	30.1	30.3	30.6	
Private and public	4.9	5.1	6.5	6.6	6.3	6.1	6.3	6.1	6.2	
Transition to self-employment	0.5	0.5	0.6	0.6	0.6	0.6	0.9	0.7	0.6	
Income										
Quintile 1 (highest)	17.1	17.7	18.8	19.8	20.2	21.0	21.9	21.8	21.7	
Quintile 2	17.9	18.9	19.2	19.5	20.0	20.8	21.3	21.1	21.4	
Quintile 3	19.2	19.9	19.7	19.6	19.8	20.5	20.5	20.3	20.5	
Quintile 4	22.5	21.9	21.2	20.5	19.9	19.2	18.1	18.4	18.3	
Quintile 5 (lowest)	23.3	21.6	21.1	20.6	20.1	18.4	18.3	18.5	18.1	
Employed time										
Full year	90.5	90.4	90.6	90.8	90.5	91.5	91.4	91.2	91.3	
200-364 days	6.8	7.0	7.1	6.9	6.5	6.1	6.4	6.5	6.3	
1-199 days	2.7	2.6	2.4	2.2	3.0	2.4	2.2	2.3	2.4	
Employment episodes										
1	90.0	89.5	88.2	88.3	89.2	89.3	88.5	88.9	89.1	
2	7.0	7.4	8.5	8.5	7.8	7.7	8.5	8.2	8.0	
3+	3.0	3.0	3.4	3.2	3.1	2.9	3.0	2.9	2.9	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
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**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

	Upper non-manual					Lower non-manual					Manual				
	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All
Age															
25-29	7.7	9.0	12.9	9.5	10.1	12.4	18.3	15.1	11.1	13.7	13.6	21.3	14.2	7.1	14.8
30-34	15.5	14.6	18.6	12.4	15.0	16.5	16.1	14.5	12.2	13.9	13.6	16.4	10.9	7.7	12.9
35-39	19.2	17.1	16.7	13.6	15.7	15.5	15.2	12.7	13.1	13.7	14.0	14.7	11.1	10.3	13.1
40-44	18.9	18.9	15.4	15.6	16.4	15.4	15.2	14.6	15.2	15.2	14.9	14.4	13.5	1.4	14.7
45-49	15.9	17.1	14.5	17.5	16.0	14.3	13.4	15.3	17.2	15.8	15.2	12.8	16.1	17.6	15.5
50-54	12.7	13.3	12.1	17.4	14.5	13.6	11.5	14.7	17.1	15.0	15.5	11.2	17.6	20.9	15.6
55-59	10.3	10.1	9.7	14.0	12.4	12.2	10.2	13.1	14.1	12.9	13.1	9.3	16.6	22.3	13.5
Gender															
Men	78.5	68.5	65.0	18.2	52.0	56.1	37.6	37.9	7.6	30.3	77.8	79.1	65.0	15.4	69.1
Women	21.5	31.6	35.0	81.8	48.0	43.9	62.4	62.1	92.4	69.7	22.2	20.9	35.0	84.6	30.9
Education															
Higher tertiary	38.2	25.2	42.4	45.0	47.7	10.9	3.0	9.1	1.2	4.7	0.4	0.4	1.6	0.6	0.5
Lower tertiary	46.4	46.7	37.6	48.4	37.0	54.2	32.6	51.2	43.4	44.2	6.5	7.8	11.0	6.7	6.9
Secondary	11.2	21.5	16.7	5.8	12.4	27.0	47.2	31.0	49.9	41.6	70.3	68.7	63.9	69.3	67.9
Primary	4.1	6.7	3.4	0.7	3.0	7.9	17.2	8.7	5.5	9.5	22.9	23.0	23.4	23.3	24.7
Employment sector															
Private	96.2	95.6	81.4	14.0	49.0	97.1	96.1	86.2	17.4	56.9	97.6	95.6	66.3	20.4	80.8
Public	0.1	0.2	12.1	72.3	41.4	0.2	0.2	9.9	73.3	36.7	0.1	1.3	27.4	71.2	14.7
Private and public	3.1	3.1	5.6	12.9	8.8	2.4	3.0	3.4	9.0	6.0	1.9	2.3	5.7	8.2	3.8
Transition to self-employment	0.6	1.1	0.9	0.9	0.8	0.4	0.7	0.5	0.3	0.5	0.4	0.8	0.6	0.2	0.7

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Income																
Quintile 1 (highest)	73.3	66.4	56.7	32.6	48.7	28.8	13.0	19.8	2.0	11.7	13.1	5.0	5.5	0.9	8.1	
Quintile 2	15.7	16.1	22.4	21.0	24.0	33.7	14.0	24.6	12.3	18.5	25.6	15.3	15.2	2.5	18.7	
Quintile 3	5.5	7.2	9.5	21.0	12.1	19.4	15.2	24.1	29.5	23.0	27.5	22.9	22.7	8.7	22.5	
Quintile 4	2.6	4.4	5.1	15.3	7.4	10.9	22.3	17.8	33.6	24.9	21.3	28.0	25.8	36.0	23.7	
Quintile 5 (lowest)	3.0	5.9	6.3	10.2	7.9	7.2	35.5	13.6	22.7	21.9	12.5	28.8	30.9	51.9	27.1	
Employed time																
Full year	94.9	93.2	93.6	93.2	93.3	94.3	90.9	93.1	91.5	91.8	92.9	89.8	89.1	81.6	87.9	
200-364 days	3.6	5.0	4.9	5.3	5.2	4.0	6.7	5.0	6.3	5.9	4.9	7.3	7.4	11.0	8.7	
1-199 days	1.5	1.8	1.5	1.5	1.5	1.7	2.4	1.9	2.2	2.3	2.2	2.9	3.5	7.4	3.4	
Employment episodes																
1	94.3	92.9	90.6	82.7	87.2	95.2	92.2	93.1	86.5	89.9	95.0	92.2	88.7	83.0	89.3	
2	4.9	5.8	7.4	12.5	9.3	4.0	6.1	5.6	8.2	7.1	4.2	6.4	8.3	9.0	8.0	
3+	0.8	1.3	2.0	4.8	3.5	0.8	1.7	1.3	5.4	3.0	0.8	1.5	3.1	8.0	2.7	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	



**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any prespecified hypotheses	5, 6
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-10
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-10
Bias	9	Describe any efforts to address potential sources of bias	18, 19
Study size	10	Explain how the study size was arrived at	6, 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9, 10
		(b) Describe any methods used to examine subgroups and interactions	9, 10
		(c) Explain how missing data were addressed	na
		(d) If applicable, explain how loss to follow-up was addressed	na
		(e) Describe any sensitivity analyses	na
<b>Results</b>			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 7
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10, 11
		(b) Indicate number of participants with missing data for each variable of interest	na
		(c) Summarise follow-up time (eg, average and total amount)	na
Outcome data	15*	Report numbers of outcome events or summary measures over time	11, 12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-14
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-14
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	14, 15
<b>Limitations</b>			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).



# BMJ Open

## Cause-specific sickness absence trends by occupational class and industrial sector in the context of recent labour market changes: a Finnish panel data study

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2 **Cause-specific sickness absence trends by occupational class and industrial**  
3 **sector in the context of recent labour market changes: a Finnish panel data**  
4 **study**  
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## ABSTRACT

**Objectives:** We aimed to provide previously unestablished information on population-based differences in cause-specific sickness absence trends between occupational classes and further between four large industrial sectors within the different occupational classes while controlling for other socioeconomic factors and employment patterns. We focused on the period 2005–2013, during which the labour market underwent large economic and structural changes in many countries.

**Design:** Register-based panel data study.

**Setting:** Large representative data sets on Finnish wage earners aged 25–59 years.

**Outcome measure:** Annual risk of sickness absence (> ten working days) based on repeated logistic regression.

**Results:** Between 2005 and 2013, the proportion of employees with sickness absence decreased. Occupational class differences in sickness absence trends varied by disease group. Overall, the decrease in absences was smallest among lower non-manual employees. Sickness absence levels were highest in the health and social work sector and in the manufacturing sector within the non-manual and manual classes, respectively. Absences due to musculoskeletal diseases decreased temporarily during the peak of the economic recession in 2009, particularly in the manufacturing sector within the manual class. The decrease in absences due to musculoskeletal diseases was smallest in the trade sector within the lower occupational classes. Overall, education, income, and employment patterns partly explained the differences in the absence levels, but not in the trends.

