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# The effect of OSAS on sick leave and work disability

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**ABSTRACT: The objective of the present study was to examine the independent contribution of symptoms of obstructive sleep apnoea syndrome (OSAS) to long-term sick leave and permanent work disability.**

**Using a historical cohort design with 4 yrs of follow-up, information on sick leave and disability benefit recipiency were merged with health information from the Hordaland Health Study, carried out in western Norway during 1997–1999. Persons aged 40–45 yrs (n=7,028) were assessed for self-reported symptoms of OSAS (snoring, breathing cessations and daytime sleepiness), body mass index, somatic conditions and other potential confounders. The outcomes, cumulative sick leave of ⩾8 weeks and permanent work disability, were identified in records from the National Insurance Administration.**

**After excluding participants with work disability at baseline, symptoms of OSAS were found to be a significant predictor of both subsequent long-term sick leave and permanent work disability. These effects remained significant after adjustment for a range of possible confounding factors. Daytime sleepiness showed the greatest explanatory power, followed by breathing cessations and snoring.**

**It is concluded that self-reported symptoms of obstructive sleep apnoea syndrome are an independent risk factor for subsequent long-term sick leave and permanent work disability. These findings need to be replicated using objective measures of obstructive sleep apnoea syndrome.**

**KEYWORDS: Epidemiology, obstructive, population-based, risk factors, sickness absence, sleep apnoea**

Obstructive sleep apnoea syndrome (OSAS) is a sleep disorder in which the upper airway closes repeatedly during sleep, leading to sleep fragmentation and decreased levels of oxyhaemoglobin saturation [1]. The prevalence of OSAS is estimated to be ~5% [2–8], but the at-risk population is likely to be much larger [9]; only 10% of the population are adequately screened for this diagnosis [10]. Clinically characterised by snoring, breathing cessations and extreme daytime somnolence [11], OSAS has been shown to be a risk factor for a range of medical conditions, including glucose intolerance [12], impotence [13], hypertension [14], myocardial infarction [15], and stroke and mortality [16]. Untreated OSAS also increases the risk of automobile accidents [17], leads to poor quality of life [18] and has been linked with several neurocognitive consequences [19, 20].

In addition to such impacts on individual health, an Australian study recently estimated the economic costs of sleep disorders (OSAS and insomnia being the most important) to represent almost 1% of Australia's gross domestic product [21]. In addition, despite previous studies consistently showing self-reported sleep problems in general to be a significant risk factor for both long-term sick leave and permanent work disability determined objectively [22–24], the only recent study investigating OSAS severity and self-reported work limitation yielded mixed results [25]. To the best of the present authors' knowledge, no studies to date have prospectively aimed to study the independent effects of symptoms of OSAS on long-term sick leave or permanent work disability.

Although polysomnography (PSG) is recommended for making the diagnosis of OSAS, it is not easily applied in large population-based studies, being intrusive, impractical and expensive. Therefore, screening instruments based on self-reported symptoms of OSAS have been necessary in order to gain information on both

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the prevalence and comorbid conditions of OSAS [3, 4, 9], information that would be hard to obtain without using large-scale surveys.

The aim of the present study was to estimate the effect of self-reported symptoms of OSAS on both long-term sick leave and permanent work disability, using a historical cohort design. Importantly, the aim was also to adjust for the effect of a range of possible confounding and mediating factors known to be associated with OSAS, including demographic factors, lifestyle behaviours, marital/cohabitant status, body mass index and blood pressure, as well as other physical diagnoses and conditions.

## METHODS

### *Population and data material*

The Hordaland Health Study (HUSK) was a joint epidemiological research project carried out during 1997–1999 by the Norwegian Health Screening Service (Oslo, Norway) in collaboration with the University of Bergen (Bergen, Norway). The base population included 29,400 individuals in the county of Hordaland (western Norway) born during 1953–1957 and aged 40–45 yrs at the time of data collection. Data were collected by questionnaire and clinical examination. A total of 18,581 subjects (8,598 males and 9,983 females) both answered the basic questionnaire and attended for clinical examination, yielding a participation rate of 63% (57% for males and 70% for females).

