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Sickness absence as a predictor of disability retirement in different occupational classes: a register-based study of 1.7 million Finns in 2007–2014

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ABSTRACT

Objectives The objective of the study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes.

Setting Register-based prospective cohort study up to 8 years of follow-up.

Participants: A 70% random sample of the non-retired Finnish population aged 25–62 at the end of 2006 was included (N=1,727,644) and linked to data on sickness absences in 2005 and data on disability retirement in 2007–2014.

Primary and secondary outcome measures: By the use of Cox proportional hazards models, we analysed the association of all-cause and diagnosis-specific sickness absence with the risk of all-cause disability retirement in different occupational classes during an eight-year follow-up.

Results: A long sickness absence was a strong predictor of disability retirement in in all occupational classes, but in particular in upper non-manual employees. The association was seen in all diagnostic groups, but it was strongest for sickness absence due to mental and behavioural disorders. Adjusting for the diagnosis of sickness absence partly attenuated the association between the length of sickness absence and the risk of disability retirement in all employed groups.

Conclusions: A long sickness absence is a strong predictor of disability retirement in all occupational classes. Preventing the accumulation of sickness absence days and designing more efficient policies for different occupational classes may be crucial to reduce the number of transitions to early retirement due to disability.

Article summary

Strengths and limitations of this study

- A strength of this study was the 8-year prospective and population-based cohort design
- Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information
- We were able to utilize date-specific information on both sickness absence and disability retirement.
- A limitation to this study was the lack of information on, for example, health status, health behaviours or work environment that could explain or mediate the observed associations.
- Due to the observational nature of the data, causal effects cannot be established.

INTRODUCTION

Large numbers of employees leave the labour market early due to health problems [1]. In particular, those in disadvantaged social positions have an increased risk of problems with health and work ability [2–7]. Both inequalities in health and a loss of workforce due to health problems cause substantial costs for societies [1,8]. To extend working lives, which has become an important target in many OECD countries [9], identifying those with an increased risk of work disability is crucial.

Previous studies have discovered several sociodemographic, work-environmental and health-related predictors of work disability [10–13]. One of the strongest early markers of disability retirement is sickness absence [14]. The risk of disability retirement has been shown to depend on both the duration and the diagnosis of sickness absence. In particular, long-term sickness absence [4,5] and sickness absence due to musculoskeletal diseases [15]; mental and behavioural disorders [16]; and diseases of the nervous, respiratory, and circulatory systems [5] indicate a high risk of disability retirement.

However, to our knowledge, there are no studies focusing on whether this association varies by occupational class. There are large occupational class differences in both sickness absences of various lengths [17,18] and the risk of disability retirement [19–22]. The differences between occupational classes are substantial in sickness absence due to musculoskeletal diseases, but they are smaller in sickness absence due to mental and behavioural disorders [23,24]. The varying diagnostic profiles of the occupational classes may confound the association between the length of sickness absence and the risk of disability retirement. This emphasizes the need to consider both the length and diagnosis of sickness absence when occupational class differences in the risk of disability retirement are examined.

The aim of the study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes. We examined, first, how the length of all-cause sickness absence predicts disability retirement in different occupational classes and, second, how the length of sickness absence due to musculoskeletal diseases, mental and behavioural disorders or other diagnoses predicts disability retirement in different occupational classes. Finally, we studied whether the differences in the diagnoses of sickness absences explain the occupational class differences in the association between the length of sickness absence and disability retirement.

METHODS

Study population

Our data were drawn from several linked registers of the Social Insurance Institution of Finland (Kela), the Finnish Centre for Pensions and Statistic Finland. A 70% random sample of the non-retired Finnish population aged 25–62 years at the end of 2006 was retrieved from the population data file of Kela (N=1,727,644). Data on sociodemographic characteristics in 2006, new medically certified sickness absence episodes longer than ten working days starting in 2005 and new disability pensions from 2007 to 2014 were linked using the participants' personal identification numbers.

Measurement of disability retirement

Data on disability retirement were retrieved from the registers of the Finnish Centre for Pensions (earnings-related pensions) and Kela (basic level national pensions). In Finland, the disability retirement system covers all permanent residents. Disability pensions can be granted to persons aged 18–62 (earnings-related scheme) or 16–64 (national pension scheme), if their work disability is medically assessed to be long-term (at least one year) or permanent. Transferring to full- or part-time disability pensions between 1 January 2007 and 31 December 2014 was analysed in this study.

Measurement of sickness absence

Sickness absence was measured through sickness allowance, derived from the register of Kela. In Finland, sickness allowance is paid to compensate for the income losses caused by work incapacity lasting up to approximately one year, after which a disability pension can be granted. A sickness allowance may be paid after a waiting period of ten working days of work incapacity (Sundays and midweek holidays are not counted as working days). A sickness certificate from a physician is required. All new sickness absence spells that started during the time period 1 January 2005 to 31 December 2005 were included, and each spell was followed until its end. All, including possible multiple spells, were totalled per diagnostic category (see below) per person. Since disability retirement is usually followed by one year of sickness absence, we started the follow-up at 1 January 2007.

The diagnostic groups were chosen based on statistics of the two most prevalent diagnostic causes of sickness absence in 2005 [25]. Three diagnostic groups for sickness absences were used: musculoskeletal diseases (M00–M99), mental and behavioural disorders (F00–F99) and other diagnoses (the rest of the diagnostic groups). The length of sickness absence was calculated as the total number of days in each diagnostic group, and they were categorized as follows: 0 days, 1–30 days, 31–60 days, 61–180 days and over 180 days, per diagnostic group (Table 1).

Measurement of occupational class

Information on occupational class at the end of 2006 was drawn from the register of Statistic Finland [26] and categorized into five classes: upper non-manual employees, lower non-manual employees, manual workers, self-employed workers and those classified as being outside employment. The latter group included long-term unemployed persons (58.1%), students (20.1%) and missing or unknown (21.8%). Pensioners were excluded from this study at the baseline since the study focused on new disability retirements.

Other covariates

Information on gender, age, marital status and level of urbanisation at the end of 2006 was drawn from the registers of Kela. Age was categorized into four groups in 10-year intervals. Marital status was categorized into three groups: never married, married and "other", which included those who were divorced or widowed and those with missing information. The level of urbanisation was categorized into urban, densely populated and rural according to classifications of Statistic Finland [27], and those with missing information were dropped (n = 824,915). The distributions of the covariates are shown in Table 1.

Statistical methods

Each individual in the study population was followed from 1 January 2007 until the start of a disability pension, the start of another type of pension, age 63 (the first potential old-age retirement age), death or the end of the study period on 31 December 2014. The mean follow-up time was 7.0 years. Differences in the risk of disability retirement during 2007–2014 by occupational class and length of sickness absence were analysed with Cox proportional hazards regression. All analyses were conducted separately for men and women and were adjusted for age, marital status and level of urbanisation of the home municipality at the end of 2006 (later referred to as sociodemographic variables). The results are presented as hazard ratios (HR) with their 95% confidence intervals (CI). The analyses were conducted using the Stata 14.2 software.

Ethical considerations

The study used secondary data retrieved from registers, and thus no ethics approval was required according to Finnish law. Good scientific practice and data protection regulations were followed in the collection, use and reporting of the data. Kela, the Finnish Centre for Pensions and Statistics Finland provided permission to use the anonymous register-based data.

RESULTS

Population characteristics

During the 8-year follow-up, a total of 123,736 persons transferred to disability retirement, including 7.0% of men and 7.3% of women (Table 1). A higher percentage of women (12.5%) than men (8.9%) had at least one spell of sickness absence (SA) that started in 2005. Both the prevalence of sickness absence and the proportion of those experiencing disability retirement were higher among those in lower occupational classes and among those who were of older age, those whose marital status was other than married or never married, and those who lived in rural municipalities. Additionally, the same groups had a higher median number of sickness absence days. In every diagnostic group of sickness absence, the proportion of persons with a new disability retirement was higher among those with longer sickness absences.

Table 1 Distributions of the study population in 2006 (N=1,727,644), prevalence and length of sickness absence (SA) beginning in 2005 and proportion of participants experiencing a disability retirement (DR) in 2007-2014.

	Men				Women			
	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)
Occupational class								
Upper non-manual	19.6	5.3	31	2.6	18.3	7.2	31	3.3
Lower non-manual	17.7	8.1	32	4.3	41.4	11.9	33	6.5
Manual worker	35.0	12.2	34	8.1	17.7	13.8	35	10.6
Self-employed	12.2	7.0	42	7.1	6.9	7.8	40	7.3
Outside employment	15.5	8.1	60	13.2	15.7	9.0	50	10.3
Age								
25-34	25.9	5.9	33	2.4	25.0	7.1	33	2.4
35-44	27.9	8.5	34	4.2	27.6	10.0	33	4.5
45-54	28.3	10.6	37	11.6	28.9	12.7	35	11.7
55-62	17.9	11.0	40	11.0	18.5	13.5	37	11.0

Marital status								
Never married	35.6	7.3	36	6.1	27.6	8.3	33	5.7
Married	52.2	9.3	35	6.5	55.5	11.0	34	7.1
Other	12.3	11.6	40	12.1	16.9	14.6	36	11.5
Level of urbanisation								
Urban	57.5	8.3	35	6.3	59.3	10.2	34	6.8
Densely populated	16.0	9.5	36	7.7	15.6	11.2	35	7.7
Rural	26.5	9.6	36	8.2	25.1	11.4	36	8.2
No. of SA days in 2005; All								
0	91.1		0	6.1	87.5		0	5.9
1–30	3.7		19	12.0	5.4		19	13.0
31–60	2.3		42	15.8	3.5		42	15.8
61–180	2.1		90	21.3	2.7		88	22.2
over 180	0.7		296	30.7	0.9		284	32.6
No. of SA days in 2005; MSD[2]								
0	97.1		0	6.7	97.3		0	6.7
1–30	1.3		19	15.3	1.8		19	17.9
31–60	0.7		43	19.1	1.0		44	20.5
61–180	0.7		90	22.2	0.9		91	24.8
over 180	0.2		297	30.8	0.2		294	34.7
No. of SA days in 2005; Mental[3]								
0	98.9		0	6.9	97.3		0	7.0
1–30	0.4		19	14.2	1.0		20	14.0
31–60	0.3		43	19.4	0.6		43	18.0
61–180	0.3		93	27.3	0.5		93	24.4
over 180	0.2		319	33.3	0.2		303.5	32.9
No. of SA days in 2005; Other[4]								
0	95.0		0	6.7	93.7		0	6.9
1–30	2.3		20	11.0	3.1		20	11.6
31–60	1.3		42	13.7	1.9		41	13.1
61–180	1.0		89	18.0	1.1		85	17.5
over 180	0.3		289	28.9	0.3		265	28.5
All	*100*	*8.9*	*36*	*7.0*	*100*	*12.5*	*35*	*7.3*
N	*867,585*	*76,817*		*60,932*	*860,059*	*107,475*		*62,804*

[1] Those with new sickness absence spell that started in 2005, [2] Musculoskeletal diseases, [3] Mental and behavioural disorders, [4] Other diagnoses

[Figure 1]

Hazard ratios (HRs) for the risk of disability retirement for different lengths of sickness absence in different occupational classes are shown in Figure 1, and the reference group is upper non-manual employees with no new sickness absence spells, starting in 2005. Due to their multiplicative nature and to enable direct visual comparability, the HRs are plotted on a logarithmic scale [28,29]. In addition, Appendix tables 1 and 2 show the hazard ratios for disability retirement calculated with a separate reference group for each occupational class.

In general, the longer the sickness absence is, the higher the risk of all-cause disability retirement is in all occupational classes and in both genders. Upper non-manual employees had the lowest risk of disability retirement in men and women. Among men, those outside employment clearly had the highest risk of disability retirement, while among women the risk was highest for manual workers and those outside employment. Lower non-manual workers and self-employed workers were between these classes.

[Figure 2]

Among upper non-manual employees, the risk of disability retirement increased slightly more steeply with increasing length of sickness absence than in other occupational classes (Figure 1, Appendix tables 1 and 2). In upper non-manual men with over 180 days of sickness absence, the HR of disability retirement was almost 10-fold (HR 9.19 95% CI 7.40–11.40) compared to those with no sickness absence, whereas in manual workers, the same HR was 3.51 (95% CI 3.23–3.81) (Appendix table 1). Among women, the pattern was similar, but the occupational class differences were not as large as in men, with the HR being 7.26 (95% CI 6.16–8.57) in upper non-manual employees and 3.94 (95% CI 3.6–4.3) in manual workers, accordingly (Appendix table 2).