**Conclusions:** We found a complex interplay between the associations of occupational class and industrial sector with sickness absence trends. During the economic recession, absences due to musculoskeletal diseases decreased temporarily in a segment of wage earners that are known to have been hit hard by the recession. However, the trend differences were not explained by the

1 measured structural changes in the characteristics of the study population. Both occupational class  
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4 and industrial sector should be taken into account when tackling problems of work disability.  
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### 10 **Strengths and limitations of this study**

- 13 • The large register-based data sets were representative of Finnish wage earners and did not  
14 have the problem of missing information due to non-response.
- 17 • The data had sufficient statistical power for examining cause-specific sickness absence  
18 trends by large industrial sectors within different occupational classes.
- 21 • The rich data included information on various covariates, including education, employment  
22 sector, income, time spent in employment, and the number of employment episodes.
- 25 • The data lacked information on some potentially important covariates such as health status,  
26 lifestyle factors, work exposures, and labour market conditions.
- 29 • The sickness absence outcome was based on national data on compensated spells that begin  
30 after a period of ten working days, thereby excluding shorter spells.  
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## INTRODUCTION

The association of low occupational class with a higher likelihood of sickness absence has been established in many European countries.[1-11] The occupational class differences have been particularly large in absences due to musculoskeletal diseases, and smaller but still notable in most other disease groups. In mental disorders, the absence levels have been similar or even higher among lower non-manual employees than among manual workers.[2, 10]

In addition to occupational class, industrial sector is closely associated with working conditions and the broader work environment, which affect the ability of an individual to perform in his or her own job. A previous study from Denmark indicated that the risk of long-term sickness absence was higher than average in the health care and social services sector and lower than average in the private administration sector, but otherwise the differences between the sectors were small.[12]

Accordingly, a Norwegian study indicated that the risk of long-term sickness absence was higher among women employed in health and social occupations than among the general female employed population.[13] There may also be an important interplay between occupational class and industrial sector; even within a particular occupational class, the types of jobs may vary considerably between different sectors. Previous population-based findings from Denmark[12] and Sweden[14] have shown large differences in long-term sickness absence between particular occupational groups. Variation in sickness absence between industrial sectors within different occupational classes nevertheless remains unclear.

From the start of the millennium, Finland and other European countries have experienced two key labour market changes that may have had varying consequences for the health, work ability, and illness behaviour of individuals in different occupational classes and industrial sectors. Firstly, particular sectors including manufacturing and construction were hit hard by the economic recession of the late 2000s, whereas other sectors such health and social services were less affected.[15] In Finland, the economic recession peaked in 2009. This was the only year in which the change in the GDP was negative (-6.5%). A specific feature for Finland was that there was

1 another decline in the GDP growth after 2011. The manufacturing sector was affected the most: the  
2 number of wage earners employed in this sector decreased by 9.4% between 2008 and 2009, while  
3 the corresponding decrease in the total wage-earner population was 3.8%.[16] Secondly, the labour  
4 market has undergone longer-term structural changes through which employment in non-manual  
5 occupations as well as in the knowledge work and service sectors has increased.[16, 17] These  
6 economic and structural changes are likely to have been associated with changes in the types of jobs  
7 as well as in the work, employment and social conditions of individuals within particular  
8 occupational classes and industrial sectors.  
9

10 Recent economic and structural changes in the labor market may have led to changes in the  
11 associations of occupational class and industrial sector with sickness absence. Previous studies from  
12 Finland indicated that during recent decades, the overall level as well as occupational class  
13 differences in sickness absence have mainly decreased.[9-11] However, the contribution of the  
14 recession of the late 2000s to changes in the occupational class differences in sickness absence  
15 remains unclear. Moreover, information on trends in sickness absence by industrial sector are  
16 altogether lacking. Further, little is known of whether occupational class and industrial sector  
17 differences in sickness absence trends can be attributed to longer-term structural changes in the  
18 labour market, such as those related to educational attainment, income, private versus public sector  
19 employment, or other employment patterns. Information on sickness absence trends and their  
20 explanations would help identify vulnerable groups in order to prevent work disability and extend  
21 working careers.  
22

23 We used large register-based data sets to examine cause-specific sickness absence trends in 2005–  
24 2013 by occupational class and further by industrial sector among the general population of Finnish  
25 wage earners while accounting for other socioeconomic factors and employment patterns. We  
26 thereby aimed to explore whether occupational class and industrial sector differences in cause-  
27 specific sickness absence trends were influenced by changes in the characteristics of the wage-  
28

1 earner population over a period of major economic fluctuations. The more particular research  
2 questions are listed below.  
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7 1. Do the trends in sickness absence due to all causes, musculoskeletal diseases, mental  
8 disorders, neoplasms, circulatory diseases, respiratory diseases, or digestive diseases differ  
9 between occupational classes?  
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13 2. Do the trends in sickness absence due to the two largest disease groups, i.e. musculoskeletal  
14 diseases and mental disorders, vary between four large industrial sectors within different  
15 occupational classes?  
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- 18  
19 3. Are the occupational class and industrial sector differences in cause-specific sickness  
20 absence trends influenced by changes over the study period in education, employment  
21 sector, income, time spent in employment, and the number of employment episodes?  
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## 27 **MATERIAL AND METHODS**

### 28 **Study population**

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31 We used large register-based data sets with 70% nationally representative random samples of the  
32 Finnish working aged population from three cross-sections on the last days of the years 2004, 2007,  
33 and 2010. Each of the cohorts were followed up for three calendar years to cover a nine-year study  
34 period between 2005 and 2013. The data included information on compensated sickness absences  
35 and national pensions obtained from the Social Insurance Institution of Finland, on  
36 sociodemographic factors obtained from the Finnish Longitudinal Employer-Employee Data  
37 (FLEED) of Statistics Finland, and on employment and earnings-related pensions from the Finnish  
38 Centre for Pensions, as also described in our previous study on gender differences in sickness  
39 absence.[18]  
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52 Criteria for being included in the study population were applied separately to each study year. An  
53 individual could thus be excluded in one year and included in others. We restricted the study  
54 population to those aged 25–59 on the last day of the year preceding the study year. We included  
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1 individuals who were employed wage earners according to their main economic activity and  
2 socioeconomic status and did not receive full pensions (full disability pensions, unemployment  
3 pensions, special pensions for farmers, or old-age pensions) before the study year. We also required  
4 that the study person had an ongoing employment period (in the private sector, in the public sector,  
5 or in both, but not in self-employment) and did not have an ongoing compensated sickness absence  
6 spell at the beginning of the study year. The excluded were subsequently either self-employed  
7 (8.7% of the original study population), unemployed (8.0%), retired (14.1%), otherwise non-  
8 employed (9.9%), or on sick leave (0.8%). We allowed for non-employment and self-employment  
9 later during the study year, adjusting for these factors in the analyses. We nevertheless excluded  
10 those who started receiving full pensions (0.2%), emigrated (0.1%), or died (0.05%) during the  
11 study year. Finally, we excluded those who did not live in Finland two years before the end of the  
12 year preceding the study year (0.2%). We did this because we used the population samples from the  
13 end of years 2004, 2007, and 2010 to form the study population in years 2005–2007, 2008–2010,  
14 and 2011–2013, respectively; since the study population in years 2007, 2010, and 2013 by design  
15 lived in Finland two years before, we applied the same inclusion criteria for all of the years.

16 After all exclusions, 74.0% of the remaining individuals were included in the study population in  
17 each of the three consecutive years (calculated among those who fit the age range 25–59 in all three  
18 years). The final study population consisted of around 1.1 million individuals per study year  
19 (Supplementary Table 1).

### 20 **Sickness absence outcome**

21 For permanent Finnish residents, sickness absence is compensated by the Social Insurance  
22 Institution of Finland after a period of ten working days that are typically paid by the employer.[19]  
23 Only sickness absence spells compensated by the Social Insurance Institution are registered at the  
24 national level and included in our data. The outcome of this study was therefore based on sickness  
25 absence that by definition lasted around two calendar weeks or more. We used repeated  
26 dichotomous measures of whether a study person had a new onset of compensated sickness absence



1 in a particular calendar year. The outcome included both full and part-time sickness absence, but in  
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4 Finland the first onset of work disability typically starts with full sickness absence.

