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Insomnia symptoms, Sleep Duration, and Disability Pensions: A Prospective Study of Swedish Workers

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Abstract

Background Previous studies have found insomnia and long sleep duration to be independently associated with subsequent disability pension (DP). However, the issue of a possible gender-based pattern in this context has received little attention.

Purpose To assess the impact of insomnia symptoms and sleep duration on the DP rates among Swedish women and men during a 12-year follow-up period.

Methods The participants, from the general population of Malmö, Sweden, were enrolled from 1992 to 1994 (n = 4,319; participation rate 41%), aged 45–64, healthy and employed ≥ 30 hours per week. Baseline inquiry data concerning psychosocial circumstances and self-reported sleep habits were compared with official register-based DP rates.

Results Five-hundred-and-nine persons were granted a DP. Insomnia symptoms, affirmed by 33% of the men and 41% of the women, was associated with receiving a DP; the hazard ratios in the fully-adjusted model were 1.4 for both men (95% CI: 1.1, 1.9) and women (95% CI: 1.1, 1.7). The fully-adjusted hazard ratio for women sleeping ≥ 9 hours was 7.8 (95% CI: 3.7, 16.6) for DP due to a mental disorder. In the age-adjusted analyses, the sub-domain ‘difficulties falling asleep’ was related to DP due to mental disorders in men and DP due to cardiovascular diseases in women.

Conclusions The findings suggest that preventing and treating insomnia symptoms could reduce DP, and that disease mechanisms linking sleep disturbances to DP may differ by gender.

Introduction

Regularly enjoying ‘a good night’s sleep’ is an important indicator of well-being and health, but symptoms of insomnia have significantly increased in the general population [1-3]. Prospective studies have shown clear associations between sleep problems and long-term sick leave or disability retirement [4-11]. Musculoskeletal disorders and mental illness were often implicated [9, 10]. In one study of disability pensions (DP), an increased likelihood of preexisting sleep problems was found in almost all diagnostic groups [5].

Sleeping less or more than 7 to 8 hours a day is correlated to obesity, diabetes, hypertension, and cardiovascular disease [12]. It is believed that different pathogenic mechanisms are involved in the two peaks of the U-shaped sleeping curve [13]. The Whitehall II study showed that a decrease in sleep duration among participants sleeping 6 to 8 hours at baseline was associated with cardiovascular mortality, and an increase in sleep duration beyond the same baseline correlated with non-cardiovascular mortality [14]. Long sleep duration has been associated with receiving a DP [11], but so were both deviations from a normal sleep duration in another study [10].

Women generally report more overall insomnia symptoms than men [15], but findings on sleep duration are inconsistent [16]. In contributory and earnings-related social insurance disability programs in many countries, women are often underrepresented [17]. The opposite is true in the Nordic countries, which have a high level of female employment [17]. However, potential gender differences in sleeping patterns and DP have generally been unexplored.

The aim of the present study was to determine whether insomnia symptoms and self-reported sleep duration were associated with the subsequent award of DPs in Sweden, since this has not been investigated previously, and then to stratify the results to see if gender-based differences were involved.

Methods

Participants and procedure

The target population of the Malmö Diet and Cancer Study, which included a baseline questionnaire, anthropometric testing, and blood samples, consisted of all people between the ages of 45 and 65 residing in Malmö, Sweden, in 1991; the participation rate was 41% [18]. The present cohort was taken from its sub-cohort, the Malmö Shoulder and Neck Study cohort, comprising all those recruited between February 1992 and December 1994 ($n = 14,555$) [19]. All participants in our survey were followed until the awarding of a DP, emigration, death, or until December 31, 2005. The endpoint for each individual was obtained through record linkages with a) the Swedish Social Insurance Agency, which also supplied information on the principal diagnoses justifying DP and on baseline sick-leave; b) the Cause-of-Death Register maintained by the Centre for Epidemiology at The National Board of Health and Welfare; and c) the Total Population Register at Statistics Sweden.