Figure 2 shows the HRs for all-cause disability retirement in different diagnostic groups, again calculated with upper non-manual employees without sickness absence as the reference group (see Appendix tables 1 and 2 for separate reference groups). In every diagnostic group, the association between the length of sickness absence and the risk of disability retirement was largely similar. However, the association between increasing length of sickness absence and the risk of disability retirement was slightly stronger in sickness absence due to mental and behavioural disorders than in other diagnostic groups. In upper non-manual employee men with over 180 days of sickness absence due to mental and behavioural disorders, the HR of disability retirement was 9.74 (95% CI 7.10–13.37) compared to upper non-manual employees with no sickness absence due to the same diagnostic category, and the same HR was 7.28 (95% CI 4.22–12.55) when the sickness absence was due to musculoskeletal diseases and 6.89 (95% CI 4.78–9.93) due to other diagnoses (Appendix tables 1 and 2). Additionally, in women, a long sickness absence due to mental and behavioural disorders predicted disability retirement more strongly, especially in upper non-manual employees.

[Figure 3]

To assess how the different diagnostic profiles of sickness absence in different occupational classes affect the total association between length of sickness absence and disability retirement seen above in Figure 1, we calculated the HRs after adjusting for the diagnosis of sickness absence (Figure 3). In general, adjusting for the diagnosis somewhat attenuated the association of increasing lengths of sickness absence with risk of disability retirement in every occupational class. However, in men, the length of sickness absence continued to predict disability retirement more strongly among upper non-manual employees than it did in other occupational classes. In women, the occupational class differences in the strength of association between the increasing length of sickness absence and the risk of disability retirement were largely explained by the occupational class differences after controlling for the diagnosis of sickness absence.

DISCUSSION

Main findings

Our results indicate that the length of sickness absence was associated with a higher risk of disability retirement in all occupational classes, especially in upper non-manual employees. The length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than the length of sickness absence due to other diagnoses, with the association again being stronger in upper non-manual employees than in other occupational classes. The diagnosis of sickness absence partly explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes.

Interpretation of the results

In this study, we found that manual workers and those outside employment clearly had a higher risk of disability retirement than did the other occupational classes, especially among those with no sickness absence or with short-term sickness absence. Among those with a long-term sickness absence, the occupational class differences were narrower. The unemployed, which was the largest subgroup in those outside employment, and manual workers generally had poorer health [21,30–33] and health behaviour [30,34], physically more strenuous jobs [21,30,34] and less job control [21,30,34,35] than did higher occupational classes, which increased their risk of disability retirement, even without any sickness absence or with short-term sickness absence. Health problems can select people to unemployment [31,32], and long-term health problems increase the risk of disability. In the present study, the occupational class differences were smaller in long-term sickness absences, implying that those with long-term sicknesses have an increased risk of disability retirement, despite their occupational class. However, the risk of disability retirement increased with an increasing length of sickness absence more strongly in upper non-manual employees than in other social classes. Upper non-manual employees have long sickness absences less frequently than manual workers do, indicating that upper non-manual employees with long-term sickness absence are possibly a more selected group in terms of their disability retirement risk.

The diagnoses and long-term consequences of sickness absences are known to differ between occupational classes [23,36,37]. For instance, mild injuries that prevent those with physically demanding jobs from working may not affect work ability among those in desk jobs. Previous studies have found that socioeconomic differences in the diagnoses of sickness absences are large in musculoskeletal diseases [23]. In general, our study agrees with previous findings in that the association between the length of sickness absence and the risk of disability retirement does not differ much between diagnostic groups of sickness absences [38]. However, in this study, the length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than did the length of sickness absence due to other diagnoses, particularly among upper non-manual employees. Sickness absence due to mental and behavioural disorders has been found to present a greater risk of disability retirement than has sickness absence due to other diagnoses [4,5,16,39], but previous studies have not found that the length of sickness absence predicts disability retirement differently in sickness absence due to mental and behavioural disorders compared to other diagnoses [5,38]. Our finding that the length of sickness absence due to mental and behavioural disorders was a stronger predictor in upper non-manual employees may partly be explained by work-related factors: upper non-manual employees often have psychologically demanding jobs [33,35], their employers may prefer the employees to remain absent due to sickness until fully recovered because it can be especially difficult to return to mentally complex work with mental health problems, and positions held by higher occupations are not as easily replaceable [40].

The average lengths of the sickness absence spells vary between diagnostic groups and occupational classes. We found that the adjustment of the diagnosis largely explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes, particularly in women. However, in upper non-manual employee men, the adjustment of the diagnosis did not, to a large extent, attenuate the association between the length of sickness absence and the risk of disability retirement, which can be explained by the fact that in upper non-manual employees, a large proportion of the long-term sickness absences was due to mental and behavioural disorders. In other occupational classes, the association can be explained by a more equal distribution in the proportions and the average lengths of different diagnostic groups. In all, divergent diagnostic profiles in different occupational classes partly explain the occupational class differences in the association between the length of sickness absence and the risk of disability retirement.

Methodological considerations

A key strength of the study was the 8-year prospective and population-based cohort design, based on a 70% register sample of the total Finnish non-retired working-age population. Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information. In addition, we were able to utilize date-specific information on both sickness absence and disability retirement. However, a limitation common to all register-based data is the lack of information on, for example, health status, health behaviours or work environment that could explain or mediate the observed associations. Furthermore, due to the observational nature of the data, causal effects cannot be established. Confounding by previous health status or other unmeasured factors may explain some of the observed associations.

Conclusion

Our results suggest that there are occupational class differences in the pathways from sickness absence to disability retirement. The length of sickness absence predicts disability retirement more strongly than does the diagnosis of sickness absence in all occupational classes, but the diagnostic profiles vary between occupational classes and partly explain the association between the length of sickness absence and the risk of disability retirement. It is crucial to understand the ways in which work disability develops in different occupational classes to provide more efficient preventive measures. Further research should focus on understanding the mechanisms contributing to social inequalities in sickness absence and work disability due to different diagnoses.

FOOTNOTES

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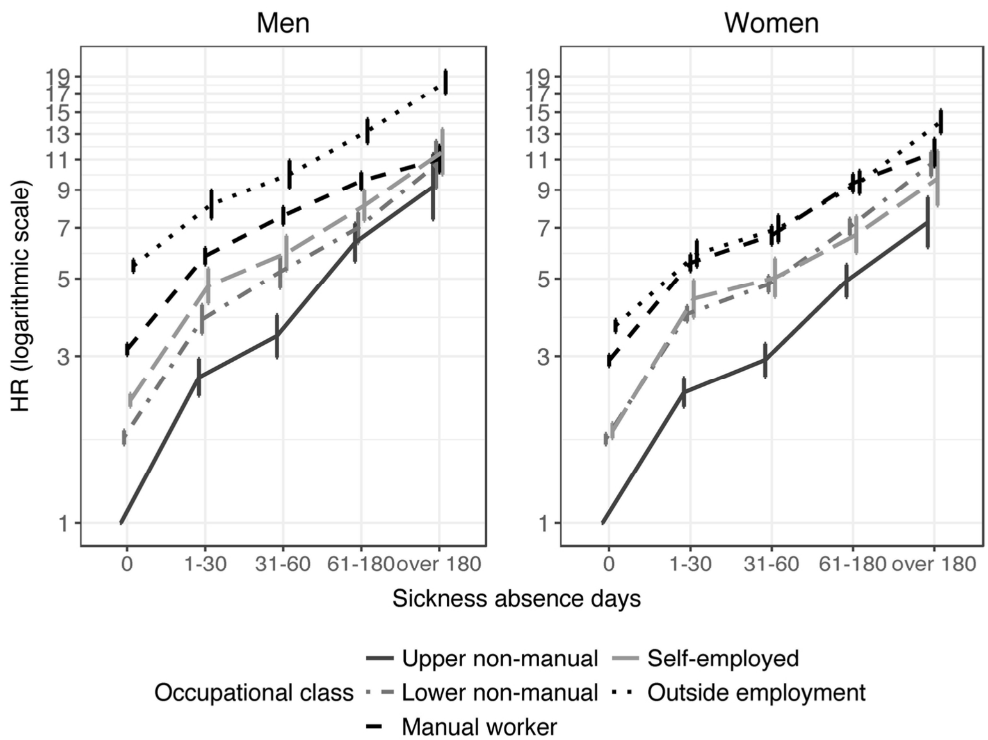

Figure 1 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of all-cause sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

134x101mm (300 x 300 DPI)

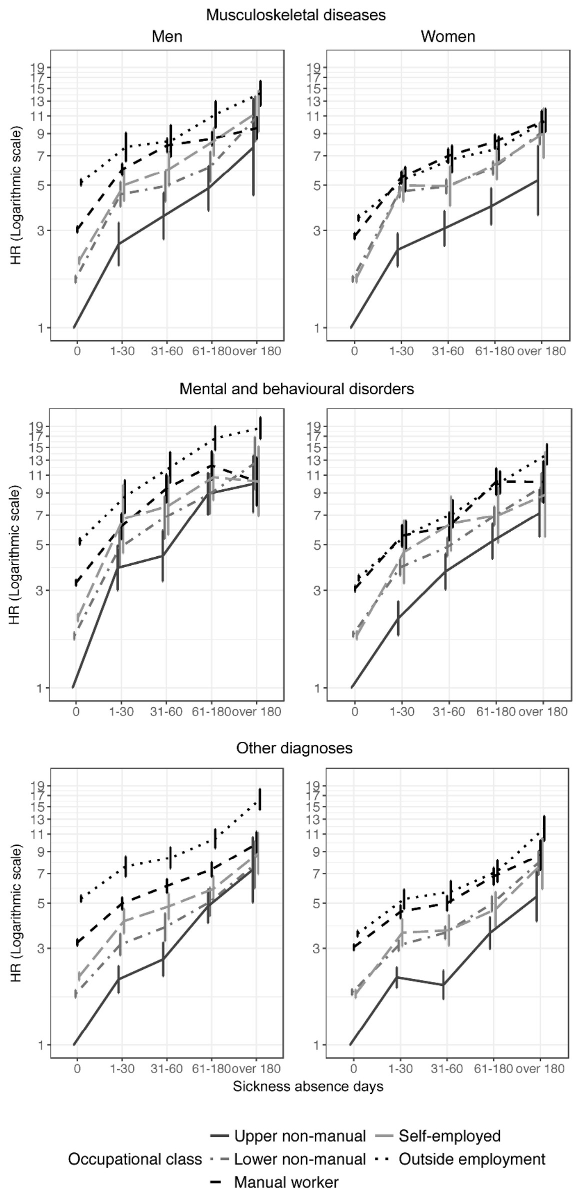

Figure 2 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of diagnosis-specific sickness absence in different occupational classes in men and women. Upper non-manual workers with zero sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

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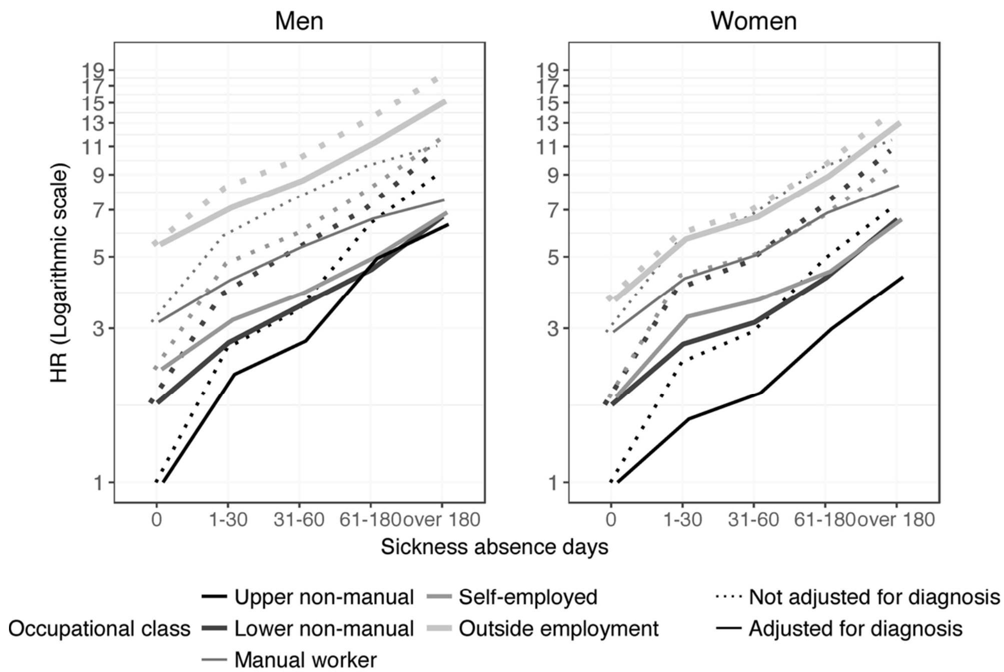

Figure 3 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 according to the length of sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables. Dotted lines represent hazard ratios when not adjusted for diagnoses, and solid lines hazard ratios after adjusting for the diagnoses.

116x79mm (300 x 300 DPI)

APPENDIX

Appendix table 1. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in men.