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7 Cause-specific sickness absence was classified according to the tenth revision of the International  
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9 Classification of Diseases (ICD-10). We examined six large groups separately, including 1)  
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11 musculoskeletal diseases (diseases of the musculoskeletal system and connective tissue, M00–  
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13 M99), 2) mental disorders (mental and behavioural disorders, F00–F99), 3) neoplasms (C00–D48),  
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15 4) circulatory diseases (I00–I99), 5) respiratory diseases (J00–J99), and 6) digestive diseases (K00–  
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17 K93). We did not examine the large disease group consisting of injuries, because absences due to  
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19 some injuries, including occupational, traffic and military accidents, are covered by other insurers  
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21 than the Social Insurance Institution of Finland and therefore not included in our data.  
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### 25 **Occupational class and industrial sector**

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27 Occupational class and industrial sector were based on information measured in the year preceding  
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29 each study year and categorized according to classifications by Statistics Finland.[20] Occupational  
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31 class consisted of categories 1) upper non-manual, 2) lower non-manual, and 3) manual.  
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35 Industrial sector included the following categories: 1) manufacturing (manufacturing, mining and  
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37 quarrying), 2) trade (wholesale and retail trade; repair of motor vehicles and motorcycles), 3)  
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39 knowledge work (information and communication; financial and insurance activities; real estate  
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41 activities; professional, scientific and technical activities), 4) human health and social work  
42  
43 activities, and 5) other (agriculture, forestry and fishing; electricity, gas, steam and air conditioning  
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45 supply; water supply; sewerage, waste management and remediation activities; construction;  
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47 transportation and storage; accommodation and food service activities; administrative and support  
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49 service activities; public administration and defence; compulsory social security; education; arts,  
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51 entertainment and recreation; other service activities; activities of households as employers;  
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53 undifferentiated goods- and services-producing activities of households for own use; activities of  
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55 extraterritorial organisations and bodies; industry unknown). This classification was from year  
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1 2008. Until 2007, the classification was based on an older version from year 2002, but virtually  
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3 equivalent main categories listed above could be constructed using a reclassification code provided  
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5 by Statistics Finland.  
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9 When examining industrial sectors within the three occupational classes, we only show results for  
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11 the four large industrial sectors 1–4. The category “other” consisted of heterogeneous smaller  
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13 sectors which could not be examined separately due to small number of events.  
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### 16 **Covariates**

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18 We examined sociodemographic factors and employment patterns as covariates. Age was divided  
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20 into 5-year groups. Education and income were based on information measured in the year  
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22 preceding each study year. Education consisted of categories 1) higher tertiary (Master's or  
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24 equivalent level, or higher), 2) lower tertiary (Bachelor's or equivalent level), 3) secondary, and 4)  
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26 primary. Tertiary education was divided into two levels, because the proportion of those with higher  
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28 tertiary education in particular increased during the study period (Supplementary Table 1). Income  
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30 consisted of both wage and capital income of the individual. It was inflation-corrected and then  
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32 divided into quintiles across the study years.  
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37 Employment patterns were measured during each study year. Employment sector was classified as  
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39 1) private, 2) public, 3) private and public, and 4) transition to self-employment. Time spent in  
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41 employment was divided into 1) full year, 2) 200–364 days, and 3) 1–199 days. The cut-point of  
42  
43 200 days was arbitrarily chosen to define those who were employed most of the year. The number  
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45 of employment episodes was divided into 1) one, 2) two, and 3) three or more.  
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### 48 **Statistical methods**

49  
50 We used generalized estimation equations (GEE) based on repeated logistic regression to estimate  
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52 the annual risk of having a new onset of compensated all-cause and cause-specific sickness absence  
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54 in 2005–2013. The GEE models account for the within-individual correlation between repeated  
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1 measurements in the three different samples followed up during periods 2005–2007, 2008–2010, or  
2 2011–2013.  
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6 Using margins derived from the logistic GEE models, we plotted trajectories of estimated  
7 proportions (‰) of employees with sickness absence including interactions of occupational class  
8 and industrial sectors within the occupational classes with categorical year. Estimated proportions  
9 demonstrate the magnitude and direction of changes in the level of sickness absence among  
10 different groups, which would not be revealed solely on the basis of information on changes in the  
11 differences between the groups. Analyses of occupational class differences were performed in each  
12 of the six disease groups. Analyses of differences between industrial sectors within the different  
13 occupational classes were performed in the two largest disease groups, i.e. musculoskeletal diseases  
14 and mental disorders. We adjusted for the annually measured covariates holding them at their mean  
15 level when plotting the trajectories.  
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29 Derived from the same GEE models, we also calculated relative differences between industrial  
30 sectors within the different occupational classes. We used those employed in the knowledge work  
31 sector as the reference group, for which the odds ratio (OR) of sickness absence was held at 1.00 in  
32 each year.  
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39 We pooled men and women, adjusting for gender in the analyses. Even though the overall level of  
40 sickness absence was much higher among the female than the male study population, changes over  
41 time were relatively similar among the genders especially after accounting for their differential  
42 occupational and sectoral distributions.[18]  
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## 48 **RESULTS**

### 49 **Characteristics of the study population**

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51 Over the study period between 2005 and 2013, the proportion of manual workers decreased  
52 especially in the manufacturing sector, but also in the health and social work sector (Table 1). The  
53 proportion of non-manual employees increased. Among upper non-manual employees, the increase  
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was largest in the knowledge work sector. Among lower non-manual employees, the proportion increased in the health and social work sector and decreased in the manufacturing sector. Annual distributions of the study population by all background characteristics are presented in Supplementary Table 1. Average distributions over the whole study period are presented also separately for those employed in different industrial sectors within different occupational classes in Supplementary Table 2.

**Table 1.** Annual distribution (%) of the study population over the study period by industrial sectors across different occupational classes.

Occupational class	Year									
	Industrial sector	2005	2006	2007	2008	2009	2010	2011	2012	2013
Upper non-manual		24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Manufacturing		3.1	3.3	3.5	3.5	3.7	3.6	3.5	3.5	3.3
Trade		1.3	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.3
Knowledge work		5.4	5.6	5.8	6.0	6.2	6.3	6.3	6.4	6.2
Health & social work		2.9	2.9	2.9	2.9	3.0	3.1	3.1	3.2	3.3
Other		11.6	11.9	11.8	11.8	12.0	12.4	11.6	11.7	11.9
Lower non-manual		40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manufacturing		4.4	4.0	4.0	4.0	3.9	3.7	3.5	3.4	3.4
Trade		7.5	7.5	7.5	7.5	7.7	7.8	8.0	8.0	7.9
Knowledge work		6.0	5.8	5.7	5.9	5.8	5.8	5.9	6.0	6.2
Health & social work		11.6	11.7	11.9	12.0	12.4	12.9	12.9	13.2	13.5
Other		11.3	11.2	11.1	10.9	10.9	11.1	12.4	12.2	12.1
Manual		34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Manufacturing		12.5	12.3	12.1	11.9	11.3	10.3	10.3	10.2	9.8
Trade		2.3	2.2	2.2	2.2	2.2	2.1	2.2	2.1	2.2
Knowledge work		1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.8
Health & social work		2.3	2.2	2.1	2.0	1.9	1.8	1.8	1.6	1.6
Other		16.7	16.8	16.9	16.9	16.6	16.7	16.5	16.6	16.5
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

### Sickness absence trends by occupational class

Upper non-manual employees had the lowest and manual workers the highest overall level of sickness absence (Table 2). Among the total study population, the age- and gender-adjusted proportion of employees with any sickness absence decreased from 127.6‰ in 2005 to 108.6‰ in 2013. Until 2009, the annual decrease was largest among manual workers. Between 2009 and 2010, sickness absence increased, but only among manual workers and lower non-manual employees.

After 2010, the decrease in sickness absence continued. Overall, the decrease in sickness absence was smallest among lower non-manual employees.

**Table 2.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of all-cause sickness absence (‰ and 95% CI) and the annual change (%) over particular years by occupational class.

