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Sleep apnoea, anxiety, depression and somatoform pain: A community-based high risk sample

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eep apnoea, anxiety, depression and pain**Abstract**
Community-based studies that measure both psychiatric diagnoses and obstructive sleep apnœa (OSA) are lacking. This study reports current psychiatric disorders in community-dwelling adults at high risk for OSA identified by the Berlin Questionnaire. Further, associations between OSA and current psychiatric disorders, unadjusted and adjusted for putative confounders, are reported.

A subsample of the Akershus Sleep Apnœa Project (ASAP) consisting of 290 adults, aged 30–65 years, with positive Berlin Questionnaire screening, underwent the Structured Clinical Interview for DSM-IV and polysomnography. Auxiliary analyses of depression are provided.

The median apnœa–hypopnœa index score in the sample was 7.7 (25^{th} percentile 2.4, 75^{th} percentile 22.2). Major depressive disorder, current anxiety and somatoform pain disorder were diagnosed in 12.4%, 14.8% and 19.3% of participants, respectively. At least one psychiatric disorder was diagnosed in 110 participants. The odds ratio of participants with OSA for having a psychiatric disorder compared with participants without was 0.54 (95% CI = 0.33–0.88). A negative association did not exist among Berlin Questionnaire low risk participants.

In conclusion, more than one-third of participants in a community-based, Berlin Questionnaire high-risk sample were diagnosed with a psychiatric disorder. A negative association between OSA and psychiatric morbidity was found.

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INTRODUCTION

In several studies of clinical populations, obstructive sleep apnœa (OSA) has been linked to symptoms of psychiatric disorders such as depression, mania, anxiety, psychosis, hypochondriasis and somatisation [1-4]. However, the actual strength of such associations may be overestimated when studied in a clinical sample [5].

Five community-based studies have investigated the relationship between OSA and symptoms of depression [6-10]. Three of these studies reported increased prevalence of depression in those with OSA [6-8], one found an effect for women only [9] and the last study did not observe any association between OSA and symptoms of depression [10]. Except for a study by Ohayon, which also assessed psychotic symptoms [6], there seem to be no community-based studies that have assessed the relationship between OSA and symptoms of other psychiatric disorders.

Most previous clinical and community-based studies of the relationship between anxiety, depression and OSA have assessed psychiatric symptoms by self-report instruments and not by diagnostic interviews [11]. Only one community-based study of OSA assessed psychiatric comorbidity with a diagnostic interview, finding that 17.6% of participants with OSA had major depressive disorder (MDD) [6]. A weakness of that study, however, is that OSA was assessed by self-report, which may contribute to misclassification.

Although the comorbidity between OSA and psychiatric disorders has been assumed to involve several disorder-specific mechanisms, it has still been argued that symptoms of depression co-occur with OSA exclusively, because of shared risk factors [12]. For example, it has been shown that established predictors for OSA, such as subjective sleepiness [13] and obesity [14], are associated with psychiatric disorders in community-based samples. Other putative confounders of these associations are sex [9] and other demographic factors [15]. However, previous studies have not consistently controlled for these variables.

Against this background, we conducted a study involving a large, community-based sample of participants identified by the Berlin Questionnaire (BQ) [16] to be at high risk for OSA, and included polysomnographic recordings for a subsample. The BQ is a widely used screening tool for OSA that has recently been used as a proxy for OSA diagnosis in large surveys [17,18] and has been validated in the Norwegian general population [19]. The present study reports current psychiatric disorders in community-dwelling adults at a high risk for OSA, as identified by the BQ. Further, we report associations between OSA and current psychiatric disorders unadjusted and adjusted for putative confounders (demographic factors (age, sex, higher education and co-habitation) or established predictors for OSA included in the BQ).

MATERIAL AND METHODS

Study participants and design

The participants took part in the Akershus Sleep Apnœa Project (ASAP), which is a two-phase, cross-sectional, community-based study designed to investigate psychological, otopharyngeal, neurological and cardiovascular aspects of OSA. A one-page screening questionnaire was mailed to 30,000 age- and gender-stratified adults (age 30–65 years, 50% female) randomly drawn from

the National Population Register. Because 742 letters were returned unopened or we got information that the drawn person was deceased or abroad, the final study population consisted of 29,258 persons who received the screening questionnaire containing a Norwegian translation of the BQ [16] (fig. 1).

A total of 16,302 (55.7%) people responded, of of whom 3960 (25.4%) were classified as being at high risk for OSA by a previously published BQ scoring algorithm [20]. BQ high-risk categories were self-reported snoring, daytime somnolence and obesity/hypertension. When confirming symptoms within two or three of these categories, the person was regarded as screening positive and categorised as a BQ high-risk individual.

Of the 3960 BQ high-risk individuals, 1085 (27.4%) were randomly drawn in five consecutive draws. The draws were organized to fill pre-defined BQ high risk age- and gender strata. Those with established cardiovascular disease, diabetes mellitus or previous otitis media surgery were oversampled. Reasons for not participating are presented in figure 1. This recruitment procedure resulted in 378 participants (44.3% of 852 BQ high risk persons invited to the ASAP).

In this sub-study of the ASAP, diagnostic, psychiatric interviews were scheduled only from June 1st 2006 until March 31st 2007 among BQ high risk participants. Thus, the present sample comprised the first BQ high-risk individuals included. During this time, 654 of the 852 persons were approached and 290 of the 378 participants (44.3% of 654 BQ high risk persons invited to the sub-study) were included.

In addition, the study comprised an auxiliary sample consisting of 157 age and gender stratified BQ low risk participants included in the ASAP. The inclusion procedure for this sample has been reported elsewhere [19].

Methods

Current psychiatric disorders (criteria met within the past month) were diagnosed by the Structured Clinical Interview for DSM-IV, axis I disorders (SCID-I) [20]. This interview involves the assessment of affective disorders (MDD, mania, hypomania, dysthymia), anxiety disorders (panic disorder with and without agoraphobia, social phobia, specific phobia, obsessive-compulsive disorder, post-traumatic stress disorder and generalised anxiety disorder), somatoform disorders (somatisation disorder, somatoform pain disorder and hypochondriasis), psychotic symptoms, substance abuse and adjustment disorder. Because there were few cases of each anxiety disorder, a composite anxiety category termed “current anxiety” was defined, which included participants who suffered from at least one current anxiety disorder. Specific phobia was not included because the disorder was regarded as clinically less important. The interviews were conducted in the evening, before sleep registration, by a trained physician (HHS). To test the reliability of the obtained diagnoses, 40 audiotapes recorded from participants with one or more diagnoses of MDD, anxiety and somatoform pain disorder were randomly selected. The tapes were rescored by an experienced psychiatrist (TD), blinded to the results of the first rater. The interrater reliability scores for presence/absence of the three selected diagnoses were excellent (Cohen’s kappa = 1.0) [21]. Participants of the ASAP received the Beck Depression Inventory (BDI), a 21-item self-report questionnaire reflecting somatic, affective and cognitive symptoms of depression [22]. Each item is scored from 0-3, thus total scores from 0-63 are possible.

All participants underwent an in-hospital polysomnography registration. Specifications of scoring and the technical equipment have been published elsewhere [19]. Sleep quality was assessed by minutes of sleep latency, waking after sleep onset, total sleep time and percentage of sleep efficiency. Obstructive apnœas were scored when airflow dropped below 10% of the reference amplitude for more than 10 seconds. Hypopnœas were scored when airflow dropped below 70% for more than 10 seconds with a subsequent oxygen desaturation of 4%. The apnœa–hypopnœa index (AHI) was calculated as the average of the total number of apnœas and hypopnœas per hour of sleep. Because all participants were included in the study based on a positive screening on more than one BQ symptom category, all participants with an AHI ≥ 5 were diagnosed with OSA [23].

Demographic data were obtained by standard questionnaires completed during the overnight stay. Higher education was defined as having any college or university degree. The variable of cohabitation was measured by a dichotomisation of different forms of cohabitation or living alone.

Excessive daytime sleepiness was defined as a score > 10 on the Epworth Sleepiness Scale (ESS) [24]. An additional screening question for depression was included in the screening questionnaire ("Have you felt depressed or less interested in participating in activities you usually enjoy?"). The response alternatives were: 1 (almost every day), 2 (3-4 times per week), 3 (1-2 times per week), 4 (1-2 times per month) and 5 (seldom or almost never). The variable "Frequent depressive thoughts or loss of interest" in table 1 comprised response categories 1 and 2. Obesity was defined by BMI > 30 kg/m^2 calculated from self reported height and weight.

The study protocol was approved by the Regional Committee for Medical Research Ethics in Eastern Norway, the National Data Inspectorate and the Norwegian Social Science Data Services. All participants provided written consent before participating.

Analysis

The chi-square test was used to assess bivariate differences between participants and non-participants and between participants with and without OSA. Crude odds ratios were calculated for associations between OSA, putative confounders and psychiatric disorders. Estimates were adjusted for one putative confounder at a time and were calculated by the Mantel–Haenszel common odds ratio. Effect modification was regarded as apparent when the Breslow–Day test of homogeneity of the odds ratio was significant. When effect modification was apparent, stratum-specific estimates were presented. Putative confounders significantly related to both OSA and the respective psychiatric disorder and interaction terms identified in stratified analyses were entered in logistic regression models. Finally, bivariate differences in BDI scores in the study sample ,and in the auxiliary sample, with and without OSA were calculated by student T-test. In all analyses, a two-tailed *P*-value of < 0.05 was used as the cut-off for statistical significance.

RESULTS

Characteristics of the screening and clinical samples are displayed in table 1. A significantly higher proportion of participants was categorised as BQ somnolent (70.7%) compared with BQ high-risk responders who did not participate (62.5%). However, there were no significant differences with respect to age, gender, snoring, obesity or hypertension. OSA was diagnosed in 175 (60,6%) participants. When OSA was defined as AHI ≥ 15, 104 (35.9%) participants were

diagnosed with OSA. In the auxiliary sample, mean BDI score was 4.4 (SD = 4.9) and median AHI was 3.2 (25^{th} percentile 0.7, 75^{th} percentile 10.9).

Frequencies of psychiatric disorders are displayed in table 2. The disorder diagnosed most frequently was somatoform pain disorder (19.3%). Of the 110 subjects with one or more psychiatric disorders, only 41 (37.3%) had an affective disorder (MDD or dysthymia). No participants reported psychosis, mania or hypomania.

No relationship was observed between OSA and any DSM-IV psychiatric disorder (table 2). However, the odds of participants with OSA having at least one psychiatric disorder was 0.54 (95% CI = 0.33–0.88) compared with participants without OSA. Psychiatric disorders by other definitions of OSA (AHI ≥15 and ≥ 30) are reported in the online supplement. Overall, no relations were observed by alternative definitions of OSA. There were no significant differences in mean BDI score between participants with (7.9 (SD=6.4)) and without (9.1 (SD=7.2)) OSA. A similar lack of statistically significant differences between symptoms of depression and OSA were found among persons with BQ low risk in the auxiliary sample. In this sample, persons with OSA had a mean BDI score of 5.0 (SD = 5.3) while persons without OSA had a mean BDI score of 4.0 (SD = 4.6, p= 0.222).

Crude odds ratios for associations between putative confounders of associations between MDD, anxiety, somatoform pain disorder and OSA are presented in table 3. Associations with having at least one psychiatric disorder followed the same pattern as the three individual disorders regarding all putative confounders (data not shown). Associations between OSA and individual psychiatric disorders stratified by these putative confounders identified effect modification by sex and co-habitation (table 4): Among men, the risk of having MDD was significantly lower among participants with OSA than among those without OSA. Moreover, the risk of having current anxiety in participants living alone was lower in participants with OSA than in those without OSA.