	Length of sickness absence								
	0	1-30		31-60		61-180		over 180	
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI
Upper non-manual	1	2.61	2.31-2.95	3.43	2.98-3.93	6.35	5.60-7.21	9.19	7.40-11.40
Lower non-manual	1	2.16	1.97-2.37	2.96	2.66-3.29	3.97	3.59-4.39	6.02	5.16-7.02
Manual worker	1	1.84	1.76-1.93	2.40	2.29-2.53	3.03	2.89-3.18	3.51	3.23-3.81
Self-employed	1	2.12	1.90-2.37	2.64	2.36-2.96	3.63	3.29-4.00	5.19	4.49-6.01
Outside employment	1	1.49	1.37-1.63	1.82	1.67-1.99	2.41	2.25-2.59	3.35	3.12-3.59
Musculoskeletal diseases									
Upper non-manual	1	2.73	2.17-3.44	3.47	2.68-4.50	4.94	3.87-6.32	7.28	4.22-12.55
Lower non-manual	1	2.75	2.40-3.14	2.95	2.50-3.49	3.51	2.96-4.17	6.02	4.70-7.70
Manual worker	1	2.03	1.92-2.15	2.67	2.49-2.86	2.87	2.68-3.08	3.23	2.88-3.63
Self-employed	1	2.49	2.10-2.96	2.91	2.42-3.50	3.94	3.38-4.58	5.58	4.45-7.00
Outside employment	1	1.55	1.33-1.80	1.71	1.44-2.02	2.18	1.89-2.52	2.73	2.39-3.13
Mental and behavioural disorders									
Upper non-manual	1	4.02	3.16-5.11	4.48	3.38-5.92	8.80	6.99-11.09	9.74	7.10-13.37
Lower non-manual	1	2.73	2.20-3.37	4.32	3.47-5.37	5.03	4.06-6.24	6.55	4.90-8.76
Manual worker	1	2.04	1.78-2.32	2.97	2.57-3.44	3.69	3.17-4.29	3.15	2.44-4.06
Self-employed	1	3.25	2.27-4.65	3.48	2.52-4.81	5.16	4.04-6.58	5.19	3.60-7.48
Outside employment	1	1.65	1.38-1.97	2.28	1.94-2.69	3.14	2.77-3.57	3.49	3.11-3.92
Other diagnoses									
Upper non-manual	1	2.19	1.89-2.54	2.69	2.23-3.25	5.05	4.21-6.06	6.89	4.78-9.93
Lower non-manual	1	1.85	164-2.08	2.21	1.90-2.57	3.00	2.58-3.50	4.34	3.34-5.63
Manual worker	1	1.63	1.54-1.73	1.99	1.86-2.14	2.38	2.21-2.57	3.11	2.73-3.54
Self-employed	1	1.96	1.71-2.23	2.26	1.96-2.61	2.76	2.39-3.18	4.02	3.19-5.06
Outside employment	1	1.49	1.34-1.66	1.62	1.44-1.82	2.01	1.81-2.22	3.13	2.80-3.49

Adjusted for socio-demographic variables

Appendix table 2. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in women.

	Length of sickness absence								
	0	1-30		31-60		61-180		over 180	
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI
Upper non-manual	1	2.36	2.15-2.60	2.93	2.62-3.26	4.93	4.42-5.49	7.26	6.16-8.57
Lower non-manual	1	2.27	2.18-2.37	2.76	2.64-2.90	4.04	3.85-4.23	6.13	5.69-6.60
Manual worker	1	1.90	1.80-1.99	2.28	2.15-2.41	3.22	3.05-3.40	3.94	3.61-4.29
Self-employed	1	2.36	2.09-2.67	2.73	2.40-3.10	3.61	3.20-4.07	5.20	4.41-6.32
Outside employment	1	1.60	1.48-1.74	1.89	1.74-2.06	2.57	2.39-2.76	3.84	3.58-4.12
Musculoskeletal diseases									
Upper non-manual	1	2.56	2.15-3.05	3.15	2.60-3.81	4.05	3.33-4.93	5.92	4.14-8.49
Lower non-manual	1	2.74	2.59-2.90	3.03	2.82-3.26	3.65	3.40-3.91	5.40	4.80-6.06
Manual worker	1	1.99	1.87-2.12	2.54	2.36-2.74	3.00	2.79-3.24	3.70	3.28-4.16
Self-employed	1	3.04	2.56-3.60	2.85	2.29-3.54	3.83	3.21-4.57	5.18	3.96-6.78
Outside employment	1	1.57	1.37-1.79	1.99	1.71-2.30	2.30	2.02-2.62	3.11	2.75-3.52
Mental and behavioural disorders									
Upper non-manual	1	2.34	1.95-2.80	3.95	3.26-4.78	5.33	4.41-6.44	7.54	5.88-9.67
Lower non-manual	1	2.23	2.06-2.42	2.78	2.53-3.06	4.03	3.66-4.45	5.47	4.72-6.33
Manual worker	1	1.88	1.69-2.10	2.23	1.94-2.57	3.28	2.85-3.78	3.43	2.76-4.25
Self-employed	1	2.9	2.10-3.99	3.54	2.65-4.74	3.78	2.79-5.13	4.24	2.63-6.84
Outside employment	1	1.55	1.33-1.81	2.03	1.74-2.36	2.93	2.61-3.29	3.94	3.53-4.39
Other diagnoses									
Upper non-manual	1	2.24	2.00-2.50	2.07	1.78-2.42	3.68	3.09-4.39	5.56	4.22-7.31
Lower non-manual	1	1.81	1.72-191	2.08	1.95-2.22	2.86	2.64-3.09	4.59	4.04-5.22
Manual worker	1	1.63	1.53-174	1.79	1.65-1.93	2.42	2.22-2.64	2.88	2.45-3.37
Self-employed	1	2.11	1.83-2.45	2.12	1.79-2.50	2.63	2.18-3.19	4.54	3-43-6.01
Outside employment	1	1.5	1.36-1.67	1.61	1.43-1.81	2.09	1.86-2.35	3.42	2.99-3.90

Adjusted for socio-demographic variables

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page no.
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
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
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	4-6
Bias	9	Describe any efforts to address potential sources of bias	12-13
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6, 12-13
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods	

	taking account of sampling strategy
	(*e*) Describe any sensitivity analyses

Continued on next page

Results			Page no.
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	6
		(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	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*7*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
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	9-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12-13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-13
Other information			
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	13

*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.

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Sickness absence as a predictor of disability retirement in different occupational classes: a register-based study of a working-age cohort in Finland in 2007–2014

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ABSTRACT

Objectives: The objective of the study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes.

Design: Register-based prospective cohort study up to 8 years of follow-up.

Participants: A 70% random sample of the non-retired Finnish population aged 25–62 at the end of 2006 was included (N=1,727,644) and linked to data on sickness absences in 2005 and data on disability retirement in 2007–2014.

Main outcome measures: Cox proportional hazards regression was utilized to analyse the association of sickness absence with the risk of all-cause disability retirement during an eight-year follow-up.

Results: The risk of disability retirement increased with increasing lengths of sickness absence in all occupational classes. A long sickness absence was a particularly strong predictor of disability retirement in upper non-manual employees as among those with over 180 sickness absence days the hazard ratio (HR) was 9.19 (95% CI 7.40–11.40), but in manual employees the HR was 3.51 (95% CI 3.23–3.81) in men. Among women the corresponding HRs were 7.26 (95% CI 6.16–8.57) and 3.94 (95% CI 3.60–4.30) respectively. Adjusting for the diagnosis of sickness absence partly attenuated the association between the length of sickness absence and the risk of disability retirement in all employed groups.

Conclusions: A long sickness absence is a strong predictor of disability retirement in all occupational classes. Preventing the accumulation of sickness absence days and designing more efficient policies for different occupational classes may be crucial to reduce the number of transitions to early retirement due to disability.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- A strength of this study was the 8-year prospective and population-based cohort design, based on a 70% register sample of the total Finnish non-retired working-age population.
- Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information
- We were able to utilize date-specific information on both sickness absence and disability retirement.
- A limitation to this study was the lack of information on, for example, health status, health behaviours or work environment that could explain or mediate the observed associations.
- Due to the observational nature of the data, causal effects cannot be established.

INTRODUCTION

Large numbers of employees leave the labour market early due to health problems [1]. In particular, those in disadvantaged social positions have an increased risk of problems with health and work ability [2–7]. Both inequalities in health and a loss of workforce due to health problems cause substantial costs for societies [1,8]. To extend working lives, which has become an important target in many OECD countries [9], identifying those with an increased risk of work disability is crucial.

Previous studies have discovered several sociodemographic, work-environmental and health-related predictors of work disability [10–13]. One of the strongest early markers of disability retirement is sickness absence [14]. The risk of disability retirement has been shown to depend on both the duration and the diagnosis of sickness absence. In particular, long-term sickness absence [4,5] and sickness absence due to musculoskeletal diseases [15]; mental and behavioural disorders [16]; and diseases of the nervous, respiratory, and circulatory systems [5] indicate a high risk of disability retirement.

However, to our knowledge, there are no studies focusing on whether this association varies by occupational class. There are large occupational class differences in both sickness absences of various lengths [17,18] and the risk of disability retirement [19–22], but no studies have been conducted on whether the length of sickness absence predicts disability retirement differently in different occupational classes. The differences between occupational classes are substantial in sickness absence due to musculoskeletal diseases, but they are smaller in sickness absence due to mental and behavioural disorders [23,24]. The varying diagnostic profiles of the occupational classes may confound the association between the length of sickness absence and the risk of disability retirement. This emphasizes the need to consider both the length and diagnosis of sickness absence when occupational class differences in the risk of disability retirement are examined.

Thus, to fill the gap in previous research, the aim of this study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes. We examined, first, how the length of all-cause sickness absence predicts disability retirement in different occupational classes and. Second, the diagnosis of sickness absence was treated as an effect modifier in order to study how the length of sickness absence due to musculoskeletal diseases, mental and behavioural disorders or other diagnoses predicts disability retirement in different occupational classes. Third, we treated the diagnosis as a confounder and studied whether the differences in the diagnoses of sickness absences explain the occupational class differences in the association between the length of sickness absence and disability retirement.

METHODS

Study population

Our data were drawn from several linked registers of the Social Insurance Institution of Finland (Kela), the Finnish Centre for Pensions and Statistic Finland. A 70% random sample of the non-retired Finnish population aged 25–62 years at the end of 2006 was retrieved from the population data file of Kela (N=1,727,644). Data on sociodemographic characteristics in 2006, new medically certified sickness absence episodes longer than ten working days starting in 2005 and new disability pensions from 2007 to 2014 were linked using the participants' personal identification numbers.

Measurement of disability retirement

Data on disability retirement were retrieved from the registers of the Finnish Centre for Pensions (earnings-related pensions) and Kela (basic level national pensions). In Finland, the disability retirement system covers all permanent residents. Disability pensions can be granted to persons aged 18–62 (earnings-related scheme) or 16–64 (national pension scheme), if their work disability is medically assessed to be long-term (at least one year) or permanent. Transferring to full- or part-time disability pensions between 1 January 2007 and 31 December 2014 was analysed in this study.

Measurement of sickness absence

Sickness absence was measured through sickness allowance, derived from the register of Kela. In Finland, sickness allowance is paid to compensate for short-term by work incapacity lasting up to approximately one year, after which a disability pension can be granted. Sickness allowance may be paid after a waiting period of ten consecutive working days of work incapacity (Sundays and midweek holidays are not counted as working days). A sickness certificate from a physician is required. All new registered sickness allowance spells that started during the time period 1 January 2005 to 31 December 2005 were included, and each spell was followed until its end. All, including possible multiple spells, were totalled per diagnostic category (see below) per person. Since disability retirement is usually followed by one year of sickness absence, we started the follow-up at 1 January 2007.

The diagnostic groups were chosen based on statistics of the two most prevalent diagnostic causes of sickness absence in 2005 [25]. Three diagnostic groups for sickness absences were used: musculoskeletal diseases (M00–M99), mental and behavioural disorders (F00–F99) and other diagnoses (the rest of the diagnostic groups). The length of sickness absence was calculated as the total number of days in each diagnostic group, and they were categorized as follows: 0 days, 1–30 days, 31–60 days, 61–180 days and over 180 days, per diagnostic group (Table 1).

Measurement of occupational class

Information on occupational class at the end of 2006 was drawn from the register of Statistic Finland [26] and categorized into five classes: upper non-manual employees, lower non-manual employees, manual workers, self-employed (including self-employed and owners of companies with salaried employees) and those classified as being outside employment. The latter group included long-term unemployed persons (58.1%), students (20.1%) and missing or unknown (21.8%). Pensioners in 2006 were excluded from this study at the baseline since the study focused on new disability retirements from January 2007 onwards.