Selected participants for the present study were employed for ≥ 30 hours per week, were less than 65 years old (the conventional retirement age in Sweden), and had not previously received a DP. Participants on sick leave at baseline were excluded if they had not returned to work in less than a year. These criteria were fulfilled by 6,675 individuals. Thereafter, further exclusion was made of those who affirmed a history of myocardial infarction, stroke, claudication, rheumatoid arthritis, diabetes mellitus of ≥ 4 years duration, or cancer of ≤ 4 years duration ($n = 445$), or having shoulder, neck, or lumbar pain ‘often’ or ‘all the time’ during the previous 12 months ($n = 2,031$) [20]; as well as of those who lacked complete data on sleeping habits ($n = 24$). Finally, since insomnia and other symptoms may increase while the award of a DP is pending [21], those who received their DP in the first year after baseline were also excluded ($n = 17$). The resulting study population consisted of 4,319 individuals (2,254 men and 2,065 women), representing 39,972 person-years.

The study was approved by the Research Ethics Committee of Lund University.

Outcome

We considered as an instance of DP any award level, partial or full. Diagnoses were coded according to ICD-9 at the beginning of the period and ICD-10 at the end. Principal diagnoses were grouped into musculoskeletal, mental, cardiovascular, and ‘other’ disorders. Information on diagnosis was lacking in 13 of the 509 DP cases.

Sleep variables

The instrument for assessing insomnia symptoms was based on the basis of the DSM-IV diagnostic criteria of insomnia [22]. Subjects were asked to rate each of four sleep disturbances as ‘no problem’, a ‘minor problem’, a ‘moderate problem’, or a ‘considerable problem’ (dichotomized into yes/no at the ‘moderate’ level). The issues were ‘difficulties falling asleep’, ‘waking up during the night’, ‘early morning awakenings’, and ‘not feeling rested after sleeping’. Affirming any of these led to a classification of having ‘insomnia symptoms’. We also inquired into how many hours a person usually slept on a typical weekday night, and the answers were trichotomized into ≤ 6 , 7 to 8, and ≥ 9 hours.

Covariates

Age was used as a continuous variable in the multivariate analyses. Country of origin was recorded as either born in Sweden or not. Marital status was dichotomized into married or cohabiting, or not. Those who said they smoked regularly were classified as smokers and all others as non-smokers. Gender-adjusted figures concerning alcohol use during the previous month were categorized by the quantity–frequency method into ‘low to medium risk’ or ‘high risk’ alcohol consumption [23]. Obesity was defined as a BMI ≥ 30 at baseline.

Occupational class was categorized according to job title and work task into non-manual and manual employment [24]. The Job Content Questionnaire was used to assess job strain, defined as a combination of high psychological demands and low decision latitude [25-27]. Six questions asking about job support received from supervisors and co-workers were also included and dichotomized into high and low job support at the median [27]. Low social participation was defined as having attended ≤ 3 of 13 formal and informal social activities during the past year [28,

29]. A yes/no answer to the following question was also solicited: “Have you felt under stress or psychological pressure lately due to problems or demands from outside the workplace?”

Self-rated health [30] was assessed by the question “How do you feel right now, physically and emotionally, considering your health and general well-being?” The reply alternatives ranged from 1 to 7, with the extremes spelled out as “I am feeling very [good/bad] and could not feel [better/worse]”.

Statistical analyses

Relationships between the exposure variables and DP are presented as cumulative incidences and hazard ratios (HR), as determined by the Cox regression model. In Table 4, sleep habits are tested against DP with the stepwise addition of possible confounders and mediators, beginning with ‘sleep duration’ for the analysis of all domains of insomnia, and with ‘insomnia symptoms’ for the analysis of sleep duration. Tests for synergy were performed for socioeconomic status and job strain in association with insomnia symptoms and DP, but no synergy was found (data not shown). All results are reported separately by gender, with the exception of the correlation between sleep duration and insomnia symptoms (Figure 1). A standard statistical analysis programme was used (SPSS Version 18.0).

Results

During the follow-up period, DPs were granted to 9.2% of the men and 14.6% of the women in our survey. The principal diagnoses were, with numbers in parentheses for men and women respectively: a) musculoskeletal (59 / 106); b) mental (31 / 70); c) cardiovascular (41 / 22); and ‘other’ disorders (73 / 94). Table 1 shows how background factors correlate with the outcome. Table 2 presents the distribution of insomnia symptoms and sleep duration. At least one sleep problem was reported by 33% of the men and 41% of the women. All insomnia subdomains were more common in women, except for problems with waking up too early, which was equally experienced by 14% of the men and women. More men than women claimed they slept ≤ 6 hours a

night. Sleeping ≥ 9 hours was uncommon in both genders: only 2% of the population slept that long.