Year	Occupational class			
	Upper non-manual	Lower non-manual	Manual	All
2005	80.8 (79.8–81.8)	120.4 (119.5–121.3)	168.6 (167.4–169.8)	127.6 (127.0–128.3)
2006	79.6 (78.6–80.6)	121.4 (120.5–122.3)	168.6 (167.3–169.8)	127.4 (126.8–128.1)
2007	78.6 (77.6–79.6)	118.6 (117.7–119.5)	166.0 (164.8–167.2)	124.9 (124.3–125.5)
2008	75.4 (74.4–76.3)	115.6 (114.7–116.4)	157.7 (156.5–158.9)	119.6 (119.0–120.2)
2009	72.8 (71.9–73.8)	112.2 (111.3–113.1)	146.2 (145.0–147.4)	113.5 (112.9–114.1)
2010	72.9 (71.9–73.8)	115.2 (114.3–116.1)	152.0 (150.7–153.2)	116.1 (115.5–116.7)
2011	70.8 (69.9–71.7)	112.2 (111.3–113.1)	147.6 (146.3–148.8)	112.9 (112.3–113.5)
2012	67.3 (66.4–68.2)	108.9 (108.0–109.8)	143.3 (142.1–144.5)	109.1 (108.5–109.7)
2013	67.5 (66.6–68.4)	108.8 (107.9–109.6)	142.1 (140.9–143.3)	108.6 (108.0–109.2)
Annual % change				
2005-2009	-2.5	-1.7	-3.3	-2.8
2009-2010	0.1	2.7	4.0	2.3
2010-2013	-2.5	-1.9	-2.2	-2.2

The occupational class differences in sickness absence varied by disease group in terms of both the overall level and time trends (Figure 1). In terms of the overall level, the differences were particularly large in musculoskeletal diseases (panel A) and negligible in neoplasms (panel C). In mental disorders (panel B), the level was highest among lower non-manual employees.

In terms of trends, the decrease in absences due to musculoskeletal diseases (panel A) was mainly restricted to manual workers, leading to decreasing class differences particularly until 2009. In mental disorders (panel B) and digestive diseases (panel F), the decrease in absences was slightly smaller among lower non-manual employees than among the other classes. In respiratory diseases (panel E), the overall decreasing trend was interrupted by an increase in absences between 2007 and 2011, most notably so among lower non-manual employees. In circulatory diseases (panel D),

1 absences decreased over the study period with no clear differences between the classes. In  
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3  
4 neoplasms (panel C), the changes over time were relatively small.

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7 Adjustment for other socioeconomic factors and employment patterns attenuated the occupational  
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9 class differences in sickness absence levels, but it had little effect on the varying trends between the  
10  
11 classes (Figure 1, model 2 compared to model 1).

### 12 13 14 **Sickness absence trends by industrial sectors within occupational classes**

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16 We examined age- and gender-adjusted (Supplementary Figure 1) as well as fully adjusted (Figure  
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18 2) annual proportions of cause-specific sickness absence by industrial sectors within the three  
19  
20 occupational classes. Although adjustment for socioeconomic factors and employment patterns  
21  
22 attenuated the industrial sector differences in the overall absence levels, it had little influence on the  
23  
24 varying trends (Figure 2 compared to Supplementary Figure 1). All further results are therefore  
25  
26 based on the fully adjusted models.

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30 Among upper (Figures 2 and 3, panels A and B) and lower (panels C and D) non-manual  
31  
32 employees, the overall level of sickness absence due to both musculoskeletal diseases and mental  
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34 disorders was highest in the health and social work sector. Among manual workers, the absence  
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36 level in musculoskeletal diseases (panel E) was highest in the manufacturing sector, whereas in  
37  
38 mental disorders (panel F) there was no consistent variation between the sectors.

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42 Among lower non-manual employees (Figure 2, panel C) and manual workers (panel E), the  
43  
44 decrease in absences due to musculoskeletal diseases was smaller in the trade sector than in the  
45  
46 other sectors. As a result, the excess risk in the trade sector compared to the reference group of  
47  
48 knowledge work increased over the study period (Figure 3, panels C and E). The temporary  
49  
50 decrease in absences due to musculoskeletal diseases around year 2009 was particularly large  
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52 among manual workers (Figure 2, panel E) in the manufacturing sector, which led to a temporary  
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54 decrease in the excess risk found in this sector (Figure 3, panel E). Also in mental disorders, there  
55  
56 were corresponding but smaller temporary decreases around year 2009 in the manufacturing sector  
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1 among lower non-manual employees (Figures 2 and 3, panel D) and manual workers (panel F).  
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3 Furthermore, there was no decrease over the study period in absences due to mental disorders  
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5 among upper non-manual employees (Figure 2, panel B) in the manufacturing sector. The absence  
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7 level was originally lowest in this sector, but by the end of the study period, the reduced risk  
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9 compared to the reference group of knowledge work disappeared (Figure 3, panel D). Otherwise,  
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11 the differences in sickness absence between industrial sectors remained relatively stable over the  
12  
13 study period.  
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## 16 17 **DISCUSSION**

18  
19 We used large register-based data sets on the general population of Finnish wage earners in order to  
20  
21 provide novel information on occupational class and industrial sector differences in cause-specific  
22  
23 sickness absence trends. We accounted for the potential influence of changes in other  
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25 socioeconomic factors and employment patterns on the varying trends. Although both occupational  
26  
27 and sectoral differences in sickness absence have been previously examined,[1-14] our study is, to  
28  
29 our knowledge, the first one to examine differences in sickness absence between industrial sectors  
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31 within particular occupational classes.  
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35 We found that the proportion of employees with sickness absence lasting more than ten working  
36  
37 days generally decreased between 2005 and 2013 in all of the examined occupational classes. All in  
38  
39 all, the change was smallest among lower non-manual employees. Upper non-manual employees  
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41 had the lowest and manual workers the highest overall level of sickness absence. The occupational  
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43 class differences in the overall absence levels were particularly large in musculoskeletal diseases. In  
44  
45 this disease group, the decrease in absences nevertheless restricted to manual workers, leading to a  
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47 reduction in the class differences over time. In mental disorders, in contrast, the absence level was  
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49 highest and the decrease over time smallest among lower non-manual employees. This led to  
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51 increasing class differences over time. Also in respiratory and digestive diseases, the decreases over  
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53 time were smallest among lower non-manual employees. In circulatory diseases, absences  
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1 decreased in all occupational classes, whereas in neoplasms, the changes over time were altogether  
2 small.  
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6 Looking at the two largest disease groups, i.e. musculoskeletal diseases and mental disorders, we  
7 found further variation in sickness absence between four large industrial sectors despite the fact that  
8 these were examined within particular occupational classes. Among non-manual employees, the  
9 overall absence levels were highest in the health and social work sector. Among manual workers,  
10 the level in musculoskeletal diseases was highest in the manufacturing sector, where a notable  
11 temporary decrease in absences nevertheless occurred during the peak of the economic recession in  
12 2009. Among manual workers and lower non-manual employees, the decrease in absences due to  
13 musculoskeletal diseases was smallest in the trade sector.  
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25 The contribution of the recession of the late 2000s to changes in the occupational class differences  
26 in sickness absence has not been clear. A previous study on municipal employees in the 1990s  
27 indicated that occupational class differences in the number of new all-cause sickness absence spells  
28 lasting over three days were smaller in the recession years than in the following period of economic  
29 growth.[3] Accordingly, we found that the class differences were smallest in 2009, i.e. during the  
30 peak of the more recent economic recession. Moreover, we found that changes in the class  
31 differences around the time of the recession were largest in musculoskeletal diseases. We also  
32 found that the temporary sharp decline in absences in 2009 was most pronounced among manual  
33 workers employed in the manufacturing sector. This was the group in our data for which  
34 employment decreased most around the time of the recession. In addition to decreases in  
35 musculoskeletal morbidity and physically demanding work, it is thus likely that the recession itself  
36 was a driving factor behind the decline in sickness absence, especially among manual workers  
37 employed in the manufacturing sector. Employees who were strongly affected by labour market  
38 insecurity and the threat of unemployment may have been less willing to be absent from work  
39 despite their health problems.[1, 3, 21-23] It is also possible that during the recession, affected  
40 groups of employees had stronger ill-health-related selection out of employment.[24-26] The  
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1 decline in sickness absence during the recession could thus have been attributable to excess  
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3 employment exit among individuals with a higher likelihood of sickness absence.[27]  
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7 Our finding on the smaller decrease among lower non-manual employees in sickness absence due to  
8  
9 mental, respiratory, and digestive diseases was not explained by changes in the distribution of  
10  
11 factors that were measured in this study, including education, income, and employment patterns.  
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13 The smaller decrease in sickness absence among lower non-manual employees may therefore have  
14  
15 been related to unobserved unfavourable changes in their work environment such as increased  
16  
17 psychosocial demands during the period of economic downturn. It may also have been related to  
18  
19 labour market changes that reduced sickness absence in the other two occupational classes.  
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21 However, according to previous findings from Finland, trends in job quality appear to have been  
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23 relatively similar between occupational classes over our study period.[28] Other findings  
24