Other covariates

Information on gender, age, marital status and level of urbanisation at the end of 2006 was drawn from the registers of Kela. The analyses were performed separately for men and women, as there are known gender differences in patterns of both sickness absence and disability retirement [24,27,28]. Age was categorized into four groups in 10-year intervals. Marital status was categorized into three groups: never married, married and "other", which included those who were divorced or widowed and those with missing information. The level of urbanisation was categorized into urban, densely populated and rural according to classifications of Statistic Finland [29]. The distributions of the covariates are shown in Table 1.

Statistical methods

Each individual in the study population was followed from 1 January 2007 until the start of a disability pension, the start of another type of pension, age 63 (the first potential old-age retirement age), death or the end of the study period on 31 December 2014. The mean follow-up time was 7.0 years. Differences in the risk of disability retirement during 2007–2014 by occupational class and length of sickness absence were analysed with Cox proportional hazards regression. All analyses were conducted separately for men and women and were adjusted for age, marital status and level of urbanisation of the home municipality at the end of 2006 (later referred to as sociodemographic variables). The results are presented as hazard ratios (HR) with their 95% confidence intervals (CI). The statistical significance of interactions between the length of sickness absence and occupational class was tested by the Wald test. The analyses were conducted using the Stata 14.2 software.

Ethical considerations

The study used secondary data retrieved from registers, and thus no ethics approval was required according to Finnish law. Good scientific practice and data protection regulations were followed in the collection, use and reporting of the data. Kela, the Finnish Centre for Pensions and Statistics Finland provided permission to use the anonymous register-based data.

RESULTS

Population characteristics

During the 8-year follow-up, a total of 123,736 persons transferred to disability retirement, including 7.0% of men and 7.3% of women (Table 1). A higher percentage of women (12.5%) than men (8.9%) had at least one spell of sickness absence (SA) that started in 2005. Both the prevalence of sickness absence and the proportion of those experiencing disability retirement were higher among those in lower occupational classes and among those who were of older age, those whose marital status was other than married or never married, and those who lived in rural municipalities. Additionally, the same groups had a higher median number of sickness absence days. In every diagnostic group of sickness absence, the proportion of persons with a new disability retirement was higher among those with longer sickness absences.

Table 1 Distributions of the study population in 2006 (N=1,727,644), prevalence and length of sickness absence (SA) beginning in 2005 and proportion of participants experiencing a disability retirement (DR) in 2007-2014.

	Men				Women			
	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)
Occupational class								
Upper non-manual	19.6	5.3	31	2.6	18.3	7.2	31	3.3
Lower non-manual	17.7	8.1	32	4.3	41.4	11.9	33	6.5
Manual worker	35.0	12.2	34	8.1	17.7	13.8	35	10.6
Self-employed	12.2	7.0	42	7.1	6.9	7.8	40	7.3
Outside employment	15.5	8.1	60	13.2	15.7	9.0	50	10.3
Age								
25-34	25.9	5.9	33	2.4	25.0	7.1	33	2.4
35-44	27.9	8.5	34	4.2	27.6	10.0	33	4.5
45-54	28.3	10.6	37	11.6	28.9	12.7	35	11.7
55-62	17.9	11.0	40	11.0	18.5	13.5	37	11.0
Marital status								
Never married	35.6	7.3	36	6.1	27.6	8.3	33	5.7
Married	52.2	9.3	35	6.5	55.5	11.0	34	7.1
Other	12.3	11.6	40	12.1	16.9	14.6	36	11.5
Level of urbanisation								
Urban	57.5	8.3	35	6.3	59.3	10.2	34	6.8
Densely populated	16.0	9.5	36	7.7	15.6	11.2	35	7.7
Rural	26.5	9.6	36	8.2	25.1	11.4	36	8.2
No. of SA days in 2005; All								
0	91.1		0	6.1	87.5		0	5.9
1–30	3.7		19	12.0	5.4		19	13.0
31–60	2.3		42	15.8	3.5		42	15.8
61–180	2.1		90	21.3	2.7		88	22.2
over 180	0.7		296	30.7	0.9		284	32.6
No. of SA days in 2005; MSD[2]								
0	97.1		0	6.7	97.3		0	6.7
1–30	1.3		19	15.3	1.8		19	17.9
31–60	0.7		43	19.1	1.0		44	20.5
61–180	0.7		90	22.2	0.9		91	24.8
over 180	0.2		297	30.8	0.2		294	34.7
No. of SA days in 2005; Mental[3]								
0	98.9		0	6.9	97.3		0	7.0
1–30	0.4		19	14.2	1.0		20	14.0
31–60	0.3		43	19.4	0.6		43	18.0
61–180	0.3		93	27.3	0.5		93	24.4
over 180	0.2		319	33.3	0.2		303.5	32.9
No. of SA days in 2005; Other[4]								
0	95.0		0	6.7	93.7		0	6.9
1–30	2.3		20	11.0	3.1		20	11.6
31–60	1.3		42	13.7	1.9		41	13.1
61–180	1.0		89	18.0	1.1		85	17.5
over 180	0.3		289	28.9	0.3		265	28.5
All	*100*	*8.9*	*36*	*7.0*	*100*	*12.5*	*35*	*7.3*
N	*867,585*	*76,817*		*60,932*	*860,059*	*107,475*		*62,804*

[1] Those with new sickness absence spell that started in 2005, [2] Musculoskeletal diseases, [3] Mental and behavioural disorders, [4] Other diagnoses

[Figure 1]

Hazard ratios (HRs) for the risk of disability retirement for different lengths of sickness absence in different occupational classes are shown in Figure 1, and the reference group is upper non-manual employees with no new sickness absence spells, starting in 2005. Due to their multiplicative nature and to enable direct visual comparability, the HRs are plotted on a logarithmic scale [30,31]. In addition, Appendix tables 1 and 2 show the hazard ratios for disability retirement calculated with a separate reference group for each occupational class.

In general, the longer the sickness absence is, the higher the risk of all-cause disability retirement is in all occupational classes and in both genders. Upper non-manual employees had the lowest risk of disability retirement in men and women. Among men, those outside employment clearly had the highest risk of disability retirement, while among women the risk was highest for manual workers and those outside employment. Lower non-manual workers and self-employed workers were between these classes. The interaction terms between the occupational class and the length of sickness absence on the risk of disability retirement were statistically significant in both men (p-values from the Wald test $p<0.001$) and in women ($p<0.001$) when comparing each occupational class separately to upper non-manual employees (Appendix tables 1 and 2).

[Figure 2]

Among upper non-manual employees, the risk of disability retirement increased slightly more steeply with increasing length of sickness absence than in other occupational classes (Figure 1, Appendix tables 1 and 2). In upper non-manual men with over 180 days of sickness absence, the HR of disability retirement was almost 10-fold (HR 9.19 95% CI 7.40–11.40) compared to those with no sickness absence, whereas in manual workers, the same HR was 3.51 (95% CI 3.23–3.81) (Appendix table 1). Among women, the pattern was similar, but the occupational class differences were not as large as in men, with the HR being 7.26 (95% CI 6.16–8.57) in upper non-manual employees and 3.94 (95% CI 3.6–4.3) in manual workers, accordingly (Appendix table 2).

Figure 2 shows the HRs for all-cause disability retirement in different diagnostic groups, again calculated with upper non-manual employees without sickness absence as the reference group (see Appendix tables 1 and 2 for separate reference groups). In every diagnostic group, the association between the length of sickness absence and the risk of disability retirement was largely similar. However, there was an indication that the association between increasing length of sickness absence and the risk of disability retirement was slightly stronger in sickness absence due to mental and behavioural disorders than in other diagnostic groups. In upper non-manual employee men with over 180 days of sickness absence due to mental and behavioural disorders, the HR of disability retirement was 9.74 (95% CI 7.10–13.37) compared to upper non-manual employees with no sickness absence due to the same diagnostic category, and the same HR was 7.28 (95% CI 4.22–12.55) when the sickness absence was due to musculoskeletal diseases and 6.89 (95% CI 4.78–9.93) due to other diagnoses (Appendix tables 1 and 2). Additionally, in women, a long sickness absence due to mental and behavioural disorders predicted disability retirement more strongly, especially in upper non-manual employees.

[Figure 3]

To assess how the different diagnostic profiles of sickness absence in different occupational classes affect the total association between length of sickness absence and disability retirement seen above in Figure 1, we calculated the HRs after adjusting for the diagnosis of sickness absence (Figure 3). In general, adjusting for the diagnosis somewhat attenuated the association of increasing lengths of sickness absence with risk of disability retirement in every occupational class. However, in men, the length of sickness absence continued to predict disability retirement more strongly among upper non-manual employees than it did in other occupational classes. In women, the occupational class differences in the strength of association between the increasing length of sickness absence and the risk of disability retirement were largely explained by the occupational class differences after controlling for the diagnosis of sickness absence.

DISCUSSION

Main findings

Our results indicate that the length of sickness absence was associated with a higher risk of disability retirement in all occupational classes, especially in upper non-manual employees.

Even short-term sickness absence spells (those less than 31 days long) were associated with a higher risk of disability retirement compared to having no sickness absence days. Furthermore, very long term sickness absence spells (those longer than 180 days) were associated with a clearly higher risk of disability retirement. There was an indication that the length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than the length of sickness absence due to other diagnoses, with the association again being stronger in upper non-manual employees than in other occupational classes. The diagnosis of sickness absence partly explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes.

Interpretation of the results

In this study, we found that manual workers and those outside employment clearly had a higher risk of disability retirement than did the other occupational classes, especially among those with no sickness absence or with short-term sickness absence. Among those with a long-term sickness absence, the occupational class differences were narrower. The unemployed, which was the largest subgroup in those outside employment, and manual workers generally had poorer health [21,32–35] and health behaviour [32,36], physically more strenuous jobs [21,32,36] and less job control [21,32,36,37] than did higher occupational classes, which increased their risk of disability retirement, even without any sickness absence or with short-term sickness absence. Health problems can select people to unemployment [33,34], and long-term health problems increase the risk of disability. In the present study, the occupational class differences were smaller in long-term sickness absences, implying that those with long-term sicknesses have an increased risk of disability retirement, despite their occupational class. However, the risk of disability retirement increased with an increasing length of sickness absence more strongly in upper non-manual employees than in other social classes. Upper non-manual employees have long sickness absences less frequently than manual workers do, indicating that upper non-manual employees with long-term sickness absence are possibly a more selected group in terms of their disability retirement risk.

The diagnoses and long-term consequences of sickness absences are known to differ between occupational classes [23,38,39]. This may be related to differences in work tasks and working conditions between the occupational classes. Some illnesses may be directly caused by work-related hazards. Furthermore, some health problems that prevent those with physically demanding jobs from working may not affect work ability among those in desk jobs. Previous studies have found that socioeconomic differences in the diagnoses of sickness absences are large in musculoskeletal diseases [23]. In general, our study agrees with previous findings in that the association between the length of sickness absence and the risk of disability retirement does not differ much between diagnostic groups of sickness absences [40]. However, in this study, there was an indication that the length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than did the length of sickness absence due to other diagnoses, particularly among upper non-manual employees. Sickness absence due to mental and behavioural disorders has been found to present a greater risk of disability retirement than has sickness absence due to other diagnoses [4,5,16,41], but previous studies have not found that the length of sickness absence predicts disability retirement differently in sickness absence due to mental and behavioural disorders compared to other diagnoses [5,40]. Our finding on the indication that the length of sickness absence due to mental and behavioural disorders was a stronger predictor in upper non-manual employees may partly be explained by work-related factors: upper non-manual employees often have psychologically demanding jobs [35,37], their employers may prefer the employees to remain absent due to sickness until fully recovered because it can be especially difficult to return to mentally complex work with mental health problems, and positions held by higher occupations are not as easily replaceable [42].

The average lengths of the sickness absence spells vary between diagnostic groups and occupational classes. We found that the adjustment of the diagnosis largely explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes, particularly in women. However, in upper non-manual employee men, the adjustment of the diagnosis did not, to a large extent, attenuate the association between the length of sickness absence and the risk of disability retirement, which can be explained by the fact that in upper non-manual employees, a large proportion of the long-term sickness absences were due to mental and behavioural disorders. In other occupational classes, the association can be explained by a more equal distribution in the proportions and the average lengths of different diagnostic groups. In all, divergent diagnostic profiles in different occupational classes partly explain the occupational class differences in the association between the length of sickness absence and the risk of disability retirement.

Methodological considerations

A key strength of the study was the 8-year prospective and population-based cohort design, based on a 70% register sample of the total Finnish non-retired working-age population. Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information. In addition, we were able to utilize date-specific information on both sickness absence and disability retirement. However, a limitation common to all register-based data is the lack of information on, for example, health status, health behaviours or physical and psychosocial work environment that could explain or mediate the observed associations. Furthermore, due to the observational nature of the data, causal effects cannot be established. Confounding by previous health status or other unmeasured factors may explain some of the observed associations. The use of relatively broad diagnostic groups instead of more exact diagnoses prohibits from drawing too generalised conclusions from the results.