Figure 1 shows that sleeping ≤ 6 hours per night was associated with insomnia symptoms. This pattern was almost identical in men and women. The association between sleep duration and insomnia symptoms was significant as tested by the two-sided Pearson's chi square test, value 90.2, $p < 0.001$.

The age-adjusted HR for sleep variables and DP are presented in Table 3. The HR for insomnia symptoms was 1.8 in men (95% CI: 1.4, 2.4) and 1.6 in women (95% CI: 1.3, 2.0). Sleeping ≤ 6 hours per night was not associated with DP, while women who slept ≥ 9 hours had an HR of 2.8 (95% CI: 1.7, 4.6). Men who slept ≤ 6 hours and who also reported insomnia symptoms were likely to receive a DP (HR 2.2; 95% CI: 1.5, 3.1). The corresponding figure for women was 1.4 (95% CI: 0.99, 2.0).

Table 4 shows HRs for insomnia symptoms and for sleep duration versus DP, with the stepwise addition of potential confounders and mediators. The HRs decrease gradually. In the final step, the HR for insomnia symptoms was 1.4 for both genders (95% CI: 1.1, 1.9 in men and 1.1, 1.7 in women). For sleep duration, after adjustment as above, a significant association between sleeping ≥ 9 hours and DP remained for women.

The associations between age-adjusted sleep variables and diagnosis-specific DPs are presented in Table 5. For women, having insomnia symptoms was associated with an almost 2-fold risk of DP on the basis of a musculoskeletal disorder (age-adjusted HR 1.9; 95% CI: 1.3, 2.8). This association was hardly affected by adjustments performed with the same variables as in Table 4. The final HR was 1.8 (95% CI: 1.2, 2.8; data not shown). For men, the HR for a DP due to a mental disorder was 3.4 (95% CI: 1.7, 7.0). After full adjustment, the HR was 2.6 (95% CI: 1.2, 5.9).

Regarding the subdomains of insomnia symptoms, a gender-based pattern appeared between 'difficulties falling asleep' and DPs. This variable was, therefore, investigated more closely. For

men with DPs due to mental disorders, the HR was 3.4 (95% CI: 1.7, 7.0); however, in the full model the association was no longer statistically significant (HR 2.0; 95% CI: 0.8, 4.8; data not shown). The corresponding (unadjusted) HR for women was 0.8. The reverse was true for ‘difficulties falling asleep’ and cardiovascular disorders, with an HR of 2.9 for women (95% CI: 1.2, 7.0) and 0.9 for men. Again, the increased risk (in this case for women) was attenuated after full adjustment (HR 1.7; 95% CI: 0.7, 4.3; data not shown).

In men, there was a moderate association between sleeping ≤ 6 hours and DP due to a musculoskeletal disorder (HR 1.7; 95% CI: 1.04, 3.0). In women, a much stronger association appeared between sleeping ≥ 9 hours and DP due to a mental disorder (HR 7.3; 95% CI: 3.6, 14.9). The association increased after full adjustment (HR 7.8; 95% CI 3.7, 16.6; data not shown).

The study design, with a healthy cohort, was chosen as an attempt to clarify the potential impact of sleep problems in themselves, since persons suffering from chronic diseases or musculoskeletal pain are more prone both to receive a disability pension [11] and to suffer from insomnia [8]. However, in order to obtain an estimate of the associations between insomnia symptoms and the outcome in a less selected population, an analysis was performed as in the top of Table 4, with these persons kept in the cohort ($n = 6,478$). The final HRs were remarkably similar; 1.4 (1.1 to 1.7) for men and 1.4 (1.2 to 1.7) for women.

Discussion

Main results and possible mechanisms

Our prospective study, with its 12-year follow-up period, confirmed that, ‘moderate’ or ‘considerable’ problems with at least one of the domains of insomnia; difficulties falling asleep, waking up during the night, waking up too early, or non-restorative sleep, was an independent risk factor for the subsequent award of a DP for both men and women. The fully-adjusted HRs were 1.4 (95% CI: 1.1, 1.9 in men and 1.1, 1.7 in women). Self-reported short sleep duration, i.e., sleeping ≤ 6 hours per night on weekdays, was associated with insomnia symptoms, while sleeping ≥ 9 hours was not. In women, long sleep duration was strongly associated with DP; the fully-

adjusted HR for all-cause DP was 2.4 (95% CI: 1.5, 4.1), and for DP due to a mental disorder 7.8 (95% CI: 3.7, 16.6). The sub-domain ‘difficulties falling asleep’ was associated with DP due to mental disorders in men and cardiovascular diseases in women; however, these associations were not statistically significant in the fully-adjusted model.

As in previous studies [8, 21, 5, 9, 10], the associations between insomnia symptoms and DP were attenuated by adjustment for possible confounders, such as work-related factors, although they remained nevertheless. In a presumed pathway from poor sleep to disease, it is not clear whether certain factors are to be treated as confounders, mediators, or instead as foregoing causes to the insomnia symptoms. For instance, in one recent study, there was no support for the hypothesis that obesity, smoking, heavy drinking, or physical inactivity would mediate between sleep problems and DP [9]. It could be argued that efforts to isolate a ‘pure’ effect of sleep problems, such as by adjusting for work-related factors, may be unreasonable, since sleep problems must have originated somewhere, and work stress is one of the plausible causes. The same line of reasoning would be valid for the variable ‘stress from outside the workplace’. Another matter would have been adjusting for the presence of a clinical entity of ‘depression’ or ‘generalized anxiety disorder’, of which sleep disturbances may constitute only one component, disappearing or decreasing with the other symptoms when the primary condition is treated. However, such diagnosing is not feasible in general population surveys. Moreover, since our cohort consisted of persons working for ≥ 30 hours per week, it is less probable that failing to adjust for these conditions would affect the validity of the present findings to a great degree. Others have also pointed out that since sleep problems may theoretically have caused a sub-clinical disease that is already present at baseline, adjustment for ‘poor self-rated health’ may be regarded as over-adjustment [8, 9]. Interpreting the findings and assessing the true impact of sleep problems is difficult, since sleep disturbances have far-reaching consequences on endocrinology, immunology, and metabolism [31]. Even if the exact mechanisms leading from poor sleep to disease are yet to be identified, it is highly plausible that sleep disturbance is an important causal factor in pathogenesis, and not just a marker of health status and quality of life [32].

‘Insomnia symptoms’ is by definition a subjective concept, but sleep duration can be measured in a more objective manner. Actigraphy-verified sleep time often differs from self-reported sleep

duration [33]. Intuitively, there is a connection between short sleep duration and insomnia symptoms, as was suggested by our research and other studies [10, 11, 34]. Others have found, on the contrary, increased rates of insomnia in ‘long sleepers’ [33]. This may reflect poor sleep quality, such as non-restorative sleep, or fragmented sleep, leading to lying in bed for long time periods, rather than sleeping longer. These facts must be kept in mind when considering our results on sleep duration, which represent self-reported data only.

As previously shown [10], short sleep duration was not in itself a risk factor for DP. People who regularly only sleep a few hours each night are believed to be a heterogeneous group that includes some whose sleep needs are minimal, and others who experience sleep insufficiency [35].

Previous studies have shown inconsistent, non-gender-specific associations between self-reported long sleep duration and DPs [10, 11]. The mechanisms linking long sleep duration with increased morbidity and mortality are little understood, although it has been suggested that psychiatric comorbidity may be a contributing factor [35]. In the present study, women who slept ≥ 9 hours per night had an 8-fold increased risk of DP due to a mental disorder in the fully-adjusted model. In one recent review it was suggested that ‘long sleepers’ are characteristically different from ‘short or normal sleepers’ in a number of domains, including tendency toward depression [33]. However, it is unclear why only women in this presumed category would be at a higher risk of ill-health and receiving a DP. There may be somewhat gender-specific pathways linking different sleep disturbances to disease. Among those with major depression, women tend to report more hypersomnia, and men more insomnia and agitation [36, 37]. This pattern seems to coincide with our findings. Men reporting insomnia symptoms, especially ‘difficulties falling asleep’, tended to have stronger associations with subsequent DPs based on mental disorders than women (Table 5, only age-adjusted data shown).

