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Association between continuous positive airway pressure usage and workforce attachment in obstructive sleep apnea

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ABSTRACT

Study objectives: We investigated the association of continuous positive airway pressure (CPAP) usage and workforce participation emphasizing the role of sex and education.
Methods: From Danish nationwide registries we identified individuals aged 30–64 with obstructive sleep apnea (OSA) diagnosed 2005–2017, classified by CPAP use, education and employment. Odds ratios (ORs) for workforce attachment were estimated by CPAP use.
Results: Among 31,113 individuals (25.9% women), 4448 were CPAP non-users, 19,871 CPAP users, and 8666 had no CPAP treatment. Vocational and college level of education had higher odds of CPAP usage compared to no education OR 1.16 (95% CI 1.07-1.25) and OR 1.17 (95% CI 1.07-1.29), respectively). Proportion of employment declined from one year before diagnosis to three years after: from 74.3% to 68.0% (CPAP non-users), 78.8% to 72.5% (CPAP users) and 77.0% to 71.4% (no CPAP treatment). Unemployment and having left the workforce one year before diagnosis (versus employed) was associated with significantly reduced odds for CPAP-use versus non-use OR 0.72 (95% CI 0.64-0.80). For women employed when diagnosed, unemployment three years after was associated with reduced odds of CPAP usage OR 0.73 (95% CI 0.55-0.98)).
Conclusions: Higher level of education was associated with CPAP usage, whereas workforce detachment before OSA diagnosis was associated with reduced CPAP usage. Among women employed when diagnosed, unemployment three years after diagnosis was associated with CPAP non-usage. The results highlight the interplay between OSA, workforce attachment and CPAP. Future studies should focus on the impact of CPAP use and adherence on employment participation.

1. Introduction

Approximately one billion people have obstructive sleep apnea (OSA) and the prevalence of OSA is expected to increase, not least because of the increasing prevalence of obesity and advanced age that predispose to OSA [1]. OSA is thus the most common sleep disorder, but remains widely underdiagnosed [2–4].

In OSA, the upper airway collapses during sleep, which causes apnea, hypopnea, increased intrathoracic pressure and sympathetic arousal. Consequently, OSA leads to inflammation and atherosclerosis, and OSA is associated with numerous comorbidities and increased cardiovascular risk including stroke [5–10]. Furthermore, OSA leads to increased daytime sleepiness and decreased cognitive function including impairment of attention and executive function and subjective impaired work performance [11,12].

Reduced work capacity in OSA is reflected by increased sick leave

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both prior to and following the diagnosis, and the repercussions include risk of unemployment, even multiple job losses and receiving permanent social security benefits including disability pension [13–17]. The societal costs related to OSA are enormous and directly affect both patients and potential spouses. Costs include direct health care costs and lost productivity as well as costs related to occupational and motor-vehicle accidents, highlighting the need for strategies that support workforce attachment in patients with OSA [18–23].

The presence of excessive daytime sleepiness (EDS) exacerbates work disability and affects self-reported work performance negatively [24–28]. Continuous positive airway pressure (CPAP) reduces EDS and improves neurocognitive function [29–32]. International guidelines recommend CPAP in case of EDS or impaired sleep-related quality of life [33]. The treatment is non-invasive and low-risk, but adherence to CPAP remains challenged, possibly due to practical circumstances such as the discomfort of wearing a mask and the need for equipment maintenance and is furthermore influenced by severity of OSA, severity of symptoms as well as socioeconomic status and psychological factors [34,35].

When evaluating the association between CPAP and quality of life, CPAP is generally considered cost-effective. However, most economic evaluations rely on medical and non-medical costs, often neglecting the economic impact of lost productivity [36].

Moreover, little is known of the association between CPAP usage and workforce participation in patients with OSA and how this is influenced by level of education and sex. Therefore, we aimed to explore the association between CPAP usage and workforce attachment in working-aged patients with newly diagnosed OSA.

2. Methods

This study was a nationwide cohort study investigating the effect of CPAP usage on labour market attachment among patients with OSA. The study was based on de-identified patient data from the Danish National Patient Registry (DNPR) and other national Danish registers containing detailed data on socio-demographic characteristics, education status, income, public transfers and employment status over time. The data from the different registries were linked using the unique Central personal registration number (CPR) that is assigned to all citizens in Denmark from the Danish Civil Registration System (CRS).

Patients aged 30-64 who were hospital-diagnosed with OSA (International Classification of Disease (ICD) 10: G47.3) for the first time in the period from January 1, 2005 to December 31, 2017 were included in the study. Patients were included on their first hospital contact with a primary or secondary OSA diagnosis registered in DNPR (index date). In DNPR, ICD-10 diagnosis data are available from 1994, ensuring that all included OSA patients were OSA naïve.