Conclusion

Our results suggest that there are occupational class differences in the pathways from sickness absence to disability retirement. The length of sickness absence predicts disability retirement more strongly than does the diagnosis of sickness absence in all occupational classes, but the diagnostic profiles vary between occupational classes and partly explain the association between the length of sickness absence and the risk of disability retirement. It is crucial to understand the ways in which work disability develops in different occupational classes to provide more efficient preventive measures. Further research should focus on understanding the mechanisms contributing to social inequalities in sickness absence and work disability due to different diagnoses.

FOOTNOTES

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Contributions: Corresponding author (LS), JB, ML and MN contributed to the planning, conducting and reporting of this study. LS conducted the statistical analyses and wrote the first and successive drafts of the manuscript. JB, ML and MN advised on the statistical approach and modelling and revised the drafts of manuscripts. LS, JB and ML interpreted the results. All authors approved the final submitted version.

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Figure 1 legend:

Figure 1 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of all-cause sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

Figure 2 legend:

Figure 2 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of diagnosis-specific sickness absence in different occupational classes in men and women. Upper non-manual workers with zero sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

Figure 3 legend:

Figure 3 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 according to the length of sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables. Dotted lines represent hazard ratios when not adjusted for diagnoses, and solid lines hazard ratios after adjusting for the diagnoses.

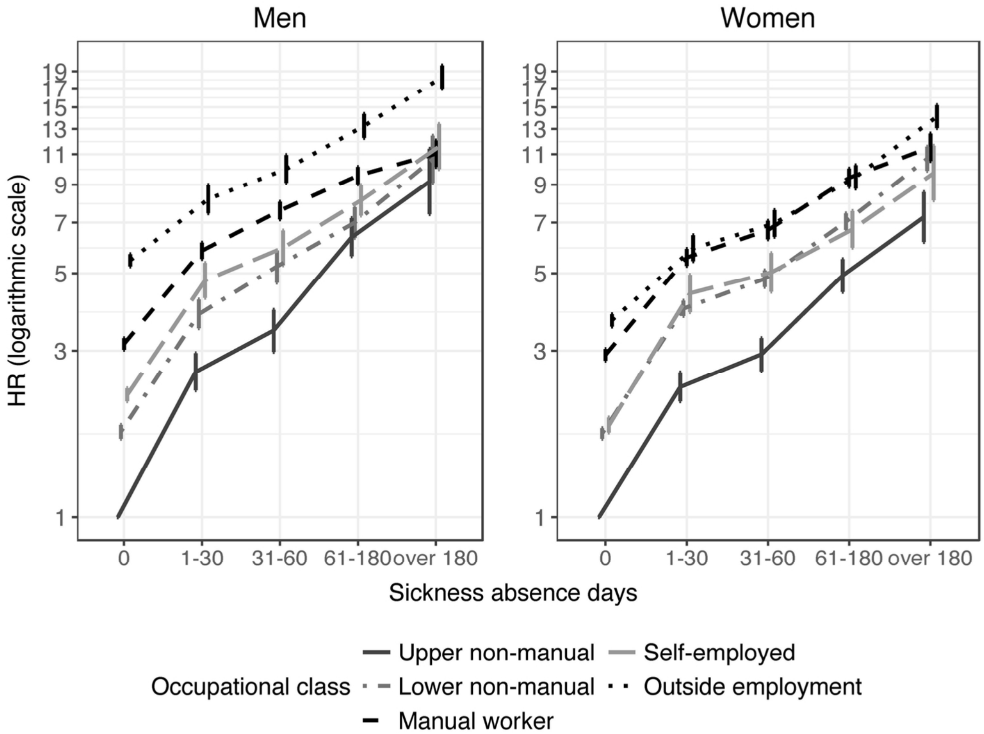

Figure 1 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of all-cause sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

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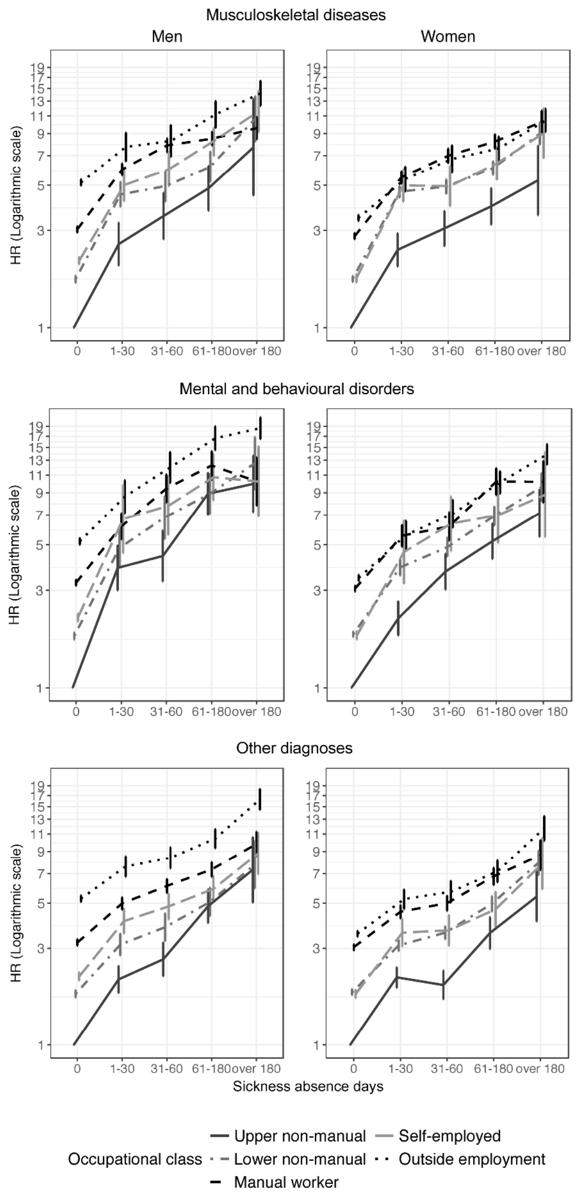

Figure 2 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of diagnosis-specific sickness absence in different occupational classes in men and women. Upper non-manual workers with zero sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

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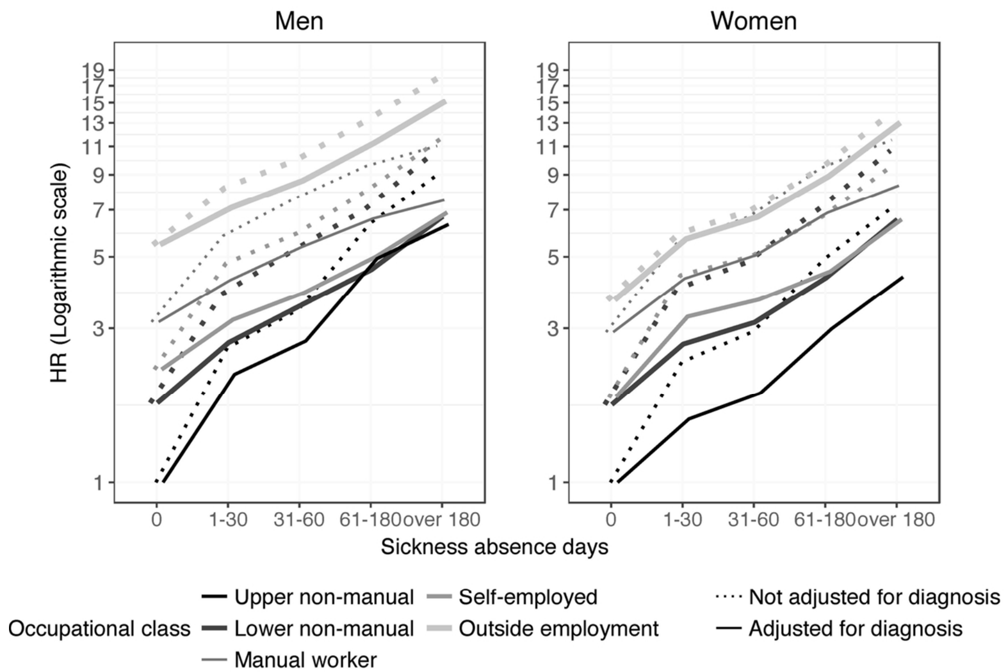

Figure 3 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 according to the length of sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables. Dotted lines represent hazard ratios when not adjusted for diagnoses, and solid lines hazard ratios after adjusting for the diagnoses.

116x79mm (300 x 300 DPI)

Appendix table 1. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in men.

	Length of sickness absence									Interaction p-value from the Wald test [1]
	0	1-30		31-60		61-180		over 180		
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI	
Upper non-manual	1	2.61	2.31-2.95	3.43	2.98-3.93	6.35	5.60-7.21	9.19	7.40-11.40	
Lower non-manual	1	2.16	1.97-2.37	2.96	2.66-3.29	3.97	3.59-4.39	6.02	5.16-7.02	p<0.001
Manual worker	1	1.84	1.76-1.93	2.40	2.29-2.53	3.03	2.89-3.18	3.51	3.23-3.81	p<0.001
Self-employed	1	2.12	1.90-2.37	2.64	2.36-2.96	3.63	3.29-4.00	5.19	4.49-6.01	p<0.001
Outside employment	1	1.49	1.37-1.63	1.82	1.67-1.99	2.41	2.25-2.59	3.35	3.12-3.59	p<0.001
Musculoskeletal diseases										
Upper non-manual	1	2.73	2.17-3.44	3.47	2.68-4.50	4.94	3.87-6.32	7.28	4.22-12.55	
Lower non-manual	1	2.75	2.40-3.14	2.95	2.50-3.49	3.51	2.96-4.17	6.02	4.70-7.70	p<0.001
Manual worker	1	2.03	1.92-2.15	2.67	2.49-2.86	2.87	2.68-3.08	3.23	2.88-3.63	p<0.001
Self-employed	1	2.49	2.10-2.96	2.91	2.42-3.50	3.94	3.38-4.58	5.58	4.45-7.00	p<0.001
Outside employment	1	1.55	1.33-1.80	1.71	1.44-2.02	2.18	1.89-2.52	2.73	2.39-3.13	p<0.001
Mental and behavioural disorders										
Upper non-manual	1	4.02	3.16-5.11	4.48	3.38-5.92	8.80	6.99-11.09	9.74	7.10-13.37	
Lower non-manual	1	2.73	2.20-3.37	4.32	3.47-5.37	5.03	4.06-6.24	6.55	4.90-8.76	p<0.001
Manual worker	1	2.04	1.78-2.32	2.97	2.57-3.44	3.69	3.17-4.29	3.15	2.44-4.06	p<0.001
Self-employed	1	3.25	2.27-4.65	3.48	2.52-4.81	5.16	4.04-6.58	5.19	3.60-7.48	p<0.001
Outside employment	1	1.65	1.38-1.97	2.28	1.94-2.69	3.14	2.77-3.57	3.49	3.11-3.92	p<0.001
Other diagnoses										
Upper non-manual	1	2.19	1.89-2.54	2.69	2.23-3.25	5.05	4.21-6.06	6.89	4.78-9.93	
Lower non-manual	1	1.85	164-2.08	2.21	1.90-2.57	3.00	2.58-3.50	4.34	3.34-5.63	p<0.001
Manual worker	1	1.63	1.54-1.73	1.99	1.86-2.14	2.38	2.21-2.57	3.11	2.73-3.54	p<0.001
Self-employed	1	1.96	1.71-2.23	2.26	1.96-2.61	2.76	2.39-3.18	4.02	3.19-5.06	p<0.001
Outside employment	1	1.49	1.34-1.66	1.62	1.44-1.82	2.01	1.81-2.22	3.13	2.80-3.49	p<0.001

Adjusted for socio-demographic variables. [1] Wald test for the interaction term between occupational class and length of sickness absence on disability retirement.

Appendix table 2. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in women.