This particular sleep problem, difficulties falling asleep, was associated with DP due to cardiovascular diseases in women, but not in men. These relationships were not statistically significant after full adjustment and may constitute chance findings. Then again, as discussed above, such adjustment may in fact be illogical. Moreover, recent publications have shown

stronger associations between poor sleep and cardiovascular disease risk factors in women than men [38-40].

Strengths and limitations

In this prospective study, participants were recruited from the general population. There were approximately as many women as men, and the follow-up time was substantial. The accuracy of the outcome was ascertained by linkage to comprehensive records from the Swedish Social Insurance Agency. The methods of measuring sociodemographic data, psychosocial work characteristics, social networks, self-rated health, musculoskeletal symptoms, and 'other somatic disorder' were previously well-validated [41].

The 4 items of the 'sleep problem' variable constitute the gold standard for insomnia in sleep research [22]. However, instrumentalizations may differ. For example, in the 4-item Jenkins Sleep Questionnaire, subjects are asked how many nights the same sleep disturbances occurred during the previous month [42]. The wording we employed to characterize a sleep disturbance as something causing a 'moderate' or a 'considerable' problem resembles the Insomnia Severity Index Scale [43], which also solicits the subjective grading of a problem's severity. The DSM-IV requires the additional presence of a daytime impairment due to the sleep problem for an insomnia diagnosis [9]. The absence of an evaluation of daytime impairment is a major limitation of our study. However, in a recent study, 'general dissatisfaction with sleep', an expression that appears close to our definition, was found to be the foremost marker in identifying individuals with daytime consequences of sleep disturbances [22]. Our study had only one assessment of insomnia symptoms and sleep duration, which may have led to both over- and underestimation of the true associations between exposure variables and DP. As discussed above, there were no sleep actigraphy measurements, neither of sleep duration, nor of 'time to sleep' or the other potentially objectively assessed aspects of 'insomnia'.

Another shortcoming is the presence of only a single question about 'stress from outside the workplace' in our assessment of concomitant psychological distress. This question has been used previously but never validated [44]. It might be considered a rough proxy for psychological

distress. A further limitation was the participation rate of 41% of the general population sample. Nevertheless, a comparison with a public health survey covering 74.6% of this same age cohort suggests that the Malmö Diet and Cancer Study population, of which our cohort comprised a random sub-sample, was selected toward better health than the general population [18], and this circumstance may therefore have biased the estimated associations toward the null.

Conclusions

Long sleep duration in women was prospectively associated with higher DP rates. This result may represent the effect of pre-existing health problems in a small group of individuals. Finding that difficulties falling asleep, one of the aspects of insomnia symptoms, were linked to cardiovascular disease in women and mental disorders in men confirms the need to present the results of research on sleep by gender. However, when it comes to implications for preventive measures, it seems likely that the key finding was the 40% increased risk of DP in both men and women affirming insomnia symptoms. In modern working life, there is a growing prevalence of job insecurity, and demands of mental workload are increasing. These factors are both linked to poor sleep quality and need to be addressed. In other words, and as established in a number of EU directives, work should adapt to the workers. Due to the structure of the population pyramid, a prolonged working life is often discussed, which makes the matter of improved working conditions even more pressing than in the past.

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Figure legend

Figure 1. Percentage of individuals in each of three sleep duration groups with and without insomnia symptoms. Participants were healthy middle-aged persons employed ≥ 30 hours per week, Malmö, Sweden, 1992 to 1994