Adjusted Mantel–Haenszel common odds ratio estimates of the associations between OSA and individual psychiatric disorders were all non-significant (data not shown). Adjustment for multiple covariates (putative confounders from table 3) only resulted in minor changes to these non-significant odds ratios (data not shown). Statistically significant Mantel–Haenszel common odds ratios for having at least one psychiatric diagnosis in participants with OSA compared with participants without OSA varied from 0.53 (95% CI = 0.33–0.87) when adjusted for the BQ snoring category to 0.59 (95% CI = 0.35–0.98) when adjusted for age. Adjustment for multiple covariates also resulted in only minor changes to the unadjusted odds ratio (data not shown).

DISCUSSION

The main findings of this study were that: more than one-third of community-dwelling, middle-aged adults at risk for OSA, identified by the BQ, had one or more current DSM-IV psychiatric disorders. Somatoform pain disorder was the most prevalent individual psychiatric disorder. No individual psychiatric disorder was related to OSA but there was a significant negative association between OSA and having at least one psychiatric disorder when compared with BQ high-risk subjects without OSA.

Psychiatric disorders in a community-based BQ high-risk sample

Our finding of an accumulation of psychiatric disorders in a BQ high-risk sample representative of the general population is in line with two previous studies [17,18]. The study by Hiestand et al. reported a prevalence of depression in 33.0% and anxiety in 18% of BQ high risk respondents of the 2005 "Sleep in America poll". The study by Kapsimalis et al. reported a prevalence of depression in 41.0% and anxiety in 22% of BQ high risk female respondents of the 2007 poll [18]. These proportions were based on self-report of psychiatric diagnoses, which can explain the somewhat higher estimates than those reported in our study.

Properties of the BQ, and in particular the items forming the BQ somnolence category [17,18] or the selection of more somnolent/sleepy participants than non-participants in our study might have contributed to the accumulation of psychiatric disorders. With respect to this potential selection to the sample, it is interesting that the proportion of participants reporting frequent depressive thoughts/loss of interest was not higher among the more sleepy participants than among the less sleepy non-participants. Moreover, because pain symptoms are common in the general population [25] and are closely related to depression [26] and symptoms of OSA [8], associations between sleepiness, depression, somatoform pain and risk for OSA should be explored in future studies.

OSA and psychiatric disorders

The findings that neither of MDD, current anxiety and somatoform pain disorder were associated with OSA has important implications for the interpretation of previous studies that have reported positive associations between OSA and symptoms of psychiatric disorders [1-4]. Most community-based studies of this relationship have concluded that OSA seems to be an independent risk factor for depression [6-8]. In contrast, our data support community-based studies that have partly or completely failed to establish an independent association between OSA and depression [9,10]. However, only two previous, community-based studies concerning the relation between OSA and depression have assessed sleep with objective measures [7,10]. In a sample with median 4% oxygen desaturation index of 4.3 in females and 6.7 in males, Kripke et al. found no association between symptoms of depression and OSA [10]. In contrast, Peppard et al. using a sample in which 6% of the females and 14% of the males showed an AHI $\geq$ 15, found a positive dose-response association between SRBD and depression [7]. The severity of OSA in our BQ high risk sample was higher than in these samples, but lower than most studies of clinical populations. Moreover, previous community-based studies investigated only depression, while our study failed to establish associations between OSA and other psychiatric disorders also.

The finding of a significant negative association between OSA and having at least one psychiatric disorder indicates that lack of statistical power is a potential explanation to the finding of no association between OSA and individual psychiatric disorders in our BQ high risk sample. Thus, although mean BDI levels or prevalence of specific disorders did not differ between OSA and no OSA, participants in the study who had high symptom reports on the BQ but who were not subsequently found to have sleep apnoea had a significantly higher level of psychiatric morbidity than participants with sleep apnoea.