25 nevertheless indicated polarization in the labour market of Finland and other Nordic countries  
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27 between the mid-1990s and mid-2000s, which was interpreted as partly relating to technological  
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29 advances in the period. The proportion of occupations at both the top and the bottom ends of the  
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31 wage distribution increased: engineering professionals and other professionals at the top level and  
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33 personal and protective services at the bottom level became more common. Accordingly, the  
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35 proportion of occupations at the intermediate level of the wage distribution decreased mainly due to  
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37 a reduction in office clerks, i.e. routine non-manual employees.[29]. Corresponding changes may  
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39 have occurred in our study period and affected the job distributions within the occupational classes.  
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42 A further notable change in the Finnish labour market is that the proportion of employees  
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44 performing distant work increased from 10% in 2003 to 20% in 2013.[30] This may have  
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46 contributed to the decrease in sickness absence among particular groups of employees. It is likely  
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48 that upper non-manual employees are more able to perform distant work while being ill than lower  
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50 non-manual employees or manual workers.  
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55 The generally higher absence levels that we found in the health and social work sector are in  
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57 accordance with previous studies.[12, 13] Findings from Norway indicated that the higher risk of  
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1 sickness absence among those employed in health and social occupations was largely explained by  
2 their unfavourable psychosocial and physical working conditions.[13] A Finnish study also showed  
3 that employees in the combined sector of education, health and social work had poorer health in  
4 terms of a higher risk of hospitalization compared to those in other sectors. This applied to various  
5 disease groups, including musculoskeletal diseases and mental disorders. Furthermore, the risk of  
6 hospitalization at least due to musculoskeletal diseases was higher in the manufacturing sector than  
7 in the trade and knowledge work -related sectors.[31] The present study adds to the literature by  
8 indicating that the higher level of sickness absence in the health and social work sector compared to  
9 other sectors was generally found in both musculoskeletal diseases and mental disorders. However,  
10 our novel findings further indicated that this sector difference was only found among non-manual  
11 employees. Among manual workers, the absence level in musculoskeletal diseases was highest in  
12 the manufacturing sector.

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Our study also indicated that the differences in sickness absence between industrial sectors within  
the occupational classes were relatively stable since the mid-2000s. Exceptions included the above  
discussed temporary fluctuations around 2009 and the smaller decrease in absences due to  
musculoskeletal diseases in the trade sector compared to other ones within the lower classes. The  
more unfavourable trends of the trade sector were not explained by changes in the distribution of  
any of the measured socioeconomic factors and employment patterns. More research is needed to  
determine whether e.g. changes in working conditions or types of jobs within the trade sector  
contributed to the trends.

Overall, our findings indicated that the occupational class and industrial sector differences in  
sickness absence trends largely depended on the disease causing work disability. In musculoskeletal  
diseases, the changes over time varied most. Musculoskeletal diseases may be considered as work-  
related and their diagnoses are often symptom-based. Changes in the work or economic conditions  
may have affected how particular groups of employees cope with their symptoms and behave while  
being ill. In other causes such as circulatory diseases, the decrease in absences was more consistent

1 across the classes, which may have been related to equality in terms of decreased morbidity and  
2 improved treatment.  
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6 The strengths of this study included nationally representative samples of the Finnish population and  
7 register-based data sets that did not have the problem of missing information due to non-response.  
8

9 The rich data comprised longitudinal information on employment and sociodemographic factors as  
10 well as on sickness absence and its diagnostic cause. Furthermore, the very large samples allowed  
11

12 us to examine cause-specific sickness absence between industrial sectors within different  
13 occupational classes, thereby capturing occupational groups with relatively similar types of jobs.  
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15 Our findings may be generalizable to countries in which the manufacturing sector in particular was  
16 affected by the recession of the late 2000s and in which also the sickness benefit system is relatively  
17 generous.  
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27 There were nevertheless also certain limitations. Our outcome measure was based on national data  
28 on compensated sickness absence spells that begin after a period of ten working days. Sickness  
29 absence spells that did not exceed ten working days were therefore not covered. Moreover, our  
30 outcome measure was based on new onset of sickness absence. The predictors of sickness absence  
31 might be different when examining e.g. the occurrence of short-term spells, the number of spells of  
32 different lengths, or the total number of absence days.[32-36]  
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41 Although our results indicated that other socioeconomic factors and employment patterns partly  
42 explained the occupational class and industrial sector differences in the overall level of cause-  
43 specific sickness absence, they did not appear to explain the varying trends. Factors that were not  
44 measured in this study, such as changes in health, lifestyle, work exposures, and labour market  
45 conditions, were therefore likely to have contributed to the differences in the trends. Sickness  
46 absence trends may have been affected also by changes in national sickness insurance legislation  
47 aiming at enhancing work participation.[37-39]  
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1 It should be noted that the recession might have led to a larger health inequality between the  
2 employed and non-employed populations than between the different socioeconomic groups among  
3 the employed. Focusing on sickness absence among an employed population may therefore not  
4 have revealed some of the potential effects of the recent economic recession on health and health  
5 inequalities.[40-44]  
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## 13 CONCLUSIONS

14  
15 The proportion of wage earners with sickness absence lasting more than ten working days decreased  
16 in Finland between 2005 and 2013 in all occupational classes. Overall, the change was smallest  
17 among lower non-manual employees. Occupational class differences in sickness absence trends  
18 nevertheless varied by disease group. There were notable and relatively stable differences in  
19 sickness absence between industrial sectors even when these were examined within particular  
20 occupational classes. Moreover, the association between industrial sector and sickness absence  
21 varied across the occupational classes. At the time of the economic recession of the late 2000s, there  
22 was a temporary decrease in sickness absence due to musculoskeletal diseases specifically among  
23 manual workers employed in the manufacturing sector, i.e. in a segment of wage earners that are  
24 known to have been hit hard by the recession. However, differences in the trends amongst  
25 occupational classes and industrial sectors were not explained by the measured structural changes in  
26 other socioeconomic factors or employment patterns. The complex interplay between occupational  
27 class and industrial sector should be taken into account when tackling problems of work disability.  
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56 designed the study. SS and TL prepared the data for analyses. TL conducted the statistical analyses.  
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1 TL, SS, EVJ, and KHP contributed to interpretation of the results. TL wrote the first drafts of the  
2 article. TL, SS, EVJ, and KHP discussed and revised the drafts and prepared the final manuscript.  
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7 **Competing interests:** None declared.  
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9  
10 **Ethics approval:** The researchers used fully anonymous register data. Research using such data  
11 does not need to undergo review by an ethics committee according to Finnish legislation. Statistics  
12 Finland linked its data to those of the Social Insurance Institution of Finland and the Finnish Centre  
13 for Pensions, after which the data were anonymized and stored by Statistics Finland. The  
14 researchers analyzed the anonymous data using a remote access system. All output extracted from  
15 the system was approved by Statistics Finland to ensure compliance with data protection  
16 regulations. The data can only be accessed by the individual researchers who have obtained  
17 permission from each of the administrative sources providing the data.  
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28 **Data sharing statement:** Due to data protection regulations of the administrative sources providing  
29 the register data, the authors do not have the permission to share the data. Permissions to use the  
30 register data can be applied from the Social Insurance Institution of Finland  
31 (<http://www.kela.fi/web/en/research-data-requests>), the Finnish Centre for Pensions  
32 (<http://www.etk.fi/en/statistics-2/statistics/producer-of-statistics/>), and Statistics Finland  
33 ([http://www.stat.fi/meta/tietosuoja/kayttolupa\\_en.html](http://www.stat.fi/meta/tietosuoja/kayttolupa_en.html)).  
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## Figure captions

**Figure 1.** Estimated annual proportion of employees with a new onset of cause-specific (A-F) sickness absence (%) by occupational class. The panels are presented in different scales; Model 1 (M1): Adjusted for age and gender; Model 2 (M2): Adjusted for age, gender, education, industrial sector, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between occupational class and year: A) M1: 0.000, M2: 0.000, B) M1: 0.000, M2: 0.000, C) M1: 0.099, M2: 0.100, D) M1: 0.035, M2: 0.041, E) M1: 0.000, M2: 0.000, F) M1: 0.021, M2: 0.165.