Based on information from all types of CPAP hospital visits at Danish hospitals, as recorded in the DNPR, patients were stratified into three groups according to CPAP usage: CPAP users, CPAP non-users, or no CPAP treatment as done previously [37]. CPAP users were defined by CPAP visits from CPAP start and CPAP visits in year 2 and/or year 3. We distinguished between 'no CPAP treatment' which refers to patients who never had a CPAP visit and 'CPAP non-usage' that refer to patients with either only one CPAP visit in three years or who retuned the CPAP apparatus within the first year. Definitions of CPAP usage groups appears from Supplementary Table 1.

Only patients with OSA who had their first CPAP contact within one year before or after their OSA diagnosis were included in the CPAP usage groups. To ensure patients were naïve to CPAP treatment at the time of their OSA diagnosis (i.e., had not used CPAP previously and could be considered non-compliant), a 4-year CPAP pre-washout period was implemented prior to the year of OSA diagnosis for all patients. The follow-up index date was defined as the CPAP initiation date for patients who began CPAP treatment within ±365 days of their OSA diagnosis. For patients who did not initiate CPAP treatment within ±365 days of their OSA diagnosis and had no prior CPAP treatment the follow-up index date was set as the date of their OSA diagnosis.

OSA patients with unsure CPAP usage were excluded – see Supplementary Table 1 for the definition of this group.

Employment outcomes were assessed using calendar-year measures relative to the index year. Employment status one year prior to index (year −1) and three years after index (year +3) were analyzed. Because CPAP initiation among initiators was restricted to within ±365 days of OSA diagnosis, the temporal distance between diagnosis and index among treated patients was limited.

Differences in employment status between year −1 and year +3 were investigated stratified by CPAP usage and gender.

In Denmark the public health system is financed through taxes and all citizens have equal access to care regardless of financial circumstances and health insurance. Additionally, a large number of Danish citizens have private health insurance related to employment but the proportion of health expenses paid by private health insurance is only 2.59% [38]. Employment status may therefore influence access to OSA diagnosis and treatment to a limited degree. In Denmark, waiting time is generally below 1-2 months, if the patient cannot be evaluated the patient have the opportunity to be referred to another center with a lower waiting time. Most patients are evaluated within this period.

2.1. Study variables and outcome definitions

2.1.1. Employment status

Employment or socioeconomic status was determined using the variable 'SOCIO13' from Statistics Denmark. This variable, derived from the Danish Income Registry, represents the most significant source of income or employment for individuals during the year. Employment status information is available for persons aged 18 years and older.

Employment status was stratified into the following:

- Employed - including employed, education (student) and other
- Unemployed including unemployed benefit, social security and sick pay (public funded)
- Permanently left the labour force before age retirement including disability pension (before 64 years old) and early retirement pension (before 64 years old)[1]

The employment status the year before the OSA diagnosis year was compared with the employment status three years after the OSA diagnosis index (year 3).

2.1.2. Education

Highest completed education is compiled by Statistics Denmark based on various national education registers, as well as collected information on education for immigrants who have not completed their education in Denmark.

In the statistical analyses, education was divided into.

- No higher education (including both primary and secondary education)
- Vocational
- College
- Unknown

2.1.3. Quan-updated Charlson comorbidity index

The Charlson Comorbidity Index was calculated based on ICD-10 codes derived from hospital contacts within three years prior to the

[1] In Denmark, the early retirement pension system is designed to provide financial support to individuals who choose to retire before the official retirement age. Individuals must have been part of the Danish labor market for at least 30 years and continuous membership in an unemployment insurance fund (A-kasse).

index date [39]. We used the updated and validated Charlson Comorbidity Index, as revised by Quan et al. (2011) [40].

2.2. Statistical methods

Descriptive statistics were used to characterize the population where continuous variables were summarized as mean and standard deviation (SD). Categorial variables were summarized as the total number of events and frequency (%).

Multinomial logistic regression models were used to estimate the crude unadjusted odds ratios and significant differences between the three OSA CPAP groups (reference category: CPAP non-users) for each socio-demographic characteristic and the Charlson Comorbidity Index. Odds ratios (OR) were presented along with their corresponding 95% confidence intervals (95% CI) and p-values.