	Length of sickness absence									Interaction p-value from the Wald test [1]
	0	1-30		31-60		61-180		over 180		
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI	
Upper non-manual	1	2.36	2.15-2.60	2.93	2.62-3.26	4.93	4.42-5.49	7.26	6.16-8.57	
Lower non-manual	1	2.27	2.18-2.37	2.76	2.64-2.90	4.04	3.85-4.23	6.13	5.69-6.60	p<0.001
Manual worker	1	1.90	1.80-1.99	2.28	2.15-2.41	3.22	3.05-3.40	3.94	3.61-4.29	p<0.001
Self-employed	1	2.36	2.09-2.67	2.73	2.40-3.10	3.61	3.20-4.07	5.20	4.41-6.32	p<0.001
Outside employment	1	1.60	1.48-1.74	1.89	1.74-2.06	2.57	2.39-2.76	3.84	3.58-4.12	p<0.001
Musculoskeletal diseases										
Upper non-manual	1	2.56	2.15-3.05	3.15	2.60-3.81	4.05	3.33-4.93	5.92	4.14-8.49	
Lower non-manual	1	2.74	2.59-2.90	3.03	2.82-3.26	3.65	3.40-3.91	5.40	4.80-6.06	p<0.001
Manual worker	1	1.99	1.87-2.12	2.54	2.36-2.74	3.00	2.79-3.24	3.70	3.28-4.16	p<0.001
Self-employed	1	3.04	2.56-3.60	2.85	2.29-3.54	3.83	3.21-4.57	5.18	3.96-6.78	p<0.001
Outside employment	1	1.57	1.37-1.79	1.99	1.71-2.30	2.30	2.02-2.62	3.11	2.75-3.52	p<0.001
Mental and behavioural disorders										
Upper non-manual	1	2.34	1.95-2.80	3.95	3.26-4.78	5.33	4.41-6.44	7.54	5.88-9.67	
Lower non-manual	1	2.23	2.06-2.42	2.78	2.53-3.06	4.03	3.66-4.45	5.47	4.72-6.33	p<0.001
Manual worker	1	1.88	1.69-2.10	2.23	1.94-2.57	3.28	2.85-3.78	3.43	2.76-4.25	p<0.001
Self-employed	1	2.9	2.10-3.99	3.54	2.65-4.74	3.78	2.79-5.13	4.24	2.63-6.84	p<0.001
Outside employment	1	1.55	1.33-1.81	2.03	1.74-2.36	2.93	2.61-3.29	3.94	3.53-4.39	p<0.001
Other diagnoses										
Upper non-manual	1	2.24	2.00-2.50	2.07	1.78-2.42	3.68	3.09-4.39	5.56	4.22-7.31	
Lower non-manual	1	1.81	1.72-191	2.08	1.95-2.22	2.86	2.64-3.09	4.59	4.04-5.22	p<0.001
Manual worker	1	1.63	1.53-174	1.79	1.65-1.93	2.42	2.22-2.64	2.88	2.45-3.37	p<0.001
Self-employed	1	2.11	1.83-2.45	2.12	1.79-2.50	2.63	2.18-3.19	4.54	3-43-6.01	p<0.001
Outside employment	1	1.5	1.36-1.67	1.61	1.43-1.81	2.09	1.86-2.35	3.42	2.99-3.90	p<0.001

Adjusted for socio-demographic variables. [1] Wald test for the interaction term between occupational class and length of sickness absence on disability retirement.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page no.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
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	4-6
Bias	9	Describe any efforts to address potential sources of bias	2, 13
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	4-6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	4, 6

(*e*) Describe any sensitivity analyses	6-7

Continued on next page

Results			Page no.
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	4
		(b) Give reasons for non-participation at each stage	
		(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	4-6
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	4, 6
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
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	9-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-13
Other information			
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	13

*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.

Sickness absence as a predictor of disability retirement in different occupational classes: a register-based study of a working-age cohort in Finland in 2007–2014

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ABSTRACT

Objectives: The objective of the study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes.

Design: Register-based prospective cohort study up to 8 years of follow-up.

Participants: A 70% random sample of the non-retired Finnish population aged 25–62 at the end of 2006 was included (N=1,727,644) and linked to data on sickness absences in 2005 and data on disability retirement in 2007–2014.

Main outcome measures: Cox proportional hazards regression was utilized to analyse the association of sickness absence with the risk of all-cause disability retirement during an eight-year follow-up.

Results: The risk of disability retirement increased with increasing lengths of sickness absence in all occupational classes. A long sickness absence was a particularly strong predictor of disability retirement in upper non-manual employees as among those with over 180 sickness absence days the hazard ratio (HR) was 9.19 (95% CI 7.40–11.40), but in manual employees the HR was 3.51 (95% CI 3.23–3.81) in men. Among women the corresponding HRs were 7.26 (95% CI 6.16–8.57) and 3.94 (95% CI 3.60–4.30) respectively. Adjusting for the diagnosis of sickness absence partly attenuated the association between the length of sickness absence and the risk of disability retirement in all employed groups.

Conclusions: A long sickness absence is a strong predictor of disability retirement in all occupational classes. Preventing the accumulation of sickness absence days and designing more efficient policies for different occupational classes may be crucial to reduce the number of transitions to early retirement due to disability.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- A strength of this study was the 8-year prospective and population-based cohort design, based on a 70% register sample of the total Finnish non-retired working-age population.
- Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information
- We were able to utilize date-specific information on both sickness absence and disability retirement.
- A limitation to this study was the lack of information on, for example, health status, health behaviours or work environment that could explain or mediate the observed associations.
- Due to the observational nature of the data, causal effects cannot be established.

INTRODUCTION

Large numbers of employees leave the labour market early due to health problems [1]. In particular, those in disadvantaged social positions have an increased risk of problems with health and work ability [2–7]. Both inequalities in health and a loss of workforce due to health problems cause substantial costs for societies [1,8]. To extend working lives, which has become an important target in many OECD countries [9], identifying those with an increased risk of work disability is crucial.

Previous studies have discovered several sociodemographic, work-environmental and health-related predictors of work disability [10–13]. One of the strongest early markers of disability retirement is sickness absence [14]. The risk of disability retirement has been shown to depend on both the duration and the diagnosis of sickness absence. In particular, long-term sickness absence [4,5] and sickness absence due to musculoskeletal diseases [15]; mental and behavioural disorders [16]; and diseases of the nervous, respiratory, and circulatory systems [5] indicate a high risk of disability retirement.

However, to our knowledge, there are no studies focusing on whether this association varies by occupational class. There are large occupational class differences in both sickness absences of various lengths [17,18] and the risk of disability retirement [19–22], but no studies have been conducted on whether the length of sickness absence predicts disability retirement differently in different occupational classes. The differences between occupational classes are substantial in sickness absence due to musculoskeletal diseases, but they are smaller in sickness absence due to mental and behavioural disorders [23,24]. The varying diagnostic profiles of the occupational classes may confound the association between the length of sickness absence and the risk of disability retirement. This emphasizes the need to consider both the length and diagnosis of sickness absence when occupational class differences in the risk of disability retirement are examined.

Thus, to fill the gap in previous research, the aim of this study was to examine diagnosis-specific sickness absences of different lengths as predictors of disability retirement in different occupational classes. We examined, first, how the length of all-cause sickness absence predicts disability retirement in different occupational classes and. Second, the diagnosis of sickness absence was treated as an effect modifier in order to study how the length of sickness absence due to musculoskeletal diseases, mental and behavioural disorders or other diagnoses predicts disability retirement in different occupational classes. Third, we treated the diagnosis as a confounder and studied whether the differences in the diagnoses of sickness absences explain the occupational class differences in the association between the length of sickness absence and disability retirement.

METHODS

Study population

Our data were drawn from several linked registers of the Social Insurance Institution of Finland (Kela), the Finnish Centre for Pensions and Statistic Finland. A 70% random sample of the non-retired Finnish population aged 25–62 years at the end of 2006 was retrieved from the population data file of Kela (N=1,727,644). Data on sociodemographic characteristics in 2006, new medically certified sickness absence episodes longer than ten working days starting in 2005 and new disability pensions from 2007 to 2014 were linked using the participants' personal identification numbers.

Measurement of disability retirement

Data on disability retirement were retrieved from the registers of the Finnish Centre for Pensions (earnings-related pensions) and Kela (basic level national pensions). In Finland, the disability retirement system covers all permanent residents. Disability pensions can be granted to persons aged 18–62 (earnings-related scheme) or 16–64 (national pension scheme), if their work disability is medically assessed to be long-term (at least one year) or permanent. Transferring to full- or part-time disability pensions between 1 January 2007 and 31 December 2014 was analysed in this study.

Measurement of sickness absence

Sickness absence was measured through sickness allowance, derived from the register of Kela. In Finland, sickness allowance is paid to compensate for short-term by work incapacity lasting up to approximately one year, after which a disability pension can be granted. Sickness allowance may be paid after a waiting period of ten consecutive working days of work incapacity (Sundays and midweek holidays are not counted as working days). A sickness certificate from a physician is required. All new registered sickness allowance spells that started during the time period 1 January 2005 to 31 December 2005 were included, and each spell was followed until its end. All, including possible multiple spells, were totalled per diagnostic category (see below) per person. Since disability retirement is usually followed by one year of sickness absence, we started the follow-up at 1 January 2007.

The diagnostic groups were chosen based on statistics of the two most prevalent diagnostic causes of sickness absence in 2005 [25]. Three diagnostic groups for sickness absences were used: musculoskeletal diseases (M00–M99), mental and behavioural disorders (F00–F99) and other diagnoses (the rest of the diagnostic groups). The length of sickness absence was calculated as the total number of days in each diagnostic group, and they were categorized as follows: 0 days, 1–30 days, 31–60 days, 61–180 days and over 180 days, per diagnostic group (Table 1).

Measurement of occupational class

Information on occupational class at the end of 2006 was drawn from the register of Statistic Finland [26] and categorized into five classes: upper non-manual employees, lower non-manual employees, manual workers, self-employed (including self-employed and owners of companies with salaried employees) and those classified as being outside employment. The latter group included long-term unemployed persons (58.1%), students (20.1%) and missing or unknown (21.8%). Pensioners in 2006 were excluded from this study at the baseline since the study focused on new disability retirements from January 2007 onwards.

Other covariates

Information on gender, age, marital status and level of urbanisation at the end of 2006 was drawn from the registers of Kela. The analyses were performed separately for men and women, as there are known gender differences in patterns of both sickness absence and disability retirement [24,27,28]. Age was categorized into four groups in 10-year intervals. Marital status was categorized into three groups: never married, married and "other", which included those who were divorced or widowed and those with missing information. The level of urbanisation was categorized into urban, densely populated and rural according to classifications of Statistic Finland [29]. The distributions of the covariates are shown in Table 1.

Statistical methods

Each individual in the study population was followed from 1 January 2007 until the start of a disability pension, the start of another type of pension, age 63 (the first potential old-age retirement age), death or the end of the study period on 31 December 2014. The mean follow-up time was 7.0 years. Differences in the risk of disability retirement during 2007–2014 by occupational class and length of sickness absence were analysed with Cox proportional hazards regression. All analyses were conducted separately for men and women and were adjusted for age, marital status and level of urbanisation of the home municipality at the end of 2006 (later referred to as sociodemographic variables). The results are presented as hazard ratios (HR) with their 95% confidence intervals (CI). The statistical significance of interactions between the length of sickness absence and occupational class was tested by the Wald test by including the length of sickness absence in the interaction model as a 5-category variable. The analyses were conducted using the Stata 14.2 software.

Ethical considerations

The study used secondary data retrieved from registers, and thus no ethics approval was required according to Finnish law. Good scientific practice and data protection regulations were followed in the collection, use and reporting of the data. Kela, the

Finnish Centre for Pensions and Statistics Finland provided permission to use the anonymous register-based data.

RESULTS

Population characteristics

During the 8-year follow-up, a total of 123,736 persons transferred to disability retirement, including 7.0% of men and 7.3% of women (Table 1). A higher percentage of women (12.5%) than men (8.9%) had at least one spell of sickness absence (SA) that started in 2005. Both the prevalence of sickness absence and the proportion of those experiencing disability retirement were higher among those in lower occupational classes and among those who were of older age, those whose marital status was other than married or never married, and those who lived in rural municipalities. Additionally, the same groups had a higher median number of sickness absence days. In every diagnostic group of sickness absence, the proportion of persons with a new disability retirement was higher among those with longer sickness absences.

Table 1 Distributions of the study population in 2006 (N=1,727,644), prevalence and length of sickness absence (SA) beginning in 2005 and proportion of participants experiencing a disability retirement (DR) in 2007-2014.