**Figure 2.** Estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

**Figure 3.** Annual risk (ORs and their 95% confidence intervals) of having a new onset of sickness absence due to musculoskeletal diseases and mental disorders by industrial sector (OR=1.00 for the knowledge work sector in each year) among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. Adjusted for age, gender, education, employment sector, income, time spent in employment, and the number of employment episodes; P-values for the interaction between industrial sector and year: A) 0.550, B) 0.053, C) 0.014, D) 0.001, E) 0.000, F) 0.000.

## Supplementary material captions

**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

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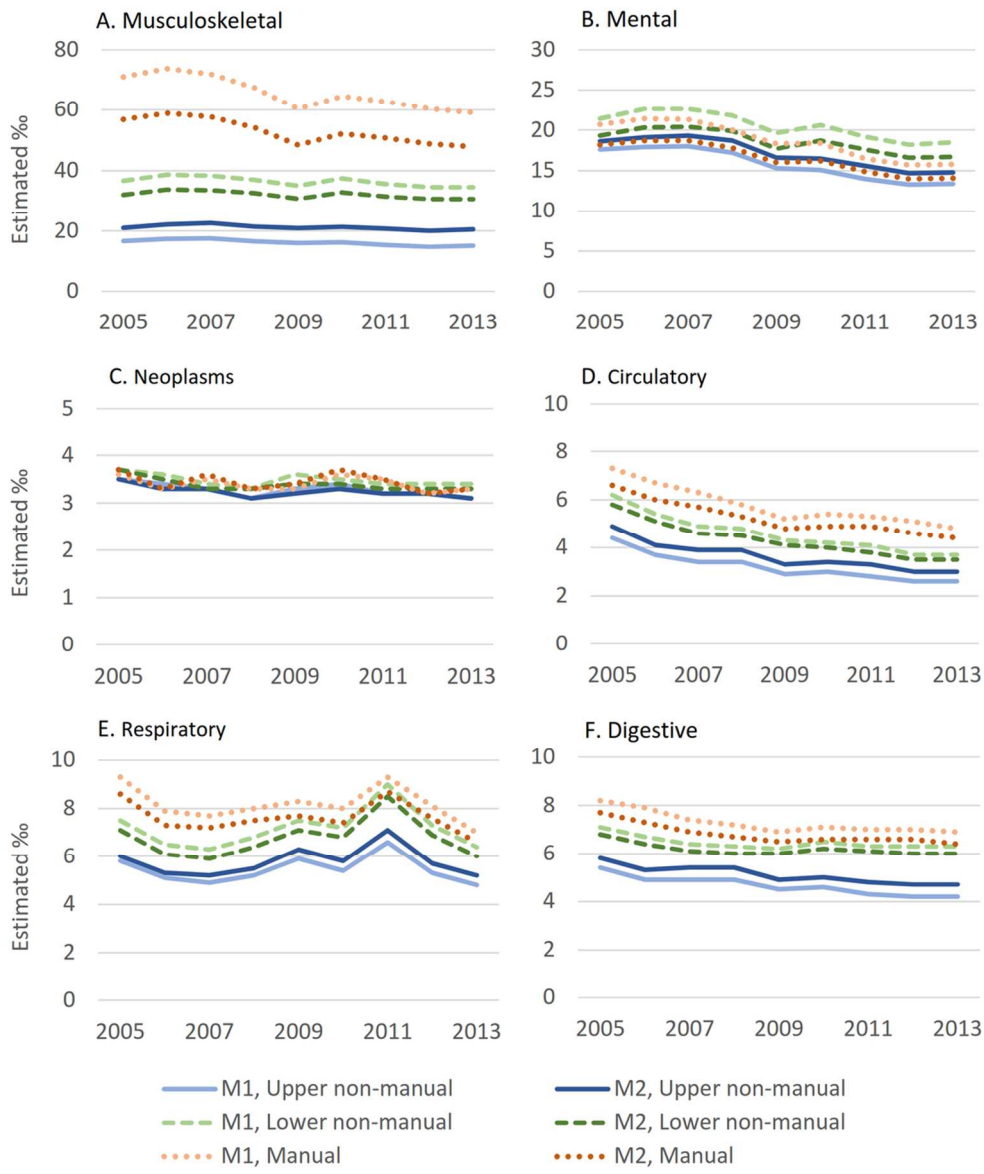


Figure 1

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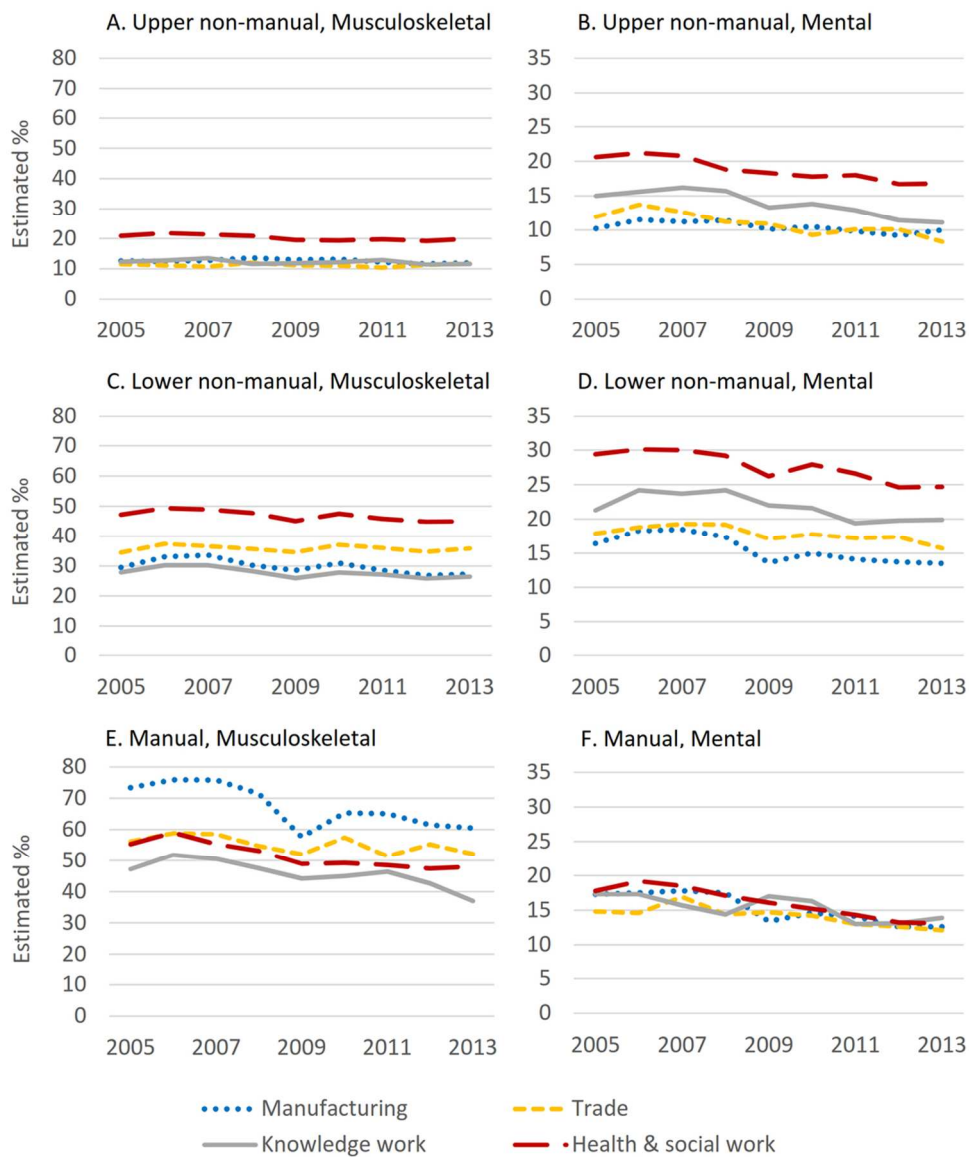