A multinomial logistic regression model was used to estimate the odds of employment (odds ratios) between the CPAP groups (reference category: CPAP non-users for being employed before their OSA

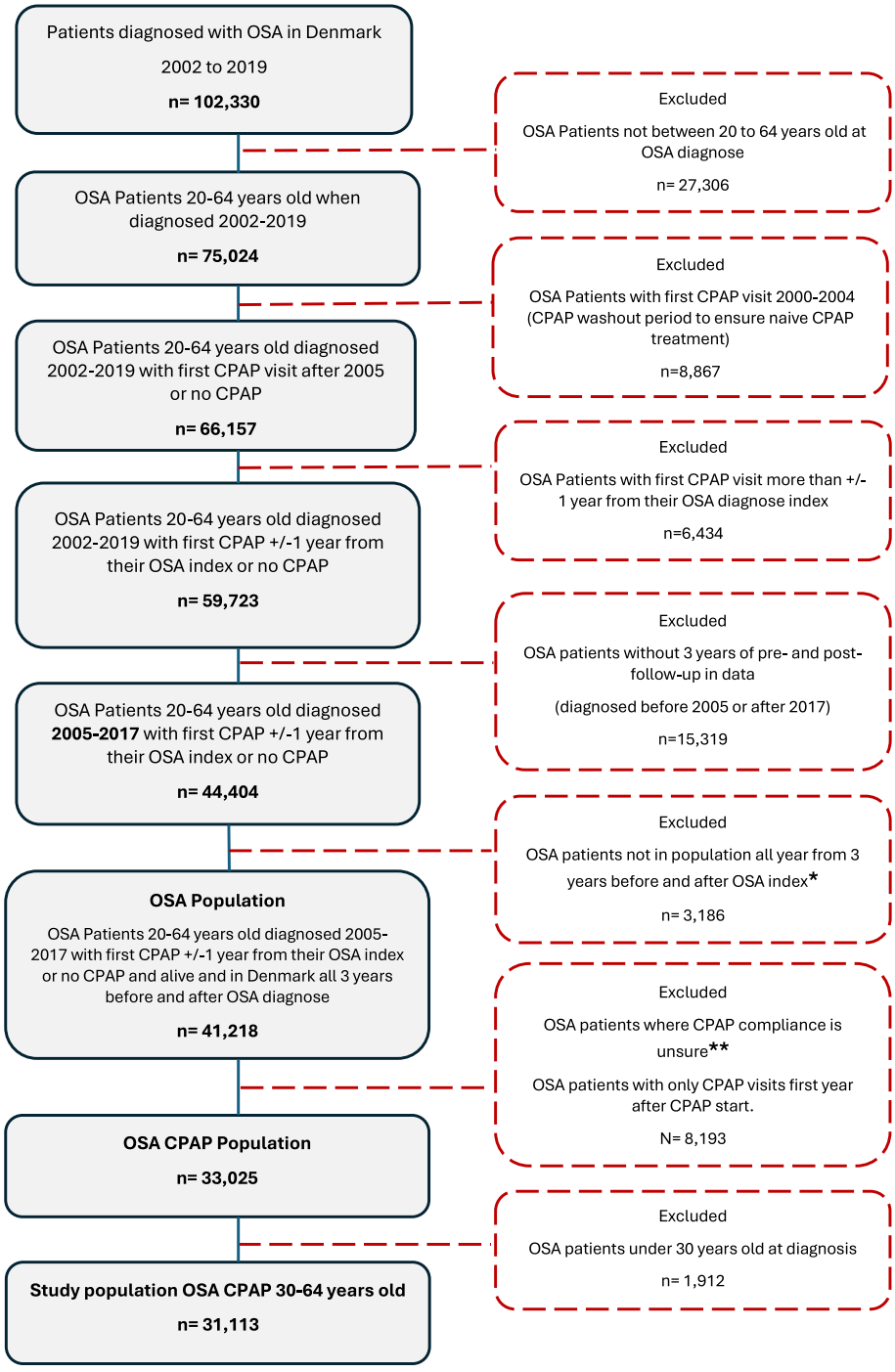


Fig. 1. Flowchart of the study population.
* Not registered as living in Denmark all three years before index year or died or emigrated after in the three years after index.
** Patients who had more than one CPAP visit within the first year after CPAP start, but did not return the CPAP device. This group may include either highly compliant patients who maintain their CPAP device (without requiring follow-up visits for the next three years) or patients who discontinued CPAP use during the first year.

diagnosis compared to being unemployed or permanently out of the labor force (reference category: employed). The model was run for all patients and separately for women and men.

Additionally, multinomial logistic regression models were used to test changes in employment status from one year before to three years after an OSA diagnosis. For this analysis, one model included patients who were employed before the diagnosis, and another model included patients who were unemployed before the diagnosis, to test the odds of changes in employment status.

These models were also run for all patients and separately for women and men.

The employment analyses were conducted using a transition design conditional on baseline employment status. Individuals were classified according to their employment state in year −1, and separate multinomial logistic regression models were used for those employed and those unemployed at baseline to estimate employment status in year +3. This approach models changes in labor-market attachment from pre-to post-diagnosis as baseline-to-follow-up transitions, with each individual contributing one baseline state and one post-diagnosis outcome rather than repeated longitudinal observations.

To formally assess whether associations between CPAP use and employment outcomes differed by sex, sex × CPAP interaction terms were included in the employment models.

All employment models were adjusted for sex, age, spouse status, education, Charlson Comorbidity Index, calendar year (to account for business cycles), and region (to address regional differences). Odds ratios for employment status were presented with their corresponding 95% confidence intervals and p-values. Statistical significance was defined as $p < 0.05$. Statistical analysis was performed using SAS 9.4 TS Level 1M5 (SAS, Inc., Cary, NC, USA).

3. Results

A flowchart of the study population is shown in Fig. 1. The population consisted of 31,113 persons aged 30-64 diagnosed in 2005-2017 with first CPAP visit ± one year from OSA index date, alive and in Demark all three years before and after OSA diagnosis. Baseline characteristics including sex, age, level of education and Charlson Comorbidity Index appears from Table 1. According to CPAP usage, 4448 were classified as CPAP non-users, 19,871 as CPAP-users and 8666 were classified as no CPAP treatment. Women constituted 25.9% of the study population (8,069), with the highest proportion of women in the no CPAP treatment (31%) group. The mean age was 49 (SD 8), 50 (SD 8) and 48 (SD 9) in CPAP non-users, CPAP users and no CPAP treatment, respectively.

The majority of patients were married/cohabitating, highest in the CPAP user group (74%). The most common levels of education were vocational (41.4-45.6%) and primary (25.3-28.2%). Mean Charlson comorbidity index was 0.19, 0.17 and 0.17 among CPAP non-users, CPAP users and no CPAP treatment, respectively.

Table 2 shows the results of an unadjusted logistic regression model of the association between sociodemographic characteristics and Charlson comorbidity index and CPAP usage at baseline. Being married/cohabitating was associated with significantly increased OR for CPAP usage versus non-usage (OR 1.24 (95% CI 1.16-1.34)). Compared to men, women had significantly increased OR for no CPAP treatment versus CPAP non-usage (OR 1.42 (95% CI 1.30-1.55)). Compared to no education, both vocational and college level were associated with significantly increased odds of CPAP usage (1.16 (95% CI 1.07-1.25) and 1.17 (95% CI 1.07-1.29), respectively), and college level was also associated with no CPAP treatment compared to CPAP non-usage (OR 1.24 (95% CI 0.96-1.13)).

Table 3 and Fig. 2 shows employment status one year prior to and three years after OSA diagnosis, stratified for CPAP usage and sex. The proportion of employment decreased over time since diagnosis: from 74.3%, 78.8% and 77.0% among CPAP non-users, CPAP-users and no CPAP treatment to 68.0%, 72.5% and 71.4%, respectively. Across CPAP usage groups, the proportion of employment was higher among men (ranging from 79.4% to 83.5% one year before diagnosis and 73.6% to 77.7% three years after diagnosis) compared to women (58.3% to 66.3% one year before diagnosis and 50.2% to 59.7% three years after

Table 1
Socio-demographic characteristics and Charlson Comorbidity Index at the time of OSA diagnosis.

	CPAP non-users		CPAP users		No CPAP treatment	
Number of patients (n)	4260		19,092		7761	
Sex (n,%)						
Women	1024	24.0	4638	24.3	2.407	31.0
Men	3236	76.0	14,454	75.7	5354	69.0
Age (mean, SD)	49	8	50	8	48	9
Age group (n,%)						
30-39 year	636	14.9	2348	12.3	1652	21.3
40-49 year	1401	32.9	5800	30.4	2659	34.3
50-59 year	1744	40.9	8489	44.5	2766	35.6
60-64 year	479	11.2	2455	12.9	684	8.8
Marital status (n,%)						
Married/Cohabiting	2967	69.6	14,136	74.0	5475	70.5
Living alone	1293	30.4	4956	26.0	2286	29.5
Education (n,%)						
Primary	1203	28.2	4821	25.3	2010	25.9
Secondary	182	4.3	793	4.2	383	4.9
Vocational	1853	43.5	8699	45.6	3216	41.4
College - short	236	5.5	1109	5.8	426	5.5
College - medium	484	11.4	2435	12.8	1072	13.8
College - long + PHD	217	5.1	909	4.8	515	6.6
Unknown	85	2.0	326	1.7	139	1.8
CCI - Quan (n,%)						
0	3766	88.4	17,165	89.9	6920	89.2
1	273	6.4	1124	5.9	501	6.5
2+	221	5.2	803	4.2	340	4.4
CCI - Quan (mean, SD)	0.19	0.62	0.17	0.62	0,17	0.60

A*: Chi-square test, CCI-Quan = Quan updated Charlson Comorbidity Index.

Table 2
Crude unadjusted odds Ratios for differences between CPAP usage groups for each socio-demographic characteristics and Charlson Comorbidity Index (Quan) at the time of OSA diagnosis (reference = CPAP non-users) (A*).

	CPAP user versus CPAP non-user		No CPAP treatment versus CPAP non-user	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Women	1.01 (0.94-1.10)	0.73	1.42 (1.30-1.55)	<0.0001
Age	1.01 (1.01-1.02)	<0.0001	0.98 (0.97-0.98)	<0.0001
Married/ Cohabiting	1.24 (1.16-1.34)	<0.0001	1.04 (0.96-1.13)	0.30
Education				
No education* (ref)				
Vocational	1.16 (1.07-1.25)	0.0002	1.00 (0.92-1.10)	0.92
College	1.17 (1.07-1.29)	0.0007	1.24 (1.12-1.38)	<0.0001
Unknown	0.95 (0.74-1.21)	0.66	0.95 (0.72-1.25)	0.70
CCI - Quan	0.95 (0.90-1.00)	0.034	0.96 (0.91-1.02)	0.17

A*: A multinomial logistic regression model was used to estimate the differences between CPAP groups for each socio-demographic characteristic and the Quan updated Charlson Comorbidity Index (CCI – Quan) at the time of OSA diagnosis. Quan updated Charlson Comorbidity Index here is a binary variable (0 = CCI = 0, 1 = CCI 1+). An unadjusted model was run separately for each characteristic.

Table 3
Employment status before the OSA diagnosis (year −1) and after the OSA diagnosis (year 3 after) by sex.

	CPAP non-users		CPAP users		No CPAP treatment	
All patients						
Number of patients (n)	4260		19,091		7761	
	Before	**After**	**Before**	**After**	**Before**	**After**
Employment status	%	%	%	%	%	%
Employed	74.3	68.0	78.8	72.5	77.0	71.4
Unemployed	12.3	11.5	9.7	10.3	12.2	12.3
Permanently pension	13.4	20.5	11.4	17.2	10.8	16.3
Women						
Number of women (n)	**1.024**		**4.638**		**2.407**	
	Before	**After**	**Before**	**After**	**Before**	**After**
Employment status	%	%	%	%	%	%
Employed	58.3	50.2	64.4	56.1	66.3	59.7
Unemployed	18.6	17.4	14.6	15.3	16.3	17.0
Permanently pension	23.1	32.4	21.0	28.6	17.4	23.3
Men						
Number of men (n)	**3.236**		**14.453**		**5.354**	
	Before	**After**	**Before**	**After**	**Before**	**After**
Employment status	%	%	%	%	%	%
Employed	79.4	73.6	83.5	77.7	81.8	76.6
Unemployed	10.3	9.7	8.2	8.7	10.4	10.2
Permanently pension	10.3	16.7	8.4	1.6	7.8	13.1

diagnosis).

The results from logistic regression analysis on association between CPAP usage and employment status are shown in Figs. 3 and 4 and Supplementary tables 2.1-2.3. The results were adjusted for sex, age, spouse status, education, Charlson Comorbidity Index, calendar year and region on employment status between CPAP groups and stratified for sex. Fig. 3 shows the association between CPAP usage and employment status one year before OSA diagnosis is shown. Among patients with OSA, the odds of being unemployed or having permanently left the workforce one year prior to diagnosis were significantly lower for those with no CPAP treatment group compared to CPAP non-users (OR 0.86 (95% CI 0.76-0.97) and OR 0.84 (95% CI 0.74-0.96), respectively), and even lower for CPAP users compared to CPAP non-users (0.72 (95% CI 0.64-0.80) and 0.84 (95% CI 0.75-0.94), respectively).

When stratified according to sex, unemployment was associated with significantly reduced odds for CPAP usage in both women (OR 0.74 (95% CI 0.60-0.91)) and men (OR 0.72 (95% CI 0.63-0.93)) as well as no CPAP treatment in women (OR 0.70 (95% CI 0.57-0.85)) compared to CPAP non-usage. Permanently having left the workforce was in men associated with reduced odds for CPAP usage compared to non-usage (OR 0.81 (95% CI 0.70-0.93)), whereas there was no significant difference in odds for women for neither no CPAP treatment nor CPAP usage.

Employment status three years after OSA diagnosis was stratified by employment status one year prior to diagnosis and by sex. The results are shown in Fig. 4. Among patients employed one year prior to diagnosis, employment status three years later was not significantly associated with different odds for CPAP users or no CPAP treatment when compared to CPAP non-users across sex. Among women, CPAP users had significantly lower odds of being unemployed three years after diagnosis compared with non-users (OR 0.73, 95% CI 0.55–0.98). No significant association was observed for permanently leaving the workforce versus remaining employed. Among men employed one year prior to diagnosis, no significant differences were found for either unemployment or permanent workforce exit three years after diagnosis compared with remaining employed. The sex × CPAP interaction analyses in the employment models showed that none of the interaction terms were statistically significant, indicating that the association between CPAP use and employment outcomes did not differ significantly between women and men.

Among patients unemployed one year prior to OSA diagnosis, no significant odds ratios were observed for remaining unemployed or leaving the workforce three years later, regardless of CPAP use or non-use, in both pooled and gender-stratified analyses.

4. Discussion

In study on more than 30,000 working-aged patients diagnosed with OSA, we examined the association between CPAP usage, education, sex and workforce attachment. Our main findings were that that both vocational and college level education were associated with higher odds of CPAP usage, unemployment and having permanently left the workforce one year prior to OSA diagnosis were associated with reduced odds of CPAP usage and that, in women employed at time of diagnosis, unemployment three years after diagnosis was associated with CPAP non-usage.

4.1. Education and CPAP usage

Results from previous studies on socioeconomic status and CPAP usage have been conflicting: A study by Gulati et al. found no association between education, socioeconomic status and CPAP usage, whereas a study by Simon-Tuval did find an association between lower socioeconomic status (measured by income) and CPAP compliance [41,42]. Our findings indicate that higher level of education, as a marker for socioeconomic status, is indeed associated with CPAP use. The association may be mediated by differences in health literacy - i.e. social and cognitive skills necessary to promote good health – associated with lower socioeconomic status [35,43]. Higher level of education may also relate better health system engagement in general, which may be reflected in our results.

Our results indicate that CPAP non-usage is related to workforce detachment prior to diagnosis which could indicate that CPAP non-use reduces work ability or possibly that factors associated with workforce attachment are also related to CPAP non-use. A recent study found that CPAP adherence was associated with reduced EDS. It is plausible that patients with higher demands related to employment were more motivated for CPAP adherence due to symptom reduction [32]. Interpretation of the association between workforce detachment prior to OSA diagnosis and CPAP non-usage should take into consideration that OSA diagnosis is often delayed. Moreover, previous studies found that OSA is associated with increased risk of lost workdays one and five years prior to OSA diagnosis in men and women, respectively and lower employment rate eight years prior to diagnosis [13,21].

Due to the study design, we are unable to determine causality between workforce detachment before diagnosis and to CPAP non-usage, but it is possible that factors such as comorbidities associated with unemployment are also associated with poor CPAP usage.

4.2. Workforce attachment after OSA diagnosis

In stratified analyses, we found that in women employed before diagnosis - but not in men - CPAP usage was associated with lower odds for unemployment, but interaction analyses did not confirm interaction between sex and CPAP. Nevertheless, it is noteworthy that OSA in women presents at lower AHI, symptoms are different e.g. women more often report insomnia and less often snoring and OSA is more often unrecognized in women [44].

Unrelated to sex, one reason for the results could be the failure of CPAP to normalize cognitive function and alleviate sleepiness in some OSA patients: Studies show that CPAP use is associated with increase in cognitive function, but not in all patients [29,45]. In a study of 174 patients with moderate to severe OSA, Antic et al. found that 40% of patients did not normalize neurobehavioral responses *despite* adequate

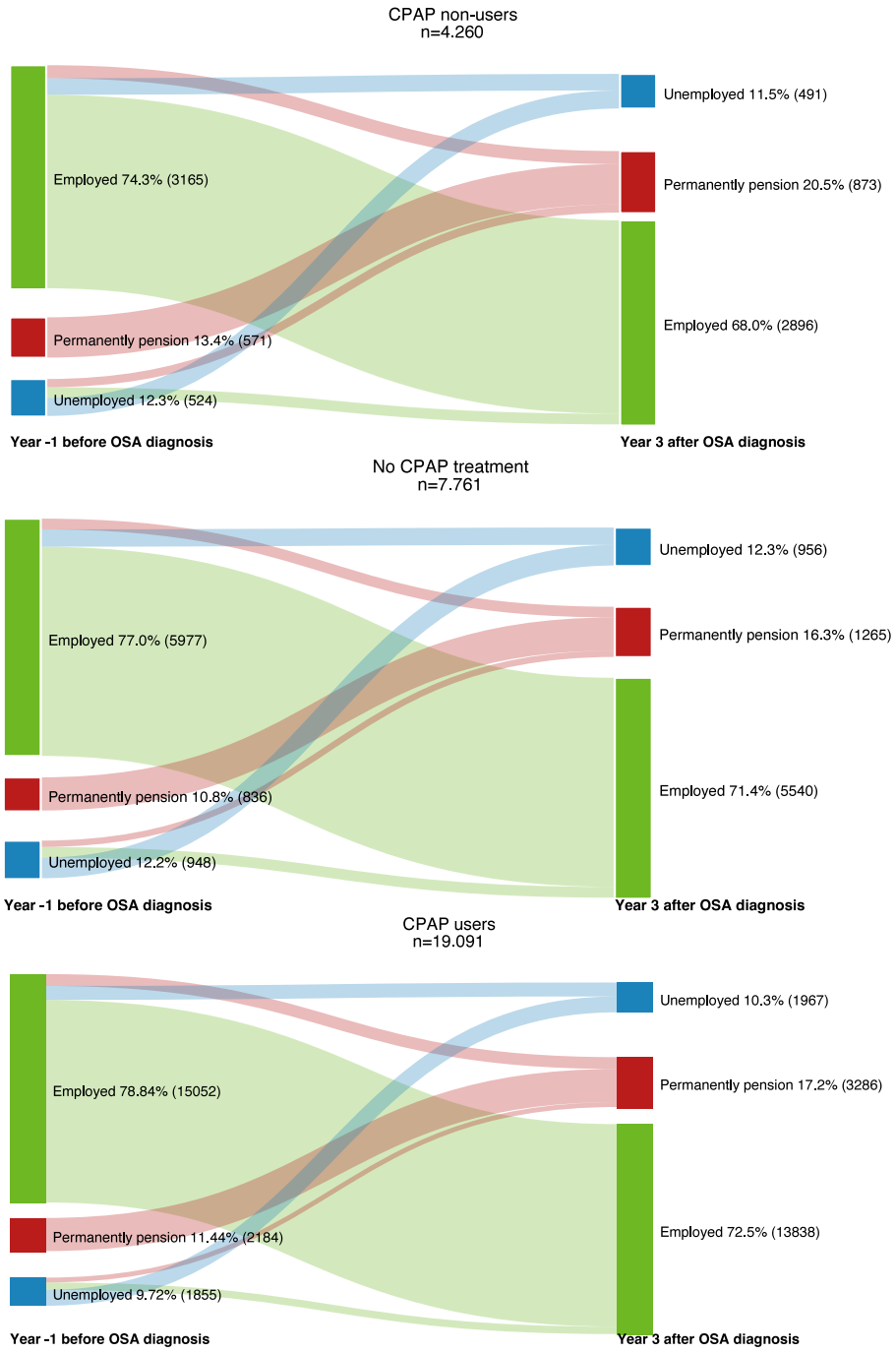


Fig. 2. Employment status before the OSA diagnosis (year −1) and after the OSA diagnosis (year 3 after).

CPAP use [30]. Similarly, Weaver et al. reported that even with optimal CPAP in severe OSA objective sleepiness (measured by multiple sleep latency test) and subjective sleepiness was only normalized in 30% and 50% of patients, respectively [46].

Possible explanations for the lack of normalizing cognitive symptoms suggested by Antic et al. include variation in nightly CPAP use, incomplete treatment of OSA (the airway obstruction remains), and use of medications or presence of comorbidities that affect sleepiness and cognition [30]. These factors could possibly explain why CPAP usage in our study is not consistently associated with workforce maintenance. Diabetes e.g. is associated with poor CPAP adherence and has a negative impact on labor market participation [47,48].

4.3. *Strengths and limitations*

Unfortunately, we did not have access to data on hours of CPAP use per night. The strengths of the study include the large sample size in a nationwide setting during a long study period with complete data of 31,113 individuals including data on workforce attachment. A limitation to the study is that CPAP adherence was defined by a proxy namely CPAP visits to the sleep clinic, thus the findings represent the association between CPAP visits and employment. This proxy was chosen under the assumption that patients who continued to visit the CPAP clinic were adherent to CPAP and that patients without visits did not use CPAP. This entails a risk of misclassification; while patients who discontinue CPAP are unlikely to have CPAP visits, it should be acknowledged that there is

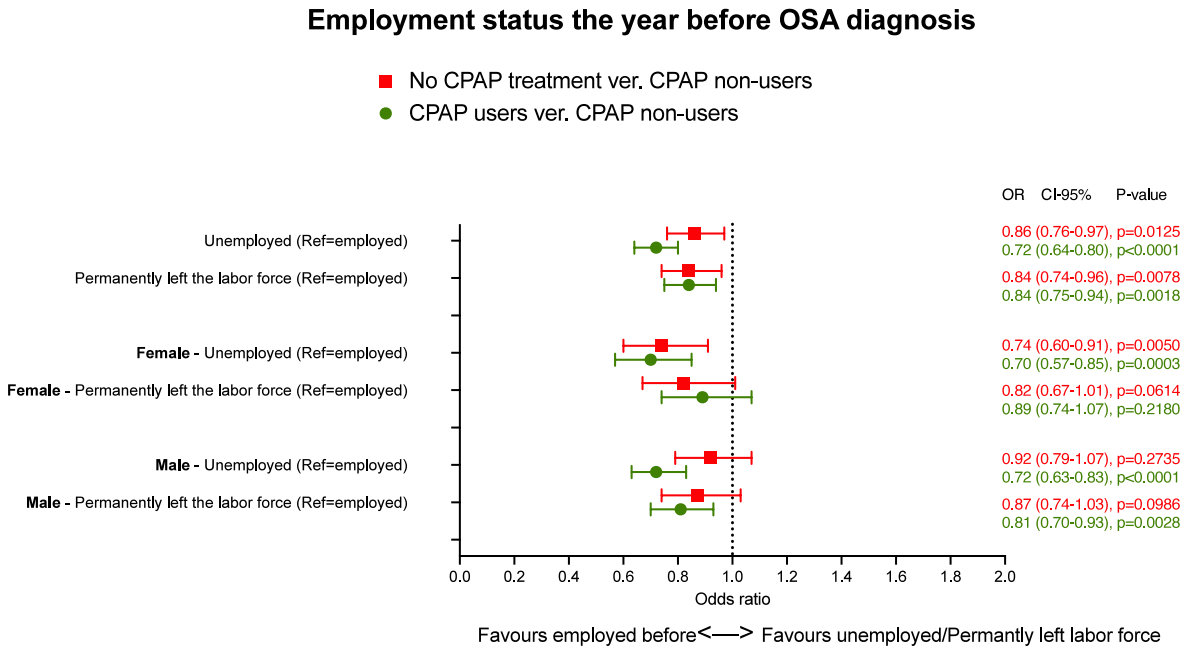


Fig. 3. Odds Ratios for employment status before diagnosis overall and by sex (A *). Results were based on logistic regression models adjusted for sex, age, spouse status, education, Charlson Comorbidity Index, calendar year and region.

a risk of misclassification as patients without CPAP visits may nevertheless have used CPAP. Telemedicine has rendered physical visits redundant, but during our study period 2005-2017, CPAP data were read from an SD card and in-person visits were the norm. With regards to long-term adherence, a recent study from our research group found that the adherence status of CPAP patients (high, low, no) is unlikely to change and 79% of patients with high adherence after one month maintained high adherence after one year [49]. Unfortunately, we did not have access to data on hours of CPAP use per night. With regards to CPAP usage, there is a risk of misclassification as some of the patients classified as CPAP users may not use CPAP consistently. Another limitation is lack of clinical data on OSA severity including AHI, body mass index (BMI), perceived symptoms and EDS. Particularly, EDS is strongly associated with reduced work capability. Both patients classified as either CPAP users or CPAP non-users have CPAP visits and are thought to have moderate or severe OSA. However, it is likely that patients with no CPAP initiation have less severe OSA which should be kept in mind when interpreting the results. Furthermore, although financial capacity is not thought to directly affect access to healthcare services, socioeconomic status including employment status is associated with barriers to health seeking behavior and health literacy indicating that unemployment could possibly affect CPAP visits [50,51].

The study did not include data on why patients discontinued CPAP or about comorbidities and disabilities. The reason for non-usage may in some cases be due to incident impairments that makes CPAP difficult, presence of such factors could add to the underlying association between CPAP non-adherence and reduced work capability.

5. Conclusion

In this nationwide cohort of newly diagnosed OSA patients, lower education and pre-diagnosis unemployment or workforce detachment were associated with CPAP non-use. Among employed women, CPAP non-use was linked to unemployment, but no significant interaction between sex and CPAP was found.

These findings highlight the link between CPAP usage, education and workforce attachment. Future studies should include detailed data on CPAP adherence and assess whether targeted interventions to improve CPAP adherence can enhance job retention and identify subgroups who benefit most.

CRediT authorship contribution statement

Christine Benn Christiansen: Writing – review & editing, Writing – original draft. **Jeppe Suusgaard Kjølhede:** Writing – review & editing, Conceptualization. **Mads Hashiba Jