American Journal of Epidemiology

Vol. 163, No. 11
DOI: 10.1093/aje/kwj145
Advance Access publication April 12, 2006

Original Contribution

The Long-term Effect of Insomnia on Work Disability

The HUNT-2 Historical Cohort Study

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Received for publication September 19, 2005; accepted for publication January 5, 2006.

Chronic insomnia is common in the general population. Its effect on functioning and disability is usually attributed to an underlying condition, so the diagnosis of insomnia does not qualify for award of a disability pension in the United States or Europe. The aim of this study was to investigate whether insomnia, defined according to the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, contributed to long-term work disability. Using a historical cohort design, the authors gathered baseline data from a population-based Norwegian health study of 37,308 working-age people not claiming a disability pension through 1995–1997. The outcome was subsequent award of a disability pension (18–48 months after the health screening) as registered by the National Insurance Administration. Insomnia was a strong predictor of subsequent permanent work disability (adjusted odds ratio = 3.90, 95% confidence interval: 3.20, 4.76). Sociodemographic and shift-work characteristics had little confounding effect (adjusted odds ratio = 3.69, 95% confidence interval: 3.00, 4.53), and this association remained significant after adjustment for psychiatric and physical morbidity and for health-related behaviors (adjusted odds ratio = 1.75, 95% confidence interval: 1.40, 2.20). This study suggests that insomnia should receive increased attention as a robust predictor of subsequent work disability.

cohort studies; disability evaluation; logistic models; risk factors; sleep initiation and maintenance disorders; work

Abbreviations: CI, confidence interval; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition; HUNT-2, Nord-Trøndelag Health Study; OR, odds ratio.

Difficulties in initiating or maintaining sleep are common symptoms in the population. In the adult population of the United Kingdom, 29 percent report sleep problems over the past week (1). A diagnosis of insomnia is less common, but several studies show that approximately 10 percent of the adult population in Western societies suffers from chronic insomnia (2, 3), as specified in the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (DSM-IV) (4). Impaired sleep may be secondary to both physical and mental disorders (5), but about 25 percent of

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chronic insomniacs are assumed to suffer from primary insomnia (6).

The adverse individual consequences of insomnia are well documented. Poor sleep is associated with cognitive and intellectual impairment (7–9), current and subsequent affective disorders (10, 11), and reduced immune function (12). Moreover, patients suffering from insomnia commonly report a significant reduction in quality of life (13) and impaired coping abilities (14, 15).

Despite substantial evidence that insomnia has significant negative effects on various aspects of human functioning, surprisingly few studies have focused on the societal impact of insomnia. The economic costs resulting from sleep-related accidents and lost productivity are estimated to be $92–$107 billion annually (16) in the United States alone, including such government-financed expenses as medical treatment and drugs. However, the relation between insomnia and work disability has received little attention, and insomnia is at present not accepted as sufficient for issuing disability pensions. In cross-sectional surveys, poorer sleep has been shown to be associated with lower self-assessed working capacity and employment status (17), dissatisfaction with work and high levels of work stress (18), and self-reported sick leave (19, 20). In contrast, a cohort study of Norwegian nurses found no effect of sleep complaints on medium-term sickness absence 3 months later (21). To our knowledge, the only study so far that has examined the effect of impaired sleep on subsequent long-term work functioning found a single survey item measuring subjective sleep quality to be a significant predictor for self-reported sickness absence 4 years later, even after controlling for symptoms of both somatic and mental diseases (21).

The major problems of the published studies are 1) cross-sectional designs, which limit understanding of causality; 2) disparate definitions of insomnia, reducing the interpretability of previous results; and 3) that work disability is assessed by self-report only. The aim of our study was to estimate the direct effect of DSM-IV–defined insomnia on permanent work disability using a historical cohort design and, furthermore, to adjust the effect for physical and mental symptoms and conditions as well as other potential sociodemographic confounders and shift work.