Figure 2

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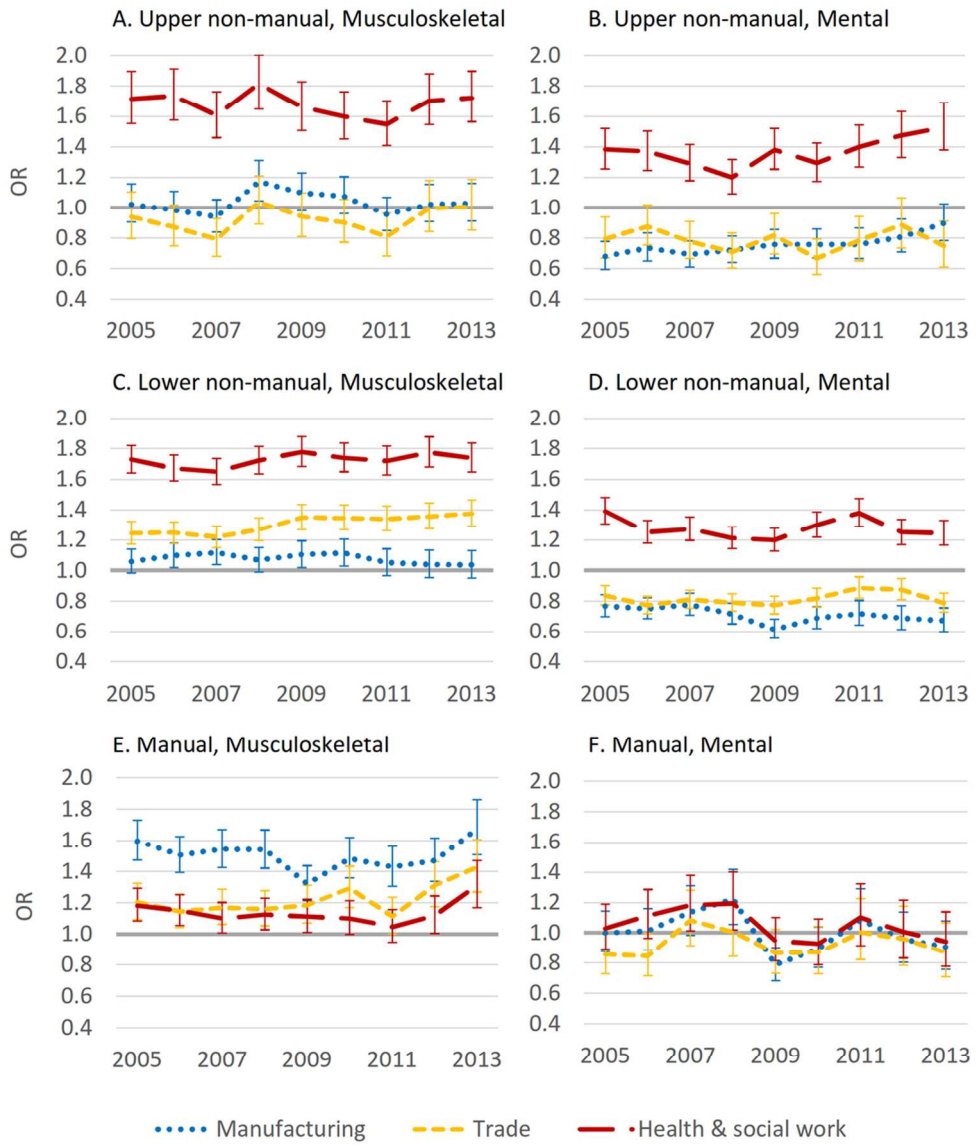


Figure 3

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**Supplementary Table 1.** Annual distribution (%) of the study population over the study period by background characteristics.

	Year								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Age									
25-29	12.8	12.9	12.9	13.2	13.3	13.2	13.5	13.4	13.1
30-34	12.8	13.0	13.3	13.7	14.2	14.3	14.5	14.4	14.5
35-39	15.0	14.7	14.3	13.8	13.3	13.4	13.5	13.8	14.2
40-44	16.0	16.0	15.9	15.8	15.6	15.3	14.8	14.5	14.0
45-49	15.8	15.8	15.7	15.6	15.7	15.8	15.7	15.7	15.7
50-54	15.1	15.1	15.3	15.2	15.0	15.0	14.9	14.9	15.0
55-59	12.5	12.6	12.7	12.8	12.9	13.1	13.1	13.4	13.5
Gender									
Men	49.3	49.3	49.3	49.2	48.6	47.9	48.2	48.2	47.9
Women	50.7	50.7	50.7	50.8	51.4	52.1	51.9	51.8	52.1
Education									
Higher tertiary	12.7	13.1	13.3	13.7	14.5	15.0	15.4	15.7	16.1
Lower tertiary	29.7	29.8	29.8	29.8	30.0	30.4	30.4	30.4	30.5
Secondary	41.8	42.2	42.7	43.1	42.8	42.8	43.0	43.2	43.2
Primary	15.9	14.9	14.2	13.5	12.7	11.8	11.3	10.8	10.2
Occupational class									
Upper non-manual	24.3	25.2	25.4	25.6	26.4	26.9	25.8	26.0	26.1
Lower non-manual	40.8	40.2	40.2	40.4	40.7	41.3	42.7	42.7	43.1
Manual	34.9	34.6	34.3	34.0	33.0	31.9	31.5	31.4	30.9
Industrial sector									
Manufacturing	20.1	19.6	19.5	19.4	18.8	17.5	17.2	17.0	16.4
Trade	11.2	11.2	11.2	11.2	11.3	11.4	11.4	11.4	11.4
Knowledge work	12.4	12.5	12.5	12.9	13.0	13.1	13.1	13.2	13.2
Health & social work	16.7	16.8	17.0	16.9	17.3	17.8	17.8	18.0	18.5
Other	39.6	39.8	39.8	39.6	39.5	40.2	40.4	40.4	40.5

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Employment sector										
Private	62.4	62.6	62.6	63.1	63.1	62.8	62.7	62.9	62.6	
Public	32.2	31.8	30.4	29.7	30.2	30.6	30.1	30.3	30.6	
Private and public	4.9	5.1	6.5	6.6	6.3	6.1	6.3	6.1	6.2	
Transition to self-employment	0.5	0.5	0.6	0.6	0.6	0.6	0.9	0.7	0.6	
Income										
Quintile 1 (highest)	17.1	17.7	18.8	19.8	20.2	21.0	21.9	21.8	21.7	
Quintile 2	17.9	18.9	19.2	19.5	20.0	20.8	21.3	21.1	21.4	
Quintile 3	19.2	19.9	19.7	19.6	19.8	20.5	20.5	20.3	20.5	
Quintile 4	22.5	21.9	21.2	20.5	19.9	19.2	18.1	18.4	18.3	
Quintile 5 (lowest)	23.3	21.6	21.1	20.6	20.1	18.4	18.3	18.5	18.1	
Employed time										
Full year	90.5	90.4	90.6	90.8	90.5	91.5	91.4	91.2	91.3	
200-364 days	6.8	7.0	7.1	6.9	6.5	6.1	6.4	6.5	6.3	
1-199 days	2.7	2.6	2.4	2.2	3.0	2.4	2.2	2.3	2.4	
Employment episodes										
1	90.0	89.5	88.2	88.3	89.2	89.3	88.5	88.9	89.1	
2	7.0	7.4	8.5	8.5	7.8	7.7	8.5	8.2	8.0	
3+	3.0	3.0	3.4	3.2	3.1	2.9	3.0	2.9	2.9	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
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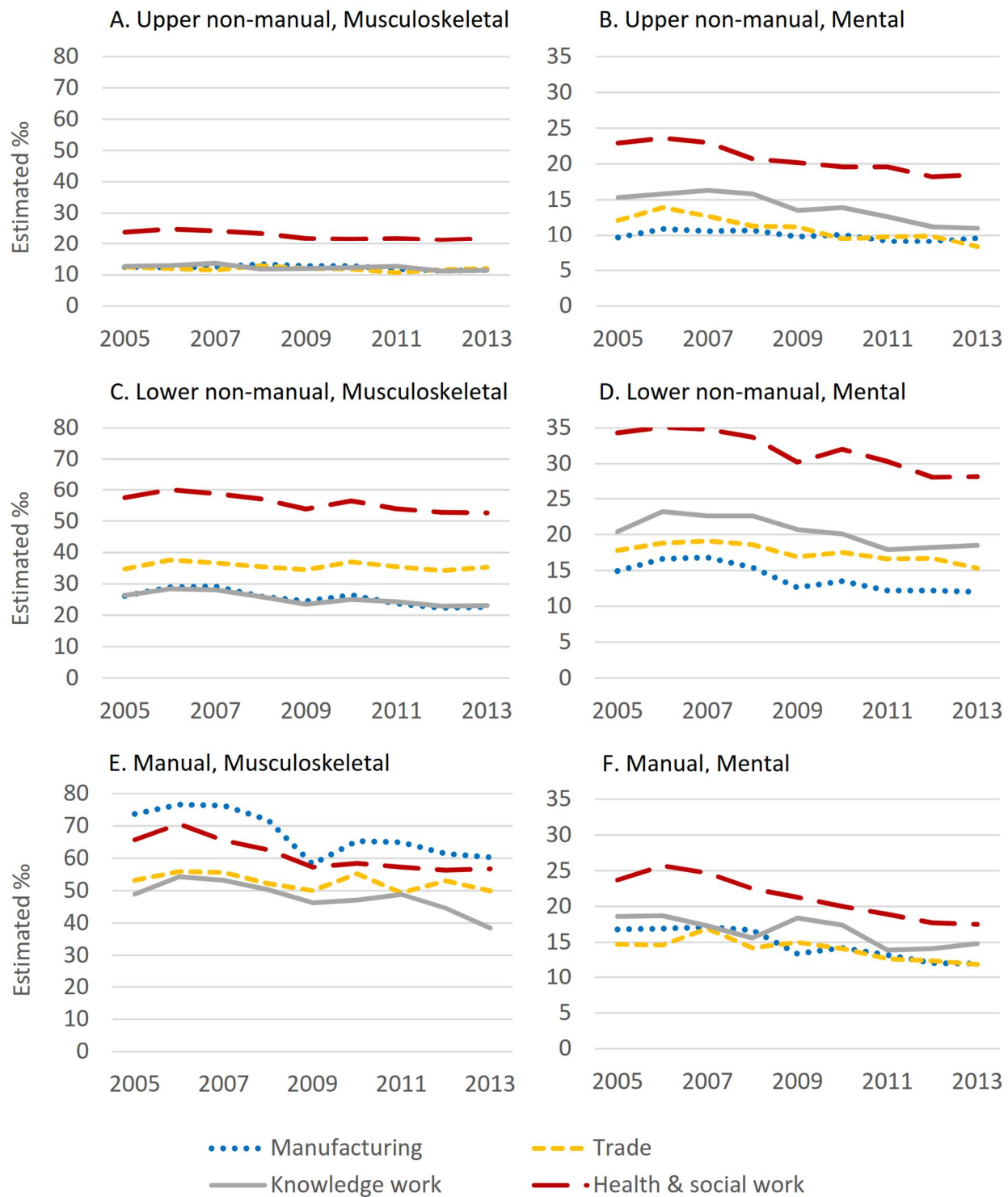


**Supplementary Table 2.** Distribution (%) of the study population by sociodemographic and employment factors among those employed in different industrial sectors within different occupational classes averaging over the whole study period.

	Upper non-manual					Lower non-manual					Manual				
	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All	Manu- fac- turing	Trade	Know- ledge work	Health & social work	All
Age															
25-29	7.7	9.0	12.9	9.5	10.1	12.4	18.3	15.1	11.1	13.7	13.6	21.3	14.2	7.1	14.8
30-34	15.5	14.6	18.6	12.4	15.0	16.5	16.1	14.5	12.2	13.9	13.6	16.4	10.9	7.7	12.9
35-39	19.2	17.1	16.7	13.6	15.7	15.5	15.2	12.7	13.1	13.7	14.0	14.7	11.1	10.3	13.1
40-44	18.9	18.9	15.4	15.6	16.4	15.4	15.2	14.6	15.2	15.2	14.9	14.4	13.5	1.4	14.7
45-49	15.9	17.1	14.5	17.5	16.0	14.3	13.4	15.3	17.2	15.8	15.2	12.8	16.1	17.6	15.5
50-54	12.7	13.3	12.1	17.4	14.5	13.6	11.5	14.7	17.1	15.0	15.5	11.2	17.6	20.9	15.6
55-59	10.3	10.1	9.7	14.0	12.4	12.2	10.2	13.1	14.1	12.9	13.1	9.3	16.6	22.3	13.5
Gender															
Men	78.5	68.5	65.0	18.2	52.0	56.1	37.6	37.9	7.6	30.3	77.8	79.1	65.0	15.4	69.1
Women	21.5	31.6	35.0	81.8	48.0	43.9	62.4	62.1	92.4	69.7	22.2	20.9	35.0	84.6	30.9
Education															
Higher tertiary	38.2	25.2	42.4	45.0	47.7	10.9	3.0	9.1	1.2	4.7	0.4	0.4	1.6	0.6	0.5
Lower tertiary	46.4	46.7	37.6	48.4	37.0	54.2	32.6	51.2	43.4	44.2	6.5	7.8	11.0	6.7	6.9
Secondary	11.2	21.5	16.7	5.8	12.4	27.0	47.2	31.0	49.9	41.6	70.3	68.7	63.9	69.3	67.9
Primary	4.1	6.7	3.4	0.7	3.0	7.9	17.2	8.7	5.5	9.5	22.9	23.0	23.4	23.3	24.7
Employment sector															
Private	96.2	95.6	81.4	14.0	49.0	97.1	96.1	86.2	17.4	56.9	97.6	95.6	66.3	20.4	80.8
Public	0.1	0.2	12.1	72.3	41.4	0.2	0.2	9.9	73.3	36.7	0.1	1.3	27.4	71.2	14.7
Private and public	3.1	3.1	5.6	12.9	8.8	2.4	3.0	3.4	9.0	6.0	1.9	2.3	5.7	8.2	3.8
Transition to self-employment	0.6	1.1	0.9	0.9	0.8	0.4	0.7	0.5	0.3	0.5	0.4	0.8	0.6	0.2	0.7

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Income																
Quintile 1 (highest)	73.3	66.4	56.7	32.6	48.7	28.8	13.0	19.8	2.0	11.7	13.1	5.0	5.5	0.9	8.1	
Quintile 2	15.7	16.1	22.4	21.0	24.0	33.7	14.0	24.6	12.3	18.5	25.6	15.3	15.2	2.5	18.7	
Quintile 3	5.5	7.2	9.5	21.0	12.1	19.4	15.2	24.1	29.5	23.0	27.5	22.9	22.7	8.7	22.5	
Quintile 4	2.6	4.4	5.1	15.3	7.4	10.9	22.3	17.8	33.6	24.9	21.3	28.0	25.8	36.0	23.7	
Quintile 5 (lowest)	3.0	5.9	6.3	10.2	7.9	7.2	35.5	13.6	22.7	21.9	12.5	28.8	30.9	51.9	27.1	
Employed time																
Full year	94.9	93.2	93.6	93.2	93.3	94.3	90.9	93.1	91.5	91.8	92.9	89.8	89.1	81.6	87.9	
200-364 days	3.6	5.0	4.9	5.3	5.2	4.0	6.7	5.0	6.3	5.9	4.9	7.3	7.4	11.0	8.7	
1-199 days	1.5	1.8	1.5	1.5	1.5	1.7	2.4	1.9	2.2	2.3	2.2	2.9	3.5	7.4	3.4	
Employment episodes																
1	94.3	92.9	90.6	82.7	87.2	95.2	92.2	93.1	86.5	89.9	95.0	92.2	88.7	83.0	89.3	
2	4.9	5.8	7.4	12.5	9.3	4.0	6.1	5.6	8.2	7.1	4.2	6.4	8.3	9.0	8.0	
3+	0.8	1.3	2.0	4.8	3.5	0.8	1.7	1.3	5.4	3.0	0.8	1.5	3.1	8.0	2.7	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	



**Supplementary Figure 1.** Age- and gender-adjusted estimated annual proportion of employees with a new onset of sickness absence due to musculoskeletal diseases and mental disorders (%) by industrial sector among A-B) upper non-manual employees, C-D) lower non-manual employees, and E-F) manual workers. The panels are presented in different scales; P-values for the interaction between industrial sector and year: A) 0.302, B) 0.006, C) 0.000, D) 0.005, E) 0.000, F) 0.004.

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any prespecified hypotheses	5, 6
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-10
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-10
Bias	9	Describe any efforts to address potential sources of bias	18, 19
Study size	10	Explain how the study size was arrived at	6, 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9, 10
		(b) Describe any methods used to examine subgroups and interactions	9, 10
		(c) Explain how missing data were addressed	na
		(d) If applicable, explain how loss to follow-up was addressed	na
		(e) Describe any sensitivity analyses	na
<b>Results</b>			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 7
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10, 11
		(b) Indicate number of participants with missing data for each variable of interest	na
		(c) Summarise follow-up time (eg, average and total amount)	na
Outcome data	15*	Report numbers of outcome events or summary measures over time	11, 12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-14
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-14
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	14, 15
<b>Limitations</b>			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).