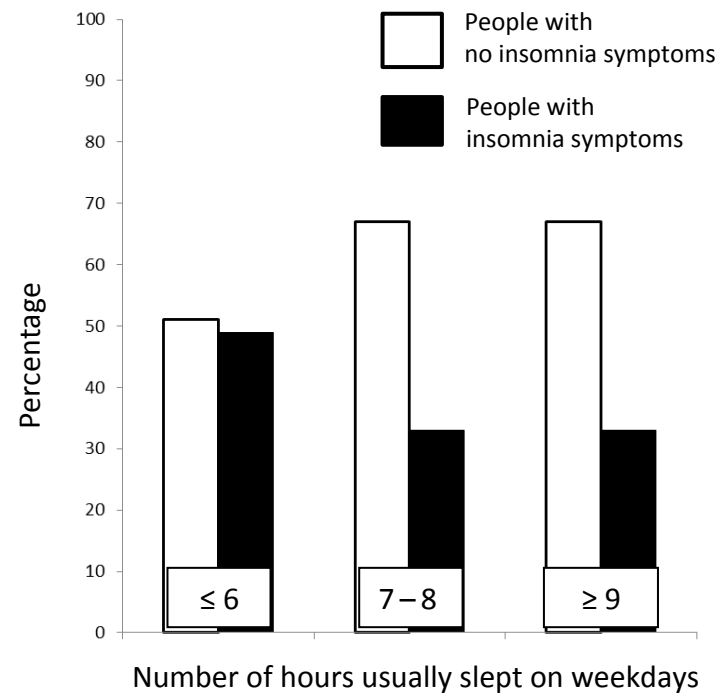


Table 1. Baseline sociodemographic characteristics and new cases of disability pension awards, in a cohort of healthy men (n = 2254) and women (n = 2065). Mamö Shoulder and Neck Study

		Men					Women				
		No.	Cases	%	HR	95% CI	No.	Cases	%	HR	95% CI
Age	45–49	451	48	10.6			439	73	16.6		
	50–54	825	86	10.4			781	150	19.2		
	55–59	654	67	10.2			570	68	11.9		
	60–64	324	7	2.2			275	10	3.6		
	Total	2254	208	9.2			2065	301	14.6		
Country of birth	Sweden	2050	176	8.6	1.0		1896	269	14.2	1.0	
	Other	202	32	15.8	1.9	1.3, 2.8	169	32	18.9	1.5	1.01, 2.1
Married or cohabiting	Yes	1821	160	8.8	1.0		1379	188	13.6	1.0	
	No	430	48	11.2	1.2	0.9, 1.7	684	113	16.5	1.3	1.1, 1.7
Socioeconomic status	Non-manual	1585	104	6.6	1.0		1508	174	11.5	1.0	
	Manual	669	104	15.5	2.5	1.9, 3.2	557	127	22.8	2.2	1.8, 2.8
High job strain	No	1980	167	8.4	1.0		1688	230	13.6	1.0	
	Yes	256	40	15.6	2.0	1.4, 2.8	347	67	19.3	1.5	1.1, 1.9
Low job support	No	1099	91	8.3	1.0		1091	137	12.6	1.0	
	Yes	1130	110	9.7	1.1	0.9, 1.5	951	160	16.8	1.3	1.1, 1.7
Low social participation	No	1801	149	8.3	1.0		1684	217	12.9	1.0	
	Yes	453	59	13.0	1.7	1.2, 2.3	381	84	22.0	2.0	1.6, 2.6
Daily smoking	No	1723	131	7.6	1.0		1543	199	12.9	1.0	
	Yes	531	77	14.5	2.0	1.5, 2.7	522	102	19.5	1.5	1.2, 1.9
Alcohol consumption	Low-risk	1654	150	9.1	1.0		1840	276	15.0	1.0	
	High-risk	597	58	9.7	1.0	0.8, 1.4	222	25	11.3	0.7	0.4, 1.02
Obese, BMI ≥ 30	No	2032	177	8.7	1.0		1876	250	13.9	1.0	
	Yes	220	30	13.6	1.6	1.1, 2.3	189	41	21.7	1.8	1.3, 2.5
Stress from outside the workplace	No	1741	141	8.1	1.0		1426	192	13.5	1.0	
	Yes	507	66	13.0	1.6	1.2, 2.1	635	109	17.2	1.3	0.99, 1.6
Self-rated health	Good	1937	155	8.0	1.0		1695	216	12.7	1.0	
	Poor	315	53	16.8	2.2	1.6, 3.0	365	83	22.7	1.9	1.4, 2.4

CI, confidence interval; HR, hazard ratio (age-adjusted).

Table 2. Insomnia symptoms and sleep duration, baseline data

		Men		Women		phi	P value
		No.	%	No.	%		
Insomnia symptoms	No	1504	66.7	1210	58.6	0.084	< 0.001
	Yes	750	33.3	855	41.4		
Domains of insomnia							
Difficulties falling asleep	No	2013	89.3	1700	82.3	0.100	< 0.001
	Yes	241	10.7	365	17.7		
Waking up during the night	No	1859	82.5	1536	74.4	0.099	< 0.001
	Yes	395	17.5	529	25.6		
Waking up too early	No	1934	85.8	1772	85.8	0	0.994
	Yes	320	14.2	293	14.2		
Not feeling rested after sleeping	No	1873	83.1	1632	79.0	0.052	0.001
	Yes	381	16.9	483	21.0		
Number of insomnia symptoms	0	1504	66.7	1210	58.6	0.093	< 0.001
	1	404	17.9	408	19.8		
	2	164	7.3	213	10.3		
	3	123	5.5	150	7.3		
	4	59	2.6	84	4.1		
Duration of sleep (usual number of hours of sleep on weekdays)	≤ 6	654	29.0	487	23.6	0.062	< 0.001
	7–8	1559	69.2	1533	74.2		
	≥ 9	41	1.8	45	2.2		

Table 3. Insomnia symptoms and sleep duration in relation to new cases of disability pension awards

		Men				Women			
		Cases	%	HR	95% CI	Cases	%	HR	95% CI
Insomnia symptoms	No	112	7.4	1.0		149	12.3	1.0	
	Yes	96	12.8	1.8	1.4, 2.4	152	17.8	1.6	1.3, 2.0
Domains of insomnia									
Difficulties falling asleep	No	177	8.8	1.0		243	14.3	1.0	
	Yes	31	12.9	1.5	1.01, 2.2	58	15.9	1.2	0.9, 1.6
Waking up during the night	No	163	8.8	1.0		199	13.0	1.0	
	Yes	45	11.4	1.4	1.02, 2.0	102	19.3	1.7	1.3, 2.1
Waking up too early	No	163	8.4	1.0		240	13.5	1.0	
	Yes	45	14.1	1.8	1.3, 2.5	61	20.8	1.7	1.3, 2.2
Not feeling rested after sleeping	No	158	8.4	1.0		225	13.8	1.0	
	Yes	50	13.1	1.6	1.2, 2.2	76	17.6	1.3	0.99, 1.7
Number of insomnia symptoms	0	112	7.4	1.0		149	12.3	1.0	
	1	51	12.6	1.8	1.3, 2.5	70	17.2	1.5	1.1, 2.0
	2	23	14.0	2.1	1.4, 3.3	37	17.4	1.5	1.1, 2.2
	3	14	11.4	1.6	0.9, 2.8	27	18.0	1.6	1.1, 2.5
	4	8	13.6	1.9	0.9, 3.9	18	21.4	2.0	1.2, 3.2
Duration of sleep (usual number of hours of sleep on weekdays)	≤ 6	71	10.9	1.3	0.9, 1.7	64	13.1	0.9	0.7, 1.2
	7–8	134	8.6	1.0		221	14.4	1.0	
	≥ 9	3	7.3	0.8	0.3, 2.7	16	35.6	2.8	1.7, 4.6
Combination of sleep duration and insomnia symptoms	≤ 6, no	29	7.9	1.1	0.7, 1.6	22	10.2	0.8	0.5, 1.2
	7–8, no	81	7.3	1.0		118	12.2	1.0	
	≥ 9, no	2	6.9	1.0	0.2, 4.0	9	31.0	2.9	1.4, 5.6
	≤ 6, yes	42	14.7	2.2	1.5, 3.1	42	15.4	1.4	0.99, 2.0
	7–8, yes	53	11.7	1.7	1.2, 2.4	103	18.2	1.6	1.2, 2.1
	≥ 9, yes	1	8.3	1.1	0.1, 7.9	7	44.0	4.2	2.0, 9.1

CI, confidence interval; *HR*, hazard ratio (age-adjusted)

Table 4 Insomnia symptoms and sleep duration in relation to new cases of disability pension awards, adjusted for possible confounders and mediators, all measured at baseline

	Model 1 ^a				Model 2 ^b				Model 3 ^c				Model 4 ^d			
	Men		Women		Men		Women		Men		Women		Men		Women	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Insomnia symptoms	1.8	1.4, 2.4	1.6	1.3, 2.0	1.7	1.3, 2.3	1.6	1.2, 2.0	1.6	1.2, 2.1	1.4	1.1, 1.8	1.4	1.1, 1.9	1.4	1.1, 1.7
Domains of insomnia																
Difficulties falling asleep	1.5	0.99, 2.2	1.2	0.9, 1.7	1.3	0.9, 2.0	1.1	0.8, 1.5	1.2	0.8, 1.7	1.0	0.8, 1.4	1.1	0.7, 1.6	1.0	0.7, 1.3
Waking up during the night	1.4	0.99, 1.9	1.7	1.3, 2.1	1.4	0.97, 1.9	1.7	1.4, 2.2	1.2	0.8, 1.7	1.6	1.3, 2.1	1.1	0.7, 1.5	1.5	1.2, 2.0
Waking up too early	1.9	1.3, 2.6	1.7	1.3, 2.3	1.9	1.3, 2.6	1.7	1.2, 2.2	1.7	1.2, 2.4	1.6	1.2, 2.2	1.6	1.1, 2.2	1.5	1.1, 2.1
Not feeling rested after sleeping	1.6	1.2, 2.2	1.4	1.04, 1.8	1.6	1.2, 2.2	1.4	1.06, 1.8	1.4	0.98, 1.9	1.2	0.9, 1.6	1.3	0.9, 1.8	1.1	0.8, 1.5
Duration of sleep (usual number of hours of sleep on weekdays)																
≤ 6	1.1	0.8, 1.5	0.9	0.7, 1.2	1.1	0.8, 1.4	0.8	0.6, 1.1	1.1	0.8, 1.4	0.8	0.6, 1.0	1.0	0.8, 1.4	0.8	0.6, 1.0
7–8	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
≥ 9	0.6	0.1, 2.4	2.8	1.7, 4.7	0.6	0.1, 2.2	2.6	1.5, 4.3	0.5	0.1, 2.0	2.4	1.4, 4.0	0.5	0.1, 1.9	2.4	1.5, 4.1

CI, confidence interval; HR, hazard ratio (age-adjusted)

^aModel 1: Adjusted for sleep duration when analyzing all domains of insomnia in relation to DP, and for ‘insomnia symptoms’ when analyzing sleep duration in relation to DP

^bModel 2: Model 1 + nationality, marital status, socioeconomic position, smoking status, alcohol consumption, and obesity

^cModel 3: Model 2 + job strain, stress from outside the workplace, social participation, and job support

^dModel 4: Model 3 + self-rated health

Table 5. Insomnia symptoms and sleep duration in relation to new cases of cause-specific disability pension awards

	Musculoskeletal disorders				Mental disorders				Cardiovascular disorders			
	Men (n = 59)		Women (n = 106)		Men (n = 31)		Women (n = 70)		Men (n = 41)		Women (n = 22)	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Insomnia symptoms	1.3	0.8, 2.2	1.9	1.3, 2.8	3.4	1.7, 7.0	1.6	0.98, 2.6	1.6	0.9, 3.1	2.2	0.9, 5.2
Domains of insomnia												
Difficulties falling asleep	2.4	1.3, 4.4	1.7	1.1, 2.7	3.0	1.3, 6.6	0.8	0.4, 1.6	0.9	0.3, 2.5	2.9	1.2, 7.0
Waking up during the night	1.6	0.9, 2.9	1.8	1.2, 2.6	1.5	0.6, 3.5	1.7	1.05, 2.8	1.2	0.6, 2.6	2.6	1.1, 6.1
Waking up too early	1.7	0.9, 3.2	2.0	1.3, 3.2	3.2	1.5, 6.8	2.1	1.2, 3.7	1.5	0.7, 3.4	1.4	0.5, 4.3
Not feeling rested after sleeping	1.3	0.7, 2.4	0.9	0.6, 1.5	3.2	1.5, 6.5	1.6	0.98, 2.7	1.4	0.7, 3.0	2.2	0.9, 5.2
Duration of sleep (usual number of hours of sleep on weekdays)												
≤ 6	1.7	1.04, 3.0	0.8	0.5, 1.3	1.5	0.7, 3.1	0.9	0.5, 1.6	1.2	0.6, 2.3	1.2	0.5, 3.0
7–8	1.0		1.0		1.0		1.0		1.0		1.0	
≥ 9	2.4	0.6, 10.0	1.4	0.4, 4.4	*		7.3	3.6, 14.9	*		*	

CI, confidence interval; *HR*, hazard ratio (age-adjusted); *n*, number

* HR cannot be calculated because no cases occurred in this group