MATERIALS AND METHODS

Design

A historical cohort study using baseline data on mental and somatic health obtained in the Nord-Trøndelag Health Study (HUNT-2) was carried out from August 1995 until June 1997. The outcome variable was award of a disability pension 18–48 months after participation in HUNT-2. By excluding all disability pensions awarded 0–18 months after participation in HUNT-2, we aimed to exclude subjects in the process of applying for a disability pension while they attended HUNT-2, thus reducing any possible protopathic bias.

Participants and procedures

All inhabitants of Nord-Trøndelag County, Norway, aged 20 years or older were invited to a clinical examination as part of a general health screening. In all, 92,100 persons aged 20–89 years were sent an initial questionnaire and an invitation to participate in HUNT-2. Of these, 65,648 (71 percent) attended the physical examination, where they received a second set of questionnaires, which 52,814 (80 percent) completed. Retired persons and individuals reaching the retirement age of 67 years during follow-up were excluded ($n = 11{,}123$); retirement because of old age precludes the award of a disability pension. HUNT-2 responders who were receiving a disability pension at baseline ($n = 3{,}964$) or who were granted a disability pension within 18 months after baseline ($n = 419$) were also excluded. Thus, the final study population included 37,308 persons: 19,936 women and 17,372 men. In a follow-up study of random dropouts (22), the two most common reasons for not attending the health screening were 1) not having time or experiencing a need for the health examinations and 2) grave disease. No information on disability awards was available for the nonresponders.

Measures

Disability pension award (dependent variable). The National Insurance Administration records all grants of disability pensions, which, in Norway, is solely a public responsibility. Correct registration is a prerequisite for transfers of payments; thus, the records are highly accurate. The criterion for being awarded a disability pension is an application from the general practitioner stating cause-specific and lasting reduced functional ability due to an acknowledged medical condition. Further examinations from organ-specific specialists are generally undertaken when appropriate, although independent examination is not required. In the last decade, approximately 20 percent of applications were rejected by the insurance case managers, most often because of incomplete evaluations or because the applicant attempted to obtain another job and/or received medical rehabilitation before the application was submitted.

Insomnia (exposure). The DSM-IV (4) criteria for insomnia include difficulty falling asleep, difficulty maintaining sleep, or experiencing nonrestorative sleep for a period of no less than 1 month. In addition, it is a prerequisite that the sleep disturbance significantly impairs daily functioning. In this study, a proxy for the DSM-IV insomnia diagnosis was based on three items, encompassing persons reporting sleep-onset or maintenance insomnia ''often'' or ''almost every night'' in the last month, in addition to reporting impaired work performance caused by the sleep problems during the last year.

To account for a possible circularity in classifying the outcome variable (permanent work disability) by the item on daytime work impairment, a second category, DSM-IV insomnia without daytime impairment, was constructed, otherwise similar to the former category. The remaining persons were categorized as ''unlikely'' to suffer from insomnia. All three categories were mutually exclusive.

Anxiety and depression. The Hospital Anxiety and Depression Scale (23) is a self-report questionnaire comprising 14 four-point Likert-scaled items, seven for anxiety (Hospital Anxiety and Depression Scale-A) and seven for depression

(Hospital Anxiety and Depression Scale-D). No somatic items or items regarding sleeping difficulties are included. In a recent literature review covering 31 studies, the Hospital Anxiety and Depression scale was found to have good case-finding properties for anxiety and depression in patient populations in primary care and hospital settings (24). A cutoff score of 8 on either subscale provides an optimal balance between sensitivity and specificity at about 0.80 for both depression and anxiety according to the *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition, and DSM-IV and to the *International Classification of Diseases*, Eighth Revision and Ninth Revision. By using these cutoffs, four groups were identified: baseline anxiety only, baseline depression only, baseline comorbid anxiety and depression, and a reference group (no disorder). In addition, a dummy variable, indicating anxiety and/or depression, was constructed for tests of interactions with age and gender.

Physical health in HUNT-2. Physical health was assessed in two separate ways, as described previously by Mykletun et al. (25):

1. The index for *somatic symptoms* was computed as the sum of organ systems from which symptoms were reported. These organ systems were weighted as described in the analyses. Included were gastrointestinal symptoms (four questions on nausea, heartburn, diarrhea, and constipation); musculoskeletal symptoms (pain in the neck, shoulders, elbows, hands, breasts, back (three areas), hips, knees, and ankles); the head (two questions on headache and migraine), the senses (two questions on hearing and sight); the heart (one question on palpitations); and respiratory function (one question on respiratory problems).
2. The index for self-reported *somatic diagnoses* comprised asthma, angina pectoris, stroke, myocardial infarction, diabetes, goiter, hypo- and hyperthyroid function, other diseases of the thyroid gland, fibromyalgia, osteoporosis, arthritis, rheumatism, ankylosing spondylitis, cancer, epilepsy, high blood pressure (being treated or monitored), and any other illness (one open item).

Sociodemographic variables and health-related behavior. Information on gender and on age at the time of the HUNT-2 study was obtained from the national population registry. Socioeconomic status and educational level have previously been shown to be associated with receiving a disability pension (26). Socioeconomic status was measured by using a validated approximation from the HUNT-2 study (27). Educational level (three levels), night/shift work, daily cigarette smoking, consuming too much alcohol during the last 14 days, and being physically active for 1 or more hours in the last week were recorded by self-report.

Statistics

The physical health measures (indices for symptoms and diagnoses) were weighted for their partial associations with physician-certified sick leave; two separate regression models were used to estimate weights for the diagnoses and symptoms included in the indices. Unstandardized regression coefficients were used as weights, and the indices were computed as a sum of products between the standardized symptoms and diagnoses and their weights.

Logistic regression analysis was used to examine the relation between insomnia and award of a disability pension. In this paper, results are presented as odds ratios with 95 percent confidence intervals. Possible confounders were entered into the model for adjustment in the following order: gender and age, sociodemographic factors, night/shift work, health behaviors, anxiety and depression (using ordinal transformations), somatic diagnosis, and somatic symptoms. Pearson chi-square tests were used to examine differences between baseline demographic and clinical characteristics in 1995–1997 and permanent work disability at follow-up. The Pearson chi-square test was also used to examine the causes of permanent work disability for those experiencing or not experiencing insomnia.

Ethics

HUNT-2 was approved by the National Data Inspectorate and the Board of Research Ethics in Health Region IV of Norway. Informed consent in writing was obtained from all subjects included in this study.

RESULTS

Sample characteristics

The baseline characteristics of the 37,308 persons who completed the insomnia questionnaire are shown in table 1 stratified by diagnostic classification. The prevalence rate for insomnia was 4.4 percent, while a further 5.8 percent of participants experienced insomnia without impairment. Insomnia was more prevalent among women and persons with lower educational levels, and sleep problems increased significantly with older age. Greater cigarette use and alcohol intake, and less exercise, were associated with increasing reports of sleep problems at baseline. Both self-reported somatic symptoms and diagnosis were strongly associated with increasing sleep disturbances, as were anxiety and depression (table 1).

Predictors of a disability pension award

In all, 915 persons were granted a permanent disability pension 18–48 months after baseline assessment. Female gender, older age, and the health-related behaviors of smoking, excessive consumption of alcohol, and being physically inactive were associated with a greater likelihood of receiving a subsequent disability pension, as were, unsurprisingly, self-reported symptoms, somatic diagnoses, anxiety, and depression (table 2).

The predictive effect of insomnia on disability

Persons with insomnia and impairment had a strongly elevated risk of subsequently being awarded a disability pension during follow-up (odds ratio (OR) = 3.90, 95 percent

TABLE 1. Baseline demographic and clinical characteristics of persons who completed the insomnia questionnaire in the Nord-Trøndelag Health Study, Norway, 1995–1997*,†

Characteristic	Unlikely insomnia	Insomnia without daytime work impairment	Insomnia
No. of persons (%)	33,508 (89.8)	2,155 (5.8)	1,645 (4.4)
Age (years)‡	41.9 (41.8, 42.1)	46.8 (46.3, 47.4)	43.4 (42.8, 44.0)
Gender: female (%)	52.9	58.1	58.4
Socioeconomic status (%)			
I (highest)	9.4	8.8	8.4
II	17.4	13.2	17.7
III	19.4	19.0	19.4
IV	15.7	15.0	15.1
V + VI	12.0	11.1	9.2
VII (lowest)	15.7	19.4	17.5
Not working or not applicable	10.4	13.5	12.6
Education (%)			
Compulsory school only	23.9	23.9	29.4
College	50.0	50.0	47.4
University level	26.0	26.0	23.3
Night/shift work (%)	19.7	19.2	21.0
Daily cigarette smoking (%)	18.8	23.1	23.1
Consumption of too much alcohol in the last 14 days (%)	11.4	15.0	16.0
Physically active ≥1 hour during the last week (%)	76.3	72.9	70.0
Anxiety‡	3.90 (3.86, 3.93)	5.61 (5.46, 5.76)	7.95 (7.75, 8.15)
Depression‡	2.87 (2.84, 2.89)	4.21 (4.07, 4.34)	5.70 (5.51, 5.88)
No. of somatic diagnoses‡	0.25 (0.25, 0.26)	0.42 (0.39, 0.45)	0.47 (0.43, 0.50)
No. of self-reported symptoms‡	1.46 (1.45, 1.47)	2.01 (1.96, 2.06)	2.53 (2.47, 2.58)
Disability pension at follow-up (% (no. of persons))	2.0 (686)	4.9 (105)	7.5 (124)

* All group differences for insomnia, except night/shift work, were statistically significant ($p < 0.001$).
† Some percentages do not total 100 because of rounding.
‡ Values are expressed as mean (95% confidence interval).

confidence interval (CI): 3.20, 4.76; table 3). This effect was only marginally attenuated after adjustment for age, gender, and baseline sociodemographic variables and health behaviors (OR = 3.57, 95 percent CI: 2.91, 4.39). Adjusting for anxiety and depression explained a substantial part of this effect (OR = 2.29, 95 percent CI: 1.83, 2.87), and further adjustment for somatic diagnoses reduced the odds ratio to 2.02 (95 percent CI: 1.61, 2.53). The confounding effects of somatic symptoms further explained some of this association, although the effect of insomnia remained highly significant (OR = 1.75, 95 percent CI: 1.40, 2.20; $p < 0.001$).

Persons with insomnia but no impairment showed a significant, but reduced risk of subsequently being awarded a disability pension (OR = 2.45, 95 percent CI: 1.99, 3.02). However, adjustment for the above confounders suggested no independent effect on disability pension award (OR = 1.19, 95 percent CI: 0.95, 1.49).

Musculoskeletal disorders were the most prevalent causes, accounting for almost 50 percent of all new disability awards (table 4) in all three groups. Psychiatric disorders were a significantly more prevalent cause among persons suffering from insomnia with impairment (23.4 percent) compared with insomnia without impairment (13.3 percent) and no insomnia (13.6 percent) ($\chi^2 = 10.79$, df = 4, $p = 0.03$). The remaining causes, cancer and cardiovascular diseases being the most prevalent, accounted for only 29 percent in the insomnia group compared with 40.5 percent in the group with no insomnia.

DISCUSSION

Using a historical cohort design, we found that insomnia at baseline was a significant risk factor for subsequent award of a disability pension. Almost half of this effect was not explained by the sleep disturbance being associated with anxiety and depression, somatic diagnoses, and somatic symptoms.

TABLE 2. Baseline demographic and clinical characteristics, and cumulative incidence of disability pensions at follow-up, for persons in the Nord-Trøndelag Health Study, Norway, 1995–1997

Characteristic	No. of cases	Cumulative incidence of disability pensions at follow-up	
		%	No. of cases
Age (years)**			
20–29	6,776	0.3	23
30–39	9,096	0.9	79
40–49	10,290	1.7	172
50–59	7,465	5.4	402
60–65	3,681	6.5	239
Gender*			
Female	19,936	2.6	527
Male	17,372	2.2	388
Socioeconomic status**			
I (highest)	3,487	1.5	54
II	6,405	2.0	129
III	7,229	2.6	187
IV	5,818	2.7	159
V + VI	4,397	1.8	81
VII (lowest)	5,978	3.2	189
Not working or not applicable	3,994	2.9	116
Education**			
Compulsory school only	9,314	5.0	464
College	18,501	1.7	316
University level	9,493	1.4	135
Night/shift work*			
No	29,963	2.6	765
Yes	7,345	2.0	150
Daily cigarette smoking**			
No	30,136	2.1	634
Yes	7,172	3.9	281
Consumption of too much alcohol in the last 14 days**			
No	32,898	2.3	763
Yes	4,410	3.4	152
Physically active ≥1 hour during the last week**			
No	9,002	3.5	316
Yes	28,306	2.1	599
Anxiety**			
HADS†-A score <8	32,011	2.1	676
HADS-A score ≥8	5,297	4.5	239
Depression**			
HADS-D score <8	34,370	2.2	741
HADS-D score ≥8	2,938	5.9	174
No. of somatic diagnoses**			
0	29,117	1.5	450
1	6,543	4.9	321
2	1,272	9.0	114
≥3	376	8.0	30
No. of self-reported symptoms*			
0	8,365	0.9	73
1	11,154	1.9	212
2	9,582	2.7	256
3	5,720	3.7	211
≥4	2,487	6.6	163

* $p < 0.05$; ** $p < 0.001$.

† HADS, Hospital Anxiety and Depression Scale.

TABLE 3. Effect of insomnia on risk of permanent work disability for persons in the Nord-Trøndelag Health Study, Norway, 1995–1997*

Adjustment variables	Insomnia without daytime work impairment (n = 2,155; 5.8%)		Insomnia (n = 1,645; 4.4%)	
	OR†	95% CI†	OR	95% CI
Crude	2.45	1.99, 3.02	3.90	3.20, 4.76
+ Age and gender	1.77	1.42, 2.19	3.70	3.02, 4.54
+ Socioeconomic status and education	1.71	1.38, 2.12	3.69	3.00, 4.53
+ Night/shift work	1.71	1.38, 2.12	3.69	3.00, 4.53
+ Smoking, alcohol consumption, and physical activity	1.70	1.37, 2.11	3.57	2.91, 4.39
+ Anxiety and depression	1.40	1.13, 1.75	2.29	1.83, 2.87
+ Somatic diagnoses	1.28	1.03, 1.60	2.02	1.61, 2.53
+ Somatic symptoms‡	1.19	0.95, 1.49	1.75	1.40, 2.20

* All new disability pensions: n = 915; population at risk: n = 37,308.

† OR, odds ratio; CI, confidence interval.

‡ Weighted for absence due to sickness 1 year before baseline measurement.

Methodological aspects

The present study has several strengths arising mainly from the cohort design. The study sample was large, and the participation rate at baseline was high. Both exposure and outcome assessments should be relatively unbiased. At baseline measurement, neither participants nor administrators were aware of the specific research hypotheses, which reduced the possibility of information being biased by selective symptom presentation in order to gain access to, or avoid, benefits. Disability pension status at baseline and at follow-up was ascertained from the National Insurance Administration. These data are complete (those persons moving to other parts of the country after participating in HUNT-2 are still registered) and should not have been influenced by exposure status.

There are several limitations of our study. First, no data on disability awards were available for the nonresponse group, and selection bias cannot be ruled out. In the Hordaland Health Study (HUSK; comparable to the HUNT study, but the age range of participants was more limited), the rate of disability pensioning was higher among the nonattendees than among participants, which is likely also the case in the HUNT study. Second, measurement of insomnia was established by self-report rather than clinical diagnosis and did not encompass an item on the duration of insomnia. Beyond the duration criterion, the questionnaire used in this study was tailored to meet the criteria for insomnia as specified by DSM-IV. The prevalence rate found in the present study is still somewhat lower than previously reported, suggesting a conservative estimate (2, 3). The absence of the duration

TABLE 4. Comparison of causes of disability in persons with and without insomnia in the Nord-Trøndelag Health Study, Norway, 1995–1997

Primary cause	Reference group ($n = 686$)			Insomnia without daytime work impairment ($n = 105$)			Insomnia with daytime work impairment ($n = 124$)		
	No. of cases	%	95% CI*	No. of cases	%	95% CI	No. of cases	%	95% CI
Psychiatric disorders	93	13.6	11.0, 16.1	14	13.3	16.8, 19.8	29	23.4	15.9, 30.8
Musculoskeletal disorders	315	45.9	42.2, 49.6	51	48.6	39.0, 58.1	59	47.6	38.8, 56.4
Other causes	278	40.5	36.9, 44.2	40	38.1	28.8, 47.4	36	29.0	21.0, 37.0

* CI, confidence interval.

criterion in our questions on insomnia may have reduced the specificity of the measure and thus underestimated the true association. However, when the curvilinear association between age and insomnia is considered, the prevalence rates most likely depict a reasonable estimate of insomnia because our population consisted of all working persons under the age of 67 years.

Third, our adjustments in the final analyses most likely did not capture and fully attenuate all possible confounding from chronic somatic or psychiatric conditions. Self-report instruments are prone to error, and residual confounding cannot be ruled out. Screening for psychiatric morbidity was limited to symptoms of anxiety and depression only and was conducted by using a relatively short inventory not including vegetative symptoms of anxiety and depression. In some cases, depression may be largely presented and experienced through these kinds of symptoms (28). Thus, those with subthreshold depression may have been overrepresented within the insomniacs, thus underestimating the true confounding effect of psychiatric morbidity. Furthermore, the impacts of, for example, psychoses or other psychiatric conditions are likely to have been only partly captured. Although the subjects were given one open answer category for ''other diseases,'' this option is not sufficient to capture all relevant diseases and symptoms because it demands subjective insight into psychiatric morbidity. However, it is commonly held that serious psychopathology increases the risk of being a nonattendee in epidemiologic studies (29), thus limiting the potential problem of psychopathology not being registered by the procedures we used. Information on somatic diagnoses and symptoms was self-reported, and the categories used were not exhaustive. If such diagnoses and symptoms were underreported, the effects of insomnia may in turn have been overestimated. However, in our fully adjusted model, insomnia was considered to predict disability pension only if reported somatic diagnoses, somatic symptoms, anxiety, or depression did not serve as a possible explanation. Because this model assumed that the insomnia was secondary in all instances of simultaneous occurrences, there is a risk that we underestimated the strength of the association of insomnia with later disability pension.

Finally, other potential confounders such as incipient cognitive decline, poor coping, and work pressures were not captured in our measures, but they may be related to both baseline insomnia (sleep disturbance symptoms are far more prevalent in the population than the diagnoses used in these regression models) and later disability pension. The lower association of disability with insomnia without impairment suggests that work problems and other functional limitations may be acting as unmeasured confounders.

Insomnia and disability

To our knowledge, the present study is the first to document an independent association between insomnia and subsequent permanent work disability in a prospective study. In contrast to all previous studies, ours used official records of disability pensions as the measure of work disability. Self-reports of work disability are likely to be less accurate than official records, leaving open the possibility that subjective experience of work disability is being measured, not de facto work disability. Because previous research largely has been cross-sectional, the direction of the relation and causal pathways has been difficult to determine (17). The association between poor sleep and work disability is commonly thought to be mediated through somatic or psychological factors, which may explain previous neglect of this topic. This assumption is well founded because, in addition to being linked to various medical conditions (30), impaired sleep often is a core symptom of several psychiatric disorders (4) and has been shown to precede both depression and anxiety (31, 32). Psychological morbidity, in turn, has been shown to play a considerable role in explaining permanent work disability (25). However, although we cannot rule out the possibility of residual confounding, our study suggests that insomnia is independently associated with subsequent work disability and that this relation remains significant even after adjustment for a range of clinical and demographic confounders. Furthermore, common behavioral factors often linked with sleep disturbance, such as shift work, physical exercise, and alcohol intake, did not attenuate or mediate this association. This finding suggests that the link may be through unmeasured factors warranting further exploration, and policy attempts to reduce the rising disability pension burden in Organisation for Economic Co-operation and Development (OECD, Paris, France) countries need to acknowledge this situation. Because insomnia is associated with several social dysfunctions, establishing effective preventive strategies and low-threshold treatment options for insomnia might be beneficial.

ACKNOWLEDGMENTS

Conflict of interest: none declared.

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