After the clinical examination, a second questionnaire, including the OSAS items, was distributed and completed by a random subgroup comprising 8,896 individuals. Owing to nonresponse to one or more of the variables relevant to the present study in the second set of questions, 1,600 individuals were excluded. HUSK responders who were receiving disability pension at baseline or who were granted disability pension awards within 12 months following baseline were also excluded (n=268), as were also individuals on sick leave at the time of the HUSK and 14 days thereafter. Thus, the final population consisted of 7,028 individuals.

### *Measures*

#### Outcome

The Norwegian National Insurance Administration (Oslo, Norway) records all periods of sick leave of >14 days, as well as all disability pension awards. In Norway, this is in all respects a public responsibility, and, since correct registration is a prerequisite for transfers of payments, the records are highly accurate.

In the present study, long-term sick leave was defined as cumulative sick leave of $\geqslant$8 weeks (56 days). A cut-off of 8 weeks has also been used in similar studies to denote long term [23, 26].

Permanent work disability was defined as award of a disability pension 12–48 months after participation in the HUSK. By excluding all disability pensions awarded from baseline to 12 months after participation in the HUSK, the aim was to exclude subjects in the process of applying for a disability pension while they attended the HUSK, thus reducing any possible protopathic bias. In the present study, the term work disability is synonymous with disability pension award. The criterion for being awarded a disability pension is a $\geqslant$50% permanently reduced work ability due to an acknowledged medical condition as certified by a general practitioner. Examinations by a specialist are undertaken when appropriate, although such independent examination is not required.

#### Exposure

Symptoms of OSAS were estimated using three items from the Karolinska Sleep Questionnaire [27]. These self-report items were used to identify at-risk individuals based on their own or their partner's reports on snoring and breathing cessation during sleep. In addition to the requirement for reporting both of these core symptoms as occurring either ''sometimes (several times a month)'', ''often (several times a week)'' or ''always'', participants were only classified as having symptoms of OSAS if they were also ''tired or sleepy at work or during their spare time'' ''sometimes'', ''often'' or ''always''. A similar definition based on the Hawaii Sleep Questionnaire (the apnoea score) has previously been shown to identify 100% of cases with moderate or severe sleep apnoea (apnoea/hypopnoea index (AHI) of >40) and 75% of all sleep apnoea cases with an AHI of >5, yielding an overall predictive accuracy of 88% for an AHI of >10 [28].

#### Potential confounders

Alcohol consumption was operationalised using four categories based on self-reported weekly consumption (0, 1–2, 3–4 and $\geqslant$5 units·week$^{-1}$). Body mass index was calculated from body weight (in kilograms) divided by height (in metres) squared obtained from clinical examination. Level of education was reported in four categories ranging from <7 yrs of schooling to $\geqslant$4 yrs of higher education at college/university. Type of main occupation was manually classified according to the European Union variant of the International Standard Classification of Occupations (ISCO-88 (COM)) [29] and divided into the 10 major groups (*e.g.* professionals). A detailed description of these categories is provided elsewhere [30]. Data were also collected on marital/cohabitant status (dichotomised into living alone or with partner), smoking status (current smoker or not) and weekly level of exercise (1: no or easy physical activity for 1 h·week$^{-1}$; 2: moderate physical activity for 1–2 h·week$^{-1}$; or 3: hard physical activity for >2 h·week$^{-1}$). Data on blood pressure were collected during the clinical examinations.

Symptoms of current depression were measured using the depression subscale of the hospital anxiety and depression scale [31], which is a self-report questionnaire comprising 14 four-point Likert-scaled items, seven of which are used to construct the depression subscale. No somatic items or items regarding sleeping difficulties are included. The scale was used as a continuous variable, reflecting symptom load of depression.

Questions on somatic diagnoses were framed in the form: ''do you have or have you had (one or more of the following)'' myocardial infarction, stroke, diabetes and angina. A positive response to one or more of these items was considered a positive self-reported diagnosis. In addition, participants were asked whether or not they had used any medication on the previous day, and, if so, for which condition. From these responses, a team of physicians determined appropriate

diagnoses according to anatomical therapeutic chemical classifications, producing a continuous variable indicating the number of conditions for which the person was taking medication.

In the present article, no discrimination was made between confounding and mediating factors.

### *Statistical analysis and models*

Pearson's Chi-squared tests were used to examine differences in baseline demographic and clinical characteristics in persons with and without symptoms of OSAS. Multivariate logistic regression analysis was used to examine the relation between symptoms of OSAS and sick leave and award of a disability pension. In order to avoid double counting, participants who were granted disability pension awards during the follow-up (n=139) were excluded from the sick leave analyses. However, because of the high prevalence of sick leave, participants on sick leave (n=1,790) were not excluded when work disability was the outcome measure. Data are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The following potential confounders (determined *a priori*) were entered into the model for adjustment in: 1) demographic characteristics (age and education), 2) marital/cohabitant status, 3) health behaviours (smoking, alcohol and physical exercise), 4) body mass index, 5) systolic blood pressure, 6) somatic diagnoses (angina, stroke, diabetes and myocardial infarction), and 7) prescribed drugs.

### *Ethics*

The study protocol was cleared by the Regional Committee for Medical Research Ethics of Western Norway and approved by the Norwegian Data Inspectorate (both Bergen, Norway). Informed consent was obtained in writing from all subjects included in the present study.

## RESULTS

### *Sample characteristics*

The baseline characteristics of the 7,028 participants that completed the OSAS questionnaire are shown in table 1. The prevalence rate of OSAS was found to be 6.3%. Symptoms of OSAS were more prevalent among males and persons with low educational level. Being a current smoker, less exercise, higher alcohol consumption and high body mass index were all associated with reported symptoms of OSAS. Higher systolic blood pressure was also associated with reported symptoms of OSAS, whereas angina, stroke, diabetes and myocardial infarction were not (table 1).

### *The effect of symptoms of obstructive sleep apnoea syndrome on sick leave*

Persons reporting symptoms of OSAS showed an almost doubled OR for subsequent sick leave during follow-up adjusting for sex alone (OR 1.78 (95% CI 1.42–2.20); table 2). Adjusting for age and education reduced the OR to 1.70, whereas controlling for either body mass index or depression reduced the OR to 1.71. Health behaviours, including smoking, alcohol and physical exercise, had a slightly larger explanatory effect on the relationship between OSAS and sick leave, with an adjusted OR of 1.67 (95% CI 1.33–2.08). However, even in

**TABLE 1** Baseline demographic and clinical characteristics of participants with and without self-reported obstructive sleep apnoea syndrome (OSAS) symptoms in the Norwegian Hordaland Health Study

| Characteristics | OSAS symptoms | | p-value |
|---|---|---|---|
| | Absent | Present | |
| **Subjects** | 6588 (93.7) | 440 (6.3) | |
| **Sex** | | | <0.001 |
| Male | 36.6 | 65.2 | |
| Female | 63.4 | 34.8 | |
| **Living with partner** | 76.5 | 73.6 | 0.18 |
| **Education** | | | 0.002 |
| Primary | 16.7 | 20.7 | |
| Secondary | 45.0 | 49.3 | |
| 1–3 yrs higher | 19.8 | 17.5 | |
| ⩾4 yrs higher | 18.4 | 12.5 | |
| **Occupational type#** | | | <0.001 |
| Legislators/senior officials/managers | 15.1 | 18.0 | |
| Professionals | 9.1 | 7.3 | |
| Technicians/associate professionals | 22.1 | 19.0 | |
| Clerks | 13.8 | 14.6 | |
| Shop/market sales and service workers | 20.4 | 13.9 | |
| Agricultural/forestry/ fishery workers | 2.0 | 1.0 | |
| Craft and related trades workers | 7.3 | 13.4 | |
| Plant/machine operators/ assemblers | 4.7 | 7.1 | |
| Elementary occupations | 5.0 | 4.4 | |
| Armed forces | 0.4 | 1.2 | |
| **Current smoker** | 32.6 | 48.0 | <0.001 |
| **Alcohol consumption** | | | <0.001 |
| 0 units·week$^{-1}$ | 29.0 | 22.7 | |
| 1–2 units·week$^{-1}$ | 41.8 | 37.3 | |
| 3–4 units·week$^{-1}$ | 14.6 | 12.5 | |
| ⩾5 units·week$^{-1}$ | 14.6 | 27.5 | |
| **Physical exercise** | | | 0.14 |
| No or easy | 29.3 | 33.4 | |
| Moderate | 57.0 | 55.0 | |
| Heavy | 13.7 | 11.6 | |
| **Body mass index** | | | <0.001 |
| <25 | 55.0 | 36.8 | |
| 25–30 | 35.8 | 41.6 | |
| >30 | 9.2 | 21.6 | |
| **Angina** | 0.3 | 0.2 | 1.00 |
| **Stroke** | 0.3 | 0.2 | 1.00 |
| **Diabetes** | 0.7 | 0.9 | 0.56 |
| **Myocardial infarction** | 0.2 | 0.5 | 0.17 |
| **Depression** | 2.97 (2.90–3.04) | 4.26 (3.97–4.55) | <0.001 |
| **Blood pressure (systolic)** | 125.9 (125.6–126.3) | 129.8 (128.5–131.1) | <0.001 |
| **Prescribed drugs** | 0.08 (0.07–0.09) | 0.07 (0.04–0.09) | 0.87 |

Data are presented as n (%), % or mean (95% confidence interval), unless otherwise indicated. #: listed in descending order from white- to blue-collar occupations (see [30]). 1 unit alcohol≈12 g ethanol.

**TABLE 2** Multivariate logistic regression analyses of the effect of self-reported symptoms of obstructive sleep apnoea syndrome (OSAS) on long-term[#] sick leave in the Norwegian Hordaland Health Study

| Adjustment variables | OSAS symptoms OR (95% CI) |
|---|---|
| **Sex alone** | 1.78 (1.42–2.20) |
| **Age and education** | 1.70 (1.36–2.13) |
| **Occupational type** | 1.83 (1.46–2.29) |
| **Marital/cohabitant status** | 1.77 (1.42–2.21) |
| **Smoking, alcohol and physical exercise** | 1.67 (1.33–2.08) |
| **Body mass index** | 1.71 (1.36–2.13) |
| **Angina, stroke, diabetes and myocardial infarction** | 1.79 (1.43–2.25) |
| **Depression** | 1.71 (1.37–2.14) |
| **Blood pressure (systolic)** | 1.78 (1.42–2.22) |
| **Prescribed drugs** | 1.78 (1.42–2.22) |
| **Fully adjusted model[¶]** | 1.62 (1.28–2.05) |

Of the at-risk population of 6,919 subjects, 1,824 had had ⩾8 weeks of sick leave. OR: odds ratio; CI: confidence interval. [#]: ⩾8 weeks; [¶]: adjusting for all of the above confounders.

**TABLE 3** Multivariate logistic regression analyses of the effect of self-reported symptoms of obstructive sleep apnoea syndrome (OSAS) on permanent work disability in the Norwegian Hordaland Health Study

| Adjustment variables | OSAS symptoms OR (95% CI) |
|---|---|
| **Sex alone** | 2.40 (1.38–4.19) |
| **Age and education** | 2.20 (1.26–3.85) |
| **Occupational type** | 2.35 (1.26–4.38) |
| **Marital/cohabitant status** | 2.39 (1.37–4.17) |
| **Smoking, alcohol and physical exercise** | 1.99 (1.13–3.50) |
| **Body mass index** | 2.26 (1.29–3.97) |
| **Angina, stroke, diabetes and myocardial infarction** | 2.40 (1.37–4.19) |
| **Depression** | 2.02 (1.15–3.56) |
| **Blood pressure (systolic)** | 2.30 (1.32–4.02) |
| **Prescribed drugs** | 2.45 (1.40–4.28) |
| **Fully adjusted model[#]** | 1.92 (1.01–3.66) |

Of the at-risk population of 7,028 subjects, 139 had a subsequent disability pension award. OR: odds ratio; CI: confidence interval. [#]: adjusting for all of the above confounders.

the fully adjusted model, symptoms of OSAS remained a significant risk factor for long-term sick leave (adjusted OR 1.62 (95% CI 1.28–2.05)).

### *The effect of symptoms of obstructive sleep apnoea syndrome on disability pension award*

Persons reporting symptoms of OSAS showed a more than doubled OR for subsequent award of a disability pension during follow-up, and adjusting for sex, age and education only slightly attenuated the association (adjusted OR 2.20 (95% CI 1.26–3.85); table 3). Health behaviours also explained some of this association (adjusted OR 1.99), as did depression (adjusted OR 2.02). As was the case for sick leave, neither occupational type, marital status, prescribed drugs, blood pressure, angina, stroke, diabetes nor myocardial infarction had a significant explanatory effect on the relationship between OSAS and work disability. When adjusting for the entire list of confounders, symptoms of OSAS remained a significant risk factor for permanent work disability (OR 1.92 (95% CI: 1.01–3.66)).

### *The separate effects of breathing cessations, snoring and daytime sleepiness*

In order to examine which of the components (breathing cessations, snoring or daytime sleepiness) had the greatest explanatory power on sick leave and permanent work disability, additional analyses were conducted on each of the three components included in the OSAS variable. As detailed in table 4, daytime sleepiness was a stronger risk factor than snoring and breathing cessations for both sick leave (adjusted OR 1.36) and work disability (adjusted OR 2.03). Snoring was only significantly associated with subsequent sick leave in the crude analyses (OR 1.15 (95% CI 1.10–1.21)), whereas breathing cessations also remained a significant risk factor in the fully adjusted analyses for sick leave (adjusted OR 1.08 (95% CI 1.01–1.66)), but not for work disability.

As detailed in figure 1, there was a dose–response relationship between the frequency of symptoms and long-term sick leave. Experiencing each of the symptoms always yielded higher ORs compared to often or sometimes. This effect was more evident in terms of daytime sleepiness, followed by breathing cessations and snoring. A similar dose–response relationship was also found when the outcome was permanent work disability.

## DISCUSSION

In the present study, it was found that self-reported symptoms of OSAS (snoring, breathing cessations and daytime sleepiness) were a strong risk factor for both subsequent long-term sick leave and award of disability pensions. Daytime sleepiness had the strongest explanatory effect, but breathing cessations and snoring also contributed to the effect of OSAS on these adverse outcomes. As expected, a range of adverse sociodemographic characteristics and health behaviours and states were associated with OSAS, which partly explained this association. However, even controlling for all of these factors, OSAS remained a strong risk factor for these poor outcomes.

These findings add to the understanding of OSAS as a sleep disorder with serious consequences, both individual and social. In addition to being a risk factor for a range of medical conditions [12–16], OSAS has also been demonstrated to cause variable degrees of cognitive and performance problems. Although the causal mechanisms leading to such deficits remain unclear, postulated mediating conditions (*e.g.* hypertension, angina, myocardial infarction, diabetes and stroke) of

**TABLE 4** Multivariate logistic regression analyses of the effect of items comprising the obstructive sleep apnoea syndrome variable on long-term[#] sick leave and permanent work disability in the Norwegian Hordaland Health Study

| Outcome/model | Composite variable | Breathing cessations | Snoring | Daytime sleepiness |
|---|---|---|---|---|
| **Long-term sick leave** | | | | |
| Crude | 1.78 (1.42–2.20) | 1.23 (1.15–1.32) | 1.15 (1.10–1.21) | 1.37 (1.28–1.47) |
| Fully adjusted | 1.62 (1.28–2.05) | 1.08 (1.01–1.16) | 1.03 (0.98–1.08) | 1.36 (1.27–1.46) |
| **Permanent work disability** | | | | |
| Crude | 2.40 (1.38–4.19) | 1.32 (1.10–1.60) | 1.08 (0.94–1.25) | 2.26 (1.85–2.76) |
| Fully adjusted | 1.92 (1.01–3.66) | 1.09 (0.88–1.35) | 0.93 (0.79–1.10) | 2.03 (1.61–2.57) |

Data are presented as odds ratio (95% confidence interval). [#]: ⩾8 weeks.

the effect of OSAS had no explanatory power in the present models, suggesting that the symptoms of OSAS do not lead to these negative outcomes through these mechanisms. OSAS patients have been shown to report problems in cognitive processing, memory, sustained attention and executive functioning [32]. As such, untreated OSAS represents a major problem for the patient 24 h per day, with impaired daytime functioning, expressed as forgetfulness, impaired concentration, and slowed thought processes and responses. It comes as no surprise, then, that having symptoms of OSAS is associated with subjective reported problems in work performance [33]. Although sleep complaints in general have been found to predict later work disability [24], to the present authors' knowledge, only three other studies have examined the relation between OSAS and work performance. In a retrospective Swedish study, self-reported symptoms of OSAS were found to be significantly associated with short-term sick leave and psychosocial morbidity in a sample of obese persons [34]. In this study, persons with OSAS reported, on average, 5 weeks more sick leave over the previous year than those without OSAS, an effect that remained significant after adjusting for the presence of other common disorders, such as hypertension and diabetes. In another recent study, MULGREW *et al.* [25] found no relationship between OSAS severity and self-reported work limitation in white-collar workers, whereas such an association was present in blue-collar workers. However, these studies did not attempt to adjust for potential confounders that might explain their findings. Finally, LINDBERG *et al.* [35] found self-reported snoring and daytime sleepiness to double the risk of occupational accidents during a 10-yr follow-up period, an effect that remained significant when adjusting for other factors that might explain their findings, including body mass index, smoking, alcohol dependence and working lifetime, as well as various occupational factors.

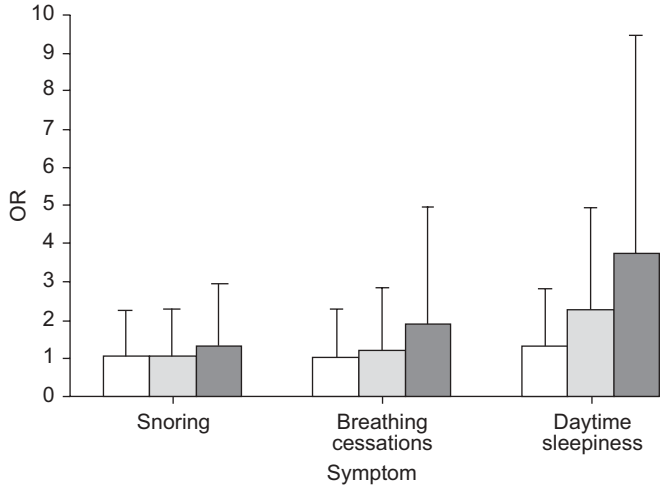


**FIGURE 1.** Multivariate logistic regression analyses of effect of frequencies (sometimes: □; often: ▫; always: ■) of symptoms comprising the obstructive sleep apnoea syndrome variable (compared to symptoms reported rarely or never) on long-term sick leave in the Norwegian Hordaland Health Study. Vertical bars represent 95% confidence intervals. OR: odds ratio.

The present findings show that, among the three symptoms constituting the OSAS variable, daytime sleepiness was the strongest risk factor for both sick leave and work disability, followed by breathing cessations and snoring. In addition, not surprisingly, a dose–response relationship was found between the frequency of symptoms and outcomes, with those always experiencing daytime sleepiness having the worst work-related outcome. However, it is worth noting that the combination of these symptoms generally yielded higher ORs than any of the individual symptoms alone (except in the fully adjusted analyses on work disability, in which the OR for sleepiness was comparable to that for the OSAS variable).

There are several strengths of the present study. First, the study sample was relatively large and the participation rate was high. Secondly, both exposure and outcome assessments should be relatively unbiased. At baseline measurement, neither participants nor administrators were aware of the specific research hypotheses, reducing the possibility of information being biased by selective symptom presentation in order to gain access to, or avoid, benefits or bias the results in the direction of a particular hypothesis. Thirdly, the data obtained from the National Insurance Administration are complete, since people moving to other parts of Norway after participation in the HUSK remained registered. The main limitation of the present study is the measurement of OSAS. Rather than employing the gold standard of a clinical diagnosis based on PSG recordings, the present study is based on a brief self-report questionnaire used to categorise persons into two groups, those with and without symptoms of OSAS. The prevalence estimate (6.3%) was similar to that found in

other epidemiological studies based on the general population in cohorts of a similar age [2–5, 7]. Nevertheless, the use of self-reported symptoms to measure OSAS remains potentially problematic, since persons are often unaware of their behaviour during sleep [36]. However, PSG data are not easily obtained in epidemiological studies, and the use of self-reports by patients are often the only feasible means of acquiring information about sleep behaviour. One way of improving the validity of such reports is by also including spouse-reported information on snoring and breathing cessations [36]. The Karolinska Sleep Questionnaire is also based on sleep problems reported by the person's spouse and thus attempts to improve the validity of symptoms. However, as noted by GRUNSTEIN *et al.* [34], a potential source of misclassification into OSAS and non-OSAS groups may relate to the presence of a current home partner, and persons sleeping alone may, as such, be more likely to be misclassified as not having OSAS. In the present analysis, adjusting for marital/cohabitant status did not attenuate the effect, and such a misclassification would tend to produce an underestimation of the health differences between the OSAS and non-OSAS groups, given that living alone is characteristically associated with poorer health [34].

In addition, previous studies have shown that self-report exhibits an acceptable level of accuracy in identifying subjects with and without OSAS [28, 37–40]. In an early study by KAPUNIAI *et al.* [28], the same operationalisation of OSAS predicted an apnoea index of >10 with a sensitivity of 83% and specificity of 63%. Another study found this operationalisation to yield a very high level of specificity for OSAS (99%), although the sensitivity was somewhat lower [37]. In that study, it was also found that persons never reporting snoring and having no observed apnoea were 35 times less likely to have OSAS (as indicated by PSG) compared to those with positive responses to these questions. Nevertheless, under ideal circumstances, self-report data should be validated by PSG readings, although this is rarely performed in such large population studies [41]. A suggestion for further studies including items on sleep apnoea might be to run PSG on a subsample in order to validate the self-reports.

The rate of receipt and later award of disability pension was higher among nonparticipants than among participants of the HUSK study [42]. Nonparticipants also have poorer health [43] and much higher mortality rates [44]. Thus the present results might be more accurate for a relatively healthier subset of the population. Among nonrespondents, there were possibly more comorbid conditions and complex health problems leading to work disability.

Finally, there are other potential confounders, such as work pressures, stress and other medical conditions (including glucose intolerance, impotence and neurocognitive deficits), that have not been captured in the present measures but which may yet be related to both baseline symptoms of OSAS and later sick leave or disability pension.

### *Conclusions*

The present findings suggest that persons with self-reported symptoms of obstructive sleep apnoea syndrome are more likely to leave the work force, and that this sleep disorder may be a significant independent contributor to increased social security costs and reduced productivity and family income. The findings warrant replication using a better-validated measure of obstructive sleep apnoea syndrome, and suggest that social outcomes should become an additional focus of interventions.

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