	Men				Women			
	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)	Distr. (%)	SA in 2005 (%)	SA days in 2005[1] (median)	New DR in 2007-2014 (%)
Occupational class								
Upper non-manual	19.6	5.3	31	2.6	18.3	7.2	31	3.3
Lower non-manual	17.7	8.1	32	4.3	41.4	11.9	33	6.5
Manual worker	35.0	12.2	34	8.1	17.7	13.8	35	10.6
Self-employed	12.2	7.0	42	7.1	6.9	7.8	40	7.3
Outside employment	15.5	8.1	60	13.2	15.7	9.0	50	10.3
Age								
25-34	25.9	5.9	33	2.4	25.0	7.1	33	2.4
35-44	27.9	8.5	34	4.2	27.6	10.0	33	4.5
45-54	28.3	10.6	37	11.6	28.9	12.7	35	11.7
55-62	17.9	11.0	40	11.0	18.5	13.5	37	11.0
Marital status								
Never married	35.6	7.3	36	6.1	27.6	8.3	33	5.7
Married	52.2	9.3	35	6.5	55.5	11.0	34	7.1
Other	12.3	11.6	40	12.1	16.9	14.6	36	11.5
Level of urbanisation								
Urban	57.5	8.3	35	6.3	59.3	10.2	34	6.8
Densely populated	16.0	9.5	36	7.7	15.6	11.2	35	7.7
Rural	26.5	9.6	36	8.2	25.1	11.4	36	8.2
No. of SA days in 2005; All								
0	91.1		0	6.1	87.5		0	5.9
1–30	3.7		19	12.0	5.4		19	13.0
31–60	2.3		42	15.8	3.5		42	15.8
61–180	2.1		90	21.3	2.7		88	22.2
over 180	0.7		296	30.7	0.9		284	32.6
No. of SA days in 2005; MSD[2]								
0	97.1		0	6.7	97.3		0	6.7
1–30	1.3		19	15.3	1.8		19	17.9
31–60	0.7		43	19.1	1.0		44	20.5
61–180	0.7		90	22.2	0.9		91	24.8
over 180	0.2		297	30.8	0.2		294	34.7
No. of SA days in 2005; Mental[3]								
0	98.9		0	6.9	97.3		0	7.0
1–30	0.4		19	14.2	1.0		20	14.0
31–60	0.3		43	19.4	0.6		43	18.0
61–180	0.3		93	27.3	0.5		93	24.4
over 180	0.2		319	33.3	0.2		303.5	32.9
No. of SA days in 2005; Other[4]								
0	95.0		0	6.7	93.7		0	6.9
1–30	2.3		20	11.0	3.1		20	11.6
31–60	1.3		42	13.7	1.9		41	13.1
61–180	1.0		89	18.0	1.1		85	17.5
over 180	0.3		289	28.9	0.3		265	28.5
All	*100*	*8.9*	*36*	*7.0*	*100*	*12.5*	*35*	*7.3*
N	*867,585*	*76,817*		*60,932*	*860,059*	*107,475*		*62,804*

[1] Those with new sickness absence spell that started in 2005, [2] Musculoskeletal diseases, [3] Mental and behavioural disorders, [4] Other diagnoses

[Figure 1]

Hazard ratios (HRs) for the risk of disability retirement for different lengths of sickness absence in different occupational classes are shown in Figure 1, and the reference group is upper non-manual employees with no new sickness absence spells, starting in 2005. Due to their multiplicative nature and to enable direct visual comparability, the HRs are plotted on a logarithmic scale [30,31]. In addition, Appendix tables 1 and 2 show the hazard ratios for disability retirement calculated with a separate reference group for each occupational class.

In general, the longer the sickness absence is, the higher the risk of all-cause disability retirement is in all occupational classes and in both genders. Upper non-manual employees had the lowest risk of disability retirement in men and women. Among men, those outside employment clearly had the highest risk of disability retirement, while among women the risk was highest for manual workers and those outside employment. Lower non-manual workers and self-employed workers were between these classes. The interaction terms between the occupational class and the length of sickness absence on the risk of disability retirement were statistically significant in both men (p-values from the Wald test $p<0.001$) and in women ($p<0.001$) when comparing each occupational class separately to upper non-manual employees (Appendix tables 1 and 2).

Among upper non-manual employees, the risk of disability retirement increased slightly more steeply with increasing length of sickness absence than in other occupational classes (Figure 1, Appendix tables 1 and 2). In upper non-manual men with over 180 days of sickness absence, the HR of disability retirement was almost 10-fold (HR 9.19 95% CI 7.40–11.40) compared to those with no sickness absence, whereas in manual workers, the same HR was 3.51 (95% CI 3.23–3.81) (Appendix table 1). Among women, the pattern was similar, but the occupational class differences were not as large as in men, with the HR being 7.26 (95% CI 6.16–8.57) in upper non-manual employees and 3.94 (95% CI 3.6–4.3) in manual workers, accordingly (Appendix table 2).

[Figure 2]

Figure 2 shows the HRs for all-cause disability retirement in different diagnostic groups, again calculated with upper non-manual employees without sickness absence as the reference group (see Appendix tables 1 and 2 for separate reference groups). In every diagnostic group, the association between the length of sickness absence and the risk of disability retirement was largely similar. However, there was an indication that the association between increasing length of sickness absence and the risk of disability retirement was slightly stronger in sickness absence due to mental and behavioural disorders than in other diagnostic groups.

The association between the length of diagnosis-specific sickness absence and the risk of disability retirement was similar in all occupational classes. However, in upper non-manual employee men with over 180 days of sickness absence due to mental and behavioural disorders, the HR of disability retirement was 9.74 (95% CI 7.10–13.37) compared to upper non-manual employees with no sickness absence due to the same diagnostic category, and the same HR was 7.28 (95% CI 4.22–12.55) when the sickness absence was due to musculoskeletal diseases and 6.89 (95% CI 4.78–9.93) due to other diagnoses (Appendix tables 1 and 2). Additionally, in women there was an indication that a long sickness absence due to mental and behavioural disorders predicted disability retirement more strongly, especially in upper non-manual employees. A similar indication, but to a lesser extent, was found in lower non-manual employees. However, in other occupational classes there were no diagnostic group differences in the association between those with no sickness absence (own occupational class as a reference group) and those with over 180 sickness absence days (Appendix tables 1 and 2).

[Figure 3]

To assess how the different diagnostic profiles of sickness absence in different occupational classes affect the total association between length of sickness absence and disability retirement seen above in Figure 1, we calculated the HRs after adjusting for the diagnosis of sickness absence (Figure 3). In general, adjusting for the diagnosis somewhat attenuated the association of increasing lengths of sickness absence with risk of disability retirement in every occupational class. However, in men, the length of sickness absence continued to predict disability retirement more strongly among upper non-manual employees than it did in other occupational classes. In women, the occupational class differences in the strength of association between the increasing length of sickness absence and the risk of disability retirement were largely explained by the occupational class differences after controlling for the diagnosis of sickness absence.

DISCUSSION

Main findings

Our results indicate that the length of sickness absence was associated with a higher risk of disability retirement in all occupational classes, especially in upper non-manual employees. Even short-term sickness absence spells (those less than 31 days long) were associated with a higher risk of disability retirement compared to having no sickness absence days. Furthermore, very long term sickness absence spells (those longer than 180 days) were associated with a clearly higher risk of disability retirement. There was an indication that the length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than the length of sickness absence due to other diagnoses, with the association again being stronger in upper non-manual employees than in other occupational classes. The diagnosis of sickness absence partly explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes.

Interpretation of the results

In this study, we found that manual workers and those outside employment clearly had a higher risk of disability retirement than did the other occupational classes, especially among those with no sickness absence or with short-term sickness absence. Among those with a long-term sickness absence, the occupational class differences were narrower. The unemployed, which was the largest subgroup in those outside employment, and manual workers generally had poorer health [21,32–35] and health behaviour [32,36], physically more strenuous jobs [21,32,36] and less job control [21,32,36,37] than did higher occupational classes, which increased their risk of disability retirement, even without any sickness absence or with short-term sickness absence. Health problems can select people to unemployment [33,34], and long-term health problems increase the risk of disability. In the present study, the occupational class differences were smaller in long-term sickness absences, implying that those with long-term sicknesses have an increased risk of disability retirement, despite their occupational class. However, the risk of disability retirement increased with an increasing length of sickness absence more strongly in upper non-manual employees than in other social classes. Upper non-manual employees have long sickness absences less frequently than manual workers do, indicating that upper non-manual employees with long-term sickness absence are possibly a more selected group in terms of their disability retirement risk.

The diagnoses and long-term consequences of sickness absences are known to differ between occupational classes [23,38,39]. This may be related to differences in work tasks and working conditions between the occupational classes. Some illnesses may be directly caused by work-related hazards. Furthermore, some health problems that prevent those with physically demanding jobs from working may not affect work ability among those in desk jobs. Previous studies have found that socioeconomic differences in the diagnoses of sickness absences are large in musculoskeletal diseases [23]. In general, our study agrees with previous findings in that the association between the length of sickness absence and the risk of disability retirement does not differ much between diagnostic groups of sickness absences [40]. However, in this study, there was an indication that the length of sickness absence due to mental and behavioural disorders predicted disability retirement slightly more strongly than did the length of sickness absence due to other diagnoses, particularly among upper non-manual employees. Sickness absence due to mental and behavioural disorders has been found to present a greater risk of disability retirement than has sickness absence due to other diagnoses [4,5,16,41], but previous studies have not found that the length of sickness absence predicts disability retirement differently in sickness absence due to mental and behavioural disorders compared to other diagnoses [5,40]. Our finding on the indication that the length of sickness absence due to mental and behavioural disorders was a stronger predictor in upper non-manual employees may partly be explained by work-related factors: upper non-manual employees often have psychologically demanding jobs [35,37], their employers may prefer the employees to remain absent due to sickness until fully recovered because it can be especially difficult to return to mentally complex work with mental health problems, and positions held by higher occupations are not as easily replaceable [42].

The average lengths of the sickness absence spells vary between diagnostic groups and occupational classes. We found that the adjustment of the diagnosis largely explained the differential association between the length of sickness absence and the risk of disability retirement in different occupational classes, particularly in women. However, in upper non-manual employee men, the adjustment of the diagnosis did not, to a large extent, attenuate the association between the length of sickness absence and the risk of disability retirement, which can be explained by the fact that in upper non-manual employees, a large proportion of the long-term sickness absences were due to mental and behavioural disorders. In other occupational classes, the association can be explained by a more equal distribution in the proportions and the average lengths of different diagnostic groups. In all, divergent diagnostic profiles in different occupational classes partly explain the occupational class differences in the association between the length of sickness absence and the risk of disability retirement.

Methodological considerations

A key strength of the study was the 8-year prospective and population-based cohort design, based on a 70% register sample of the total Finnish non-retired working-age population. Data were obtained from national registers, constituting highly reliable sources with objective register-based measures, no self-report bias, practically no loss to follow-up and very little missing information. In addition, we were able to utilize date-specific information on both sickness absence and disability retirement. However, a limitation common to all register-based data is the lack of information on, for example, health status, health behaviours or physical and psychosocial work environment that could explain or mediate the observed associations. Furthermore, due to the observational nature of the data, causal effects cannot be established. Confounding by previous health status or other unmeasured factors may explain some of the observed associations. The use of relatively broad diagnostic groups instead of more exact diagnoses prohibits from drawing too generalised conclusions from the results.

Conclusion

Our results suggest that there are occupational class differences in the pathways from sickness absence to disability retirement. The length of sickness absence predicts disability retirement more strongly than does the diagnosis of sickness absence in all occupational classes, but the diagnostic profiles vary between occupational classes and partly explain the association between the length of sickness absence and the risk of disability retirement. It is crucial to understand the ways in which work disability develops in different occupational classes to provide more efficient preventive measures. Further research should focus on understanding the mechanisms contributing to social inequalities in sickness absence and work disability due to different diagnoses.

FOOTNOTES

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Figure 1 legend:

Figure 1 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of all-cause sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

Figure 2 legend:

Figure 2 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of diagnosis-specific sickness absence in different occupational classes in men and women. Upper non-manual workers with zero sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

Figure 3 legend:

Figure 3 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 according to the length of sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables. Dotted lines represent hazard ratios when not adjusted for diagnoses, and solid lines hazard ratios after adjusting for the diagnoses.