In the auxiliary sample, both the mean BDI sum and the median AHI were 50% lower than in the BQ high risk sample. Moreover, also in this BQ low risk sample, BDI scores did not differ significantly between those with OSA and those without OSA. Consequently these findings

from the auxiliary sample imply that the high level of psychiatric comorbidity observed among BQ high risk participants more likely is related to properties of the BQ rather than being an effect of OSA as such. This interpretation is in line with Andrews et al. who hypothesized that shared co-factors between depression and OSA rather than apnoeas and hypopnoeas per se explain the association between OSA and symptoms of depression found in multiple studies of clinical samples [12]. Nevertheless, Peppard et al. found a dose- response association between OSA and symptoms of depression [7]. However, this study also identified important effects of putative confounders on the said association. We therefore believe that our findings contribute to an elucidation of the complex association between OSA, psychiatric disorders and predictors of OSA.

Among putative confounders of the association between OSA and psychiatric disorders, the odds ratios for having any of the three psychiatric disorders or having at least one psychiatric disorder were significantly higher in females than in males while the odds ratio for having OSA was opposite. Stratified analysis by sex indicated that a significant negative association between OSA and MDD was persistent in males but not in females. However, we believe that this gender difference should be attributed to a lower severity of OSA in females than in males rather than a true interaction *per se*. Stratified analysis also identified effect modification by living alone on the association between current anxiety and OSA. To the best of our knowledge, we do not know of any previous studies that have reported an effect of living alone on the relation between OSA and psychiatric disorders and this finding should be interpreted with caution.

Regarding the effect of other putative confounders, we anticipated that sleepiness and obesity would be related to both OSA and psychiatric disorders [12-14]. Sleepiness, as assessed by the ESS or the BQ somnolence category, was found to be related to individual psychiatric disorders, but not to OSA. Thus, sleepiness was not a confounder of the relationship observed between OSA and individual psychiatric disorders. On the contrary, the obesity/hypertension risk category of the BQ was related to OSA but not to individual psychiatric disorders and also could not be regarded a confounder of the relation.

In addition, the effect of risk stratification by the BQ probably had different effects on sleepy compared to non-sleepy OSA patients across age and gender strata. Unfortunately, the sample was too small for sub-analyses within single- or groups of strata. In contrast to the study of Peppard et al. utilizing multivariate analyses did not strengthen the relation between OSA and psychiatric disorders." On the other hand, studies of moderate to severe OSA have previously reported that fatigue [27] and sleepiness [28] can be up to eight times more strongly related to depression than to OSA. The results of our study are in line with these findings as psychiatric disorders seemed to be more strongly related to the BQ somnolence category or excessive sleepiness while OSA seemed to be more strongly related to the BQ snoring- and obesity/hypertension categories. Thus, these apparently contradictory relations between established features of OSA should stimulate increased attention to the contribution of anxiety, depression and somatoform pain in future studies of unsolved clinical problems, such as screening for OSA [29] and residual sleepiness in adequately treated OSA [30,31].

Strengths and limitations

A strength of this study was the use of in-hospital polysomnography to diagnose OSA. Ideally, sleep should be measured twice by polysomnography [32], but in accordance with most previous studies that assessed the screening properties of the BQ or prevalence of OSA, we chose to rely

on a single all-night recording of sleep. Moreover, the severity of OSA in the sample was mild and diagnosis was based on a simple cut-off value on the AHI. Thus, the results of the present study are generalizable only to OSA in the general population. In addition, *post hoc* analyses with other cut-off values of the AHI affected our results only to a small degree, supporting our general conclusion that putative confounders show a greater impact on this association than on OSA severity per se.

Another strength is the use of the SCID-I, which, in the present study, was administered by one investigator who performed all interviews, and achieved excellent interrater reliability when compared to the scores of an experienced psychiatrist.

With a response rate of 55.7% and a participation rate of 44.3%, this study is susceptible to selection bias caused by help-seeking behaviour [5]. Therefore, as discussed above, it is relevant to the findings of this study that selection by subjective sleep complaints occurred, but selection by screening question of depression did not. However, the potential selection bias caused by the limited response rate might have influenced the prevalence of other psychiatric disorders than depression. Consequently, the high prevalence of somatoform pain disorder should be interpreted with caution. Moreover, because no significant differences in sleepiness were found between participants with and without OSA, we have no reason to believe that any selection influenced the associations between psychiatric disorders and OSA.

Finally, it should be mentioned that because of the cross-sectional design of this study, we cannot draw any conclusions regarding causal or temporal relationships between OSA and psychiatric disorders.

In conclusion, more than one-third of participants in a community-based, Berlin Questionnaire high-risk sample were diagnosed with a psychiatric disorder. A negative association between OSA having psychiatric disorders was found. However, this negative association did not exist in an auxiliary sample consisting of persons with BQ low risk. Future community-based studies using the BQ should be aware of the large effect of sex, the caveat of selection bias and the difference between the BQ somnolence category and excessive daytime sleepiness defined by the ESS. Future community-based studies of screening instruments for OSA, associations between OSA and psychiatric disorders, and other clinical aspects of OSA should include assessment of somatoform pain disorder and anxiety in addition to depression.

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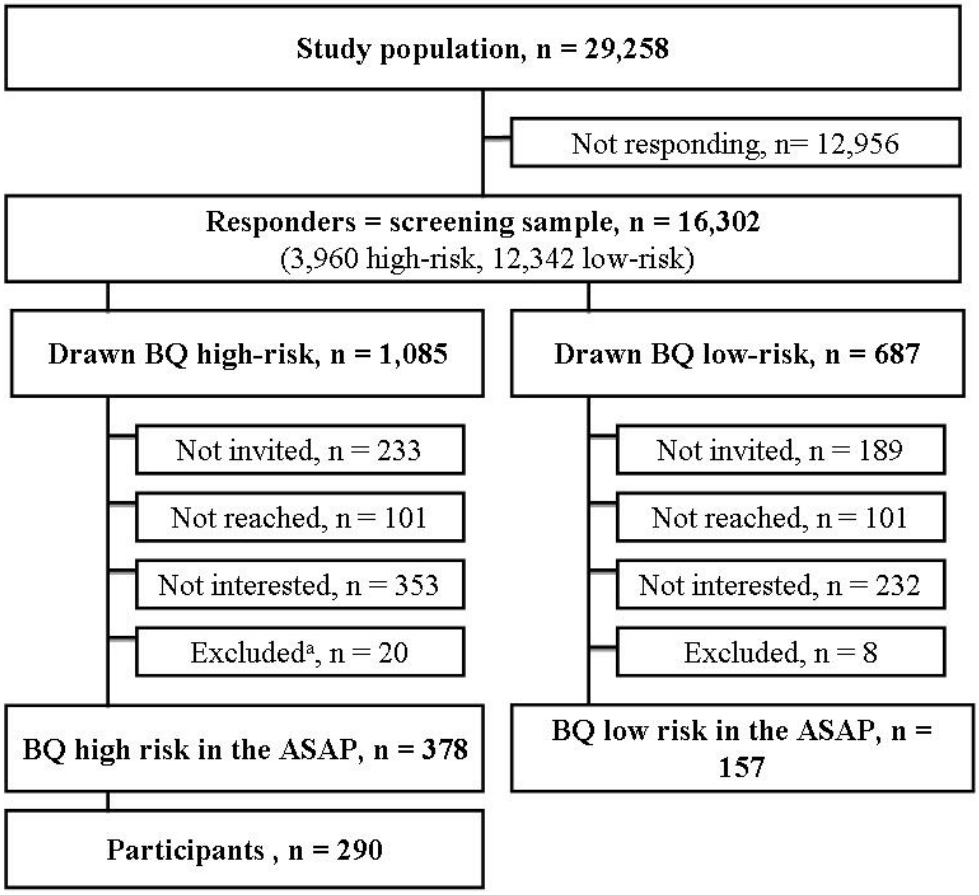
FIGURE 1. Flow chart of people from the study population to the clinical sample



[a] Exclusion criteria: Use of continuous positive airway pressure (n = 10), pregnancy (n = 4), inadequate Norwegian language skills (n = 4) and severe physical impairment as defined by inability to climb the stairs of the sleep laboratory (n = 2)

TABLE 1. Characteristics of the samples of Berlin Questionnaire high-risk subjects

	Screening sample N = 3960	**Non-participants N = 3670**	**Participants N = 290**	**P-value**
Age, yrs	48.8 ± 10.3	48.8 ± 10.3	48.2 ± 11.2	0.357
Female sex, %	44.5	44.5	44.1	0.899
Higher education, %			28.1	
Cohabitation[a], %			83.3	
BMI, kg/m2	29.1 (5.2)	29.1 (5.2)	29.0 (4.9)	0.951
Berlin Questionnaire				
Snoring category, %	92.3	92.4	91.0	0.412
Daytime somnolence category, %	63.1	62.5	70.7	0.005
Hypertension/obesity category, %	66.3	66.2	66.6	0.914
Epworth Sleepiness Scale, score	8.8 ± 4.5	8.8 ± 4.5	9.8 ± 4.5	<0.001
EDS, %	33.7	33.0	43.1	<0.001
Frequent depressive thoughts/loss of interest, %	15.3	15.5	12.9	0.253
Beck Depression Inventory, score			8.5 ± 6.9	
Sleep latency, median minutes			11.0 (6.0, 21.0)	
WASO, median minutes			55.2 (29.2, 90.5)	
Total sleep time, mean minutes			413.6 ± 86.7	
Sleep efficiency, %			83.2 ± 11.2	
AHI, median events/hour			7.7 (2.4, 22.2)	
Obstructive sleep apnœa, %			60.5	

Results are presented as mean ± standard deviation, median (25th and 75th percentiles) or percentage.
BMI = body mass index, EDS = Excessive daytime sleepiness (Epworth Sleepiness Scale > 10), WASO = Wake after sleep onset, AHI = Apnœa–hypopnœa index.
a = Married or living with partner

TABLE 2. Prevalence of current psychiatric disorders and differences between participants with and without obstructive sleep apnœa by chi-square test (N = 290[a])

	Total N (%)	**OSA N (%)**	**No OSA N (%)**	**P-value**
Affective disorders				
Major depressive disorder	**36 (12.4)[a]**	**16 (9.1)**	**19 (16.7)**	**0.055**
Dysthymia	5 (1.7)	3 (1.7)	2 (1.8)	1.000[b]
Current affective disorder	40 (13.8)[a]	18 (10.3)	21 (18.4)	0.048
Anxiety disorders				
Current panic disorder	17 (5.9)	10 (5.7)	7 (6.1)	0.880
Agoraphobia without panic disorder	2 (0.7)	2 (1.1)	0 (0)	0.521[b]
Social phobia	13 (4.5)	7 (4.0)	6 (5.3)	0.613
Obsessive–compulsive disorder	5 (1,7)	2 (1.1)	3 (2.6)	0.386[b]
Post-traumatic stress disorder	16 (5.5)	8 (4.6)	8 (7.0)	0.374
Generalised anxiety disorder	14 (4.8)	8 (4.6)	6 (5.3)	0.789
Current anxiety	**43 (14.8)**	**25 (14.3)**	**18 (15.8)**	**0.726**
Alcohol and substance abuse				
Current alcohol abuse	5 (1.7)	3 (1.7)	2 (1.8)	1.000[b]
Somatoform disorders				
Hypochondriasis	3 (1.0)	1 (0.6)	2 (1.8)	0.332[b]
Somatoform pain disorder	**56 (19.3)**	**29 (16.6)**	**27 (23.7)**	**0.135**
Somatisation disorder	9 (3.1)	4 (2.3)	5 (4.4)	0.324[b]
Current somatoform disorder	58 (20.0)	30 (17.1)	28 (24.6)	0.124
Any psychiatric disorder[c]	110 (37.9)[a]	56 (32.0)	53 (46.5)	0.013

Results are presented as number and percent of participants with disorder(s).
a = Polysomnography recordings were not available for one participant with major depressive disorder. Thus, the sum of current major depression, current affective disorder and any psychiatric disorder in OSA and no OSA differ from total disorders diagnosed.
b = Fisher's exact test
Interrater reliability was tested for disorders written in **bold**.
c = Any one or more of the psychiatric disorders listed in table 2

TABLE 3. Crude odds ratios (95% confidence interval) between putative confounders, major depressive disorder, anxiety, somatoform pain disorder and obstructive sleep apnœa

Demographic factors	**Major depressive disorder**	**Current anxiety**	**Somatoform pain disorder**	**Obstructive sleep apnœa**
Age				
< 50 years	2.01 (0.98–4.14)	1.38 (0.72–2.65)	1.37 (0.77–2.47)	1.00
≥ 50 years	1.00	1.00	1.00	3.30 (2.01–5.42)
Sex				
Female	2.51 (1.22–5.18)	3.51 (1.74–7.06)	4.15 (2.19–7.85)	1.00
Male	1.00	1.00	1.00	2.57 (1.58–4.17)
Education				
Low	4.75 (1.41–15.98)	1.85 (0.82–4.19)	1.76 (0.86–3.61)	1.16 (0.68–1.95)
High	1.00	1.00	1.00	1.00
Cohabiting[a]				
No	3.13 (1.43–6.84)	3.42 (1.66–7.08)	1.48 (0.71–3.07)	1.12 (0.60–2.12)
Yes	1.00	1.00	1.00	1.00
BQ categories				
Snoring				
No	1.00	1.00	1.00	1.00
Yes	1.77 (0.40–7.85)	0.95 (0.31–2.92)	0.78 (0.30–2.04)	2.26 (1.00–5.11)
Somnolence				
No	1.00	1.00	1.00	1.00
Yes	3.75 (1.28–10.95)	2.37 (1.01–5.57)	2.17 (1.04–4.53)	0.64 (0.38–1.10)
Hypertension / obesity				
No	1.00	1.00	1.00	1.00
Yes	0.76 (0.36–1.57)	0.65 (0.34–1.27)	0.61 (0.33–1.10)	2.00 (1.21–3.28)
Epworth Sleepiness Scale				
EDS				
No	1.00	1.00	1.00	1.00
Yes	5.67 (2.48–12.93)	2.89 (1.47–5.68)	2.43 (1.34–4.41)	0.76 (0.47.1.22)

Results are presented as crude odds ratios and 95% confidence intervals from eight bivariate logistic regression models for each disorder or group of disorders.
MDD = Major depressive disorder, BQ = Berlin Questionnaire, EDS = Excessive daytime sleepiness (Epworth Sleepiness Scale > 10)
a = Married or living with partner

TABLE 4. Effect modification by sex and co-habitation presented by stratum-specific odds ratios (95% confidence interval)

	Major depressive disorder	**Current anxiety**
Women		
No OSA	1.00	
OSA	1.37 (0.55–3.45)	
Men		
No OSA	1.00	
OSA	0.16 (0.05–0.54)	
Living alone		
No OSA		1.00
OSA		0.25 (0.07–0.91)
Cohabitation[a]		
No OSA		1.00
OSA		1.33 (0.59–3.01)

Results are presented as stratum-specific crude odds ratios and 95% confidence intervals.
MDD = Major depressive disorder, BQ = Berlin questionnaire, ESS = Epworth Sleepiness Scale, EDS = Excessive daytime sleepiness (ESS > 10)
a = Married or living with partner

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