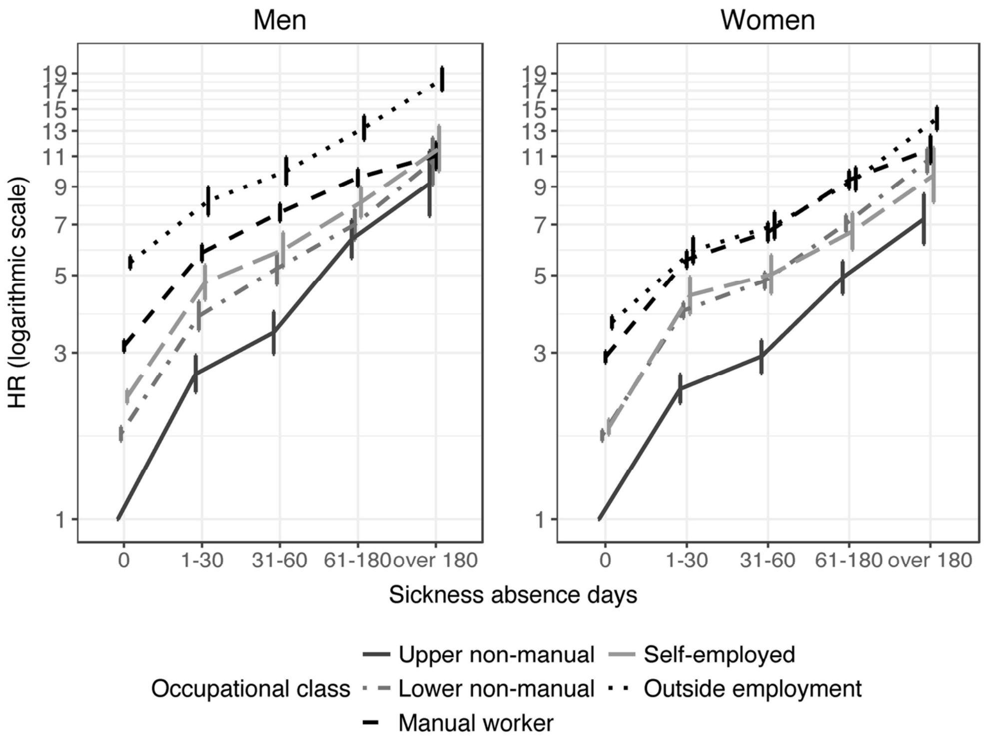

Figure 1 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of all-cause sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

134x101mm (300 x 300 DPI)

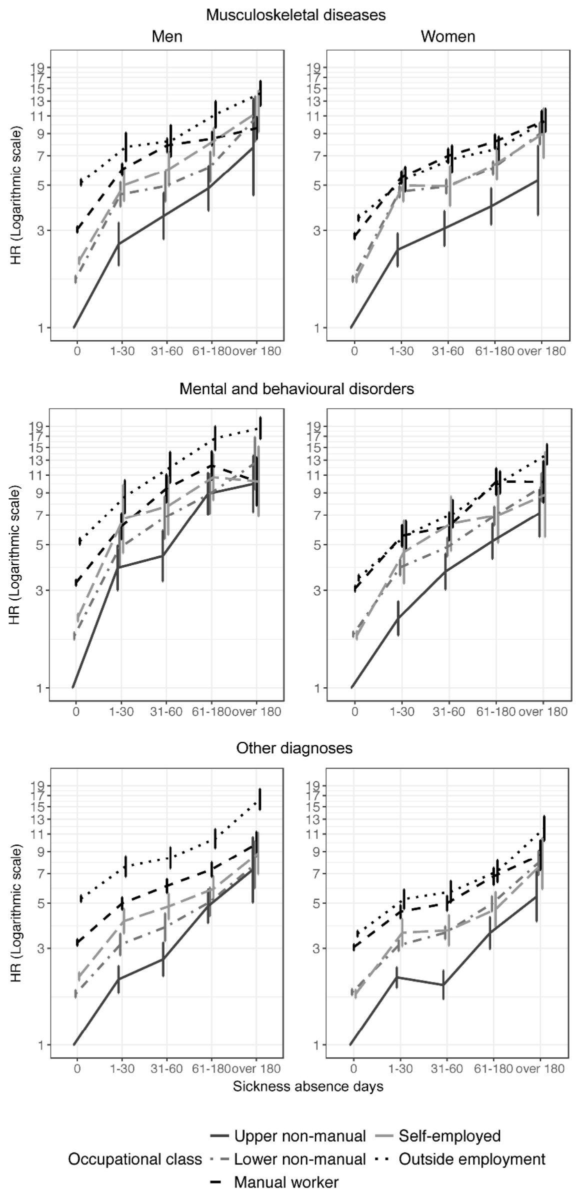

Figure 2 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 with their 95% confidence intervals according to the length of diagnosis-specific sickness absence in different occupational classes in men and women. Upper non-manual workers with zero sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables.

292x604mm (300 x 300 DPI)

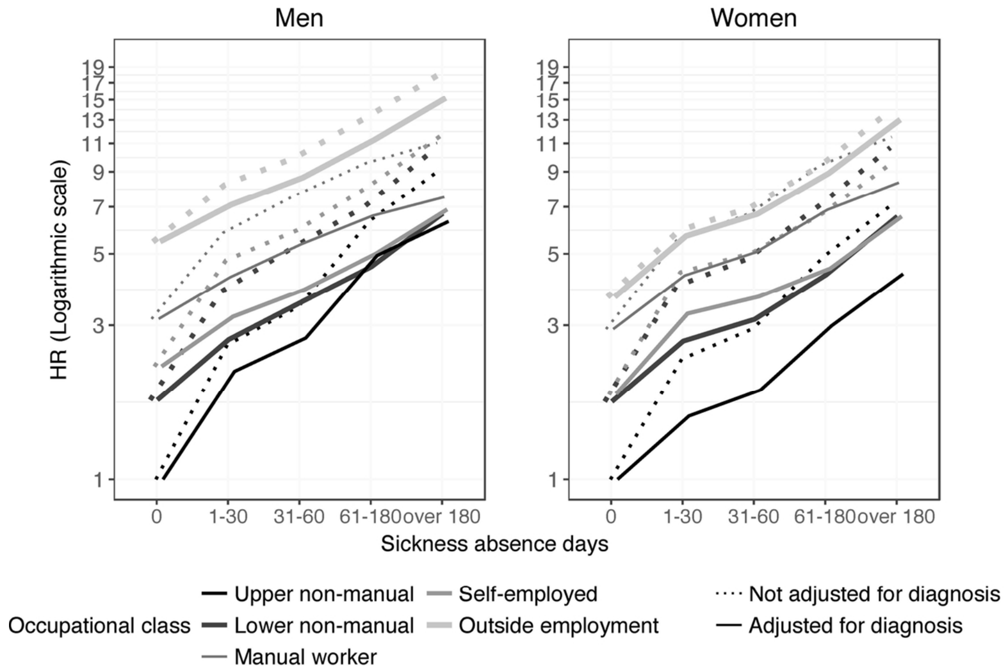

Figure 3 Hazard ratios for the risk of all-cause disability retirement in 2007–2014 according to the length of sickness absence in different occupational classes in men and women. Upper non-manual workers with no sickness allowance days is the reference group. Hazard ratios on logarithmic scale. All adjusted for all sociodemographic variables. Dotted lines represent hazard ratios when not adjusted for diagnoses, and solid lines hazard ratios after adjusting for the diagnoses.

116x79mm (300 x 300 DPI)

Appendix table 1. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in men.

	Length of sickness absence										
	0	1-30		31-60		61-180		over 180		Interaction p-value from the Wald test [1]
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI	
Upper non-manual	1	2.61	2.31-2.95	3.43	2.98-3.93	6.35	5.60-7.21	9.19	7.40-11.40	
Lower non-manual	1	2.16	1.97-2.37	2.96	2.66-3.29	3.97	3.59-4.39	6.02	5.16-7.02	p<0.001
Manual worker	1	1.84	1.76-1.93	2.40	2.29-2.53	3.03	2.89-3.18	3.51	3.23-3.81	p<0.001
Self-employed	1	2.12	1.90-2.37	2.64	2.36-2.96	3.63	3.29-4.00	5.19	4.49-6.01	p<0.001
Outside employment	1	1.49	1.37-1.63	1.82	1.67-1.99	2.41	2.25-2.59	3.35	3.12-3.59	p<0.001
Musculoskeletal diseases										
Upper non-manual	1	2.73	2.17-3.44	3.47	2.68-4.50	4.94	3.87-6.32	7.28	4.22-12.55	
Lower non-manual	1	2.75	2.40-3.14	2.95	2.50-3.49	3.51	2.96-4.17	6.02	4.70-7.70	p<0.001
Manual worker	1	2.03	1.92-2.15	2.67	2.49-2.86	2.87	2.68-3.08	3.23	2.88-3.63	p<0.001
Self-employed	1	2.49	2.10-2.96	2.91	2.42-3.50	3.94	3.38-4.58	5.58	4.45-7.00	p<0.001
Outside employment	1	1.55	1.33-1.80	1.71	1.44-2.02	2.18	1.89-2.52	2.73	2.39-3.13	p<0.001
Mental and behavioural disorders										
Upper non-manual	1	4.02	3.16-5.11	4.48	3.38-5.92	8.80	6.99-11.09	9.74	7.10-13.37	
Lower non-manual	1	2.73	2.20-3.37	4.32	3.47-5.37	5.03	4.06-6.24	6.55	4.90-8.76	p<0.001
Manual worker	1	2.04	1.78-2.32	2.97	2.57-3.44	3.69	3.17-4.29	3.15	2.44-4.06	p<0.001
Self-employed	1	3.25	2.27-4.65	3.48	2.52-4.81	5.16	4.04-6.58	5.19	3.60-7.48	p<0.001
Outside employment	1	1.65	1.38-1.97	2.28	1.94-2.69	3.14	2.77-3.57	3.49	3.11-3.92	p<0.001
Other diagnoses										
Upper non-manual	1	2.19	1.89-2.54	2.69	2.23-3.25	5.05	4.21-6.06	6.89	4.78-9.93	
Lower non-manual	1	1.85	164-2.08	2.21	1.90-2.57	3.00	2.58-3.50	4.34	3.34-5.63	p<0.001
Manual worker	1	1.63	1.54-1.73	1.99	1.86-2.14	2.38	2.21-2.57	3.11	2.73-3.54	p<0.001
Self-employed	1	1.96	1.71-2.23	2.26	1.96-2.61	2.76	2.39-3.18	4.02	3.19-5.06	p<0.001
Outside employment	1	1.49	1.34-1.66	1.62	1.44-1.82	2.01	1.81-2.22	3.13	2.80-3.49	p<0.001

Adjusted for socio-demographic variables. [1] Wald test for the interaction term between occupational class and length of sickness absence on disability retirement.

Appendix table 2. Hazard ratios with 95% confidence intervals for the risk of disability retirement according to the length and diagnosis of sickness absence in different occupational classes in women.

	Length of sickness absence									Interaction p-value from the Wald test [1]
	0	1-30		31-60		61-180		over 180		
All diagnoses	HR	HR	CI	HR	CI	HR	CI	HR	CI	
Upper non-manual	1	2.36	2.15-2.60	2.93	2.62-3.26	4.93	4.42-5.49	7.26	6.16-8.57	
Lower non-manual	1	2.27	2.18-2.37	2.76	2.64-2.90	4.04	3.85-4.23	6.13	5.69-6.60	p<0.001
Manual worker	1	1.90	1.80-1.99	2.28	2.15-2.41	3.22	3.05-3.40	3.94	3.61-4.29	p<0.001
Self-employed	1	2.36	2.09-2.67	2.73	2.40-3.10	3.61	3.20-4.07	5.20	4.41-6.32	p<0.001
Outside employment	1	1.60	1.48-1.74	1.89	1.74-2.06	2.57	2.39-2.76	3.84	3.58-4.12	p<0.001
Musculoskeletal diseases										
Upper non-manual	1	2.56	2.15-3.05	3.15	2.60-3.81	4.05	3.33-4.93	5.92	4.14-8.49	
Lower non-manual	1	2.74	2.59-2.90	3.03	2.82-3.26	3.65	3.40-3.91	5.40	4.80-6.06	p<0.001
Manual worker	1	1.99	1.87-2.12	2.54	2.36-2.74	3.00	2.79-3.24	3.70	3.28-4.16	p<0.001
Self-employed	1	3.04	2.56-3.60	2.85	2.29-3.54	3.83	3.21-4.57	5.18	3.96-6.78	p<0.001
Outside employment	1	1.57	1.37-1.79	1.99	1.71-2.30	2.30	2.02-2.62	3.11	2.75-3.52	p<0.001
Mental and behavioural disorders										
Upper non-manual	1	2.34	1.95-2.80	3.95	3.26-4.78	5.33	4.41-6.44	7.54	5.88-9.67	
Lower non-manual	1	2.23	2.06-2.42	2.78	2.53-3.06	4.03	3.66-4.45	5.47	4.72-6.33	p<0.001
Manual worker	1	1.88	1.69-2.10	2.23	1.94-2.57	3.28	2.85-3.78	3.43	2.76-4.25	p<0.001
Self-employed	1	2.9	2.10-3.99	3.54	2.65-4.74	3.78	2.79-5.13	4.24	2.63-6.84	p<0.001
Outside employment	1	1.55	1.33-1.81	2.03	1.74-2.36	2.93	2.61-3.29	3.94	3.53-4.39	p<0.001
Other diagnoses										
Upper non-manual	1	2.24	2.00-2.50	2.07	1.78-2.42	3.68	3.09-4.39	5.56	4.22-7.31	
Lower non-manual	1	1.81	1.72-191	2.08	1.95-2.22	2.86	2.64-3.09	4.59	4.04-5.22	p<0.001
Manual worker	1	1.63	1.53-174	1.79	1.65-1.93	2.42	2.22-2.64	2.88	2.45-3.37	p<0.001
Self-employed	1	2.11	1.83-2.45	2.12	1.79-2.50	2.63	2.18-3.19	4.54	3-43-6.01	p<0.001
Outside employment	1	1.5	1.36-1.67	1.61	1.43-1.81	2.09	1.86-2.35	3.42	2.99-3.90	p<0.001

Adjusted for socio-demographic variables. [1] Wald test for the interaction term between occupational class and length of sickness absence on disability retirement.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page no.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
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	4-6
Bias	9	Describe any efforts to address potential sources of bias	2, 13
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	4-6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	4, 6

	(*e*) Describe any sensitivity analyses	6-7

Continued on next page

Results			Page no.
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	4
		(b) Give reasons for non-participation at each stage	
		(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	4-6
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	4, 6
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
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	9-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-13
Other information			
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	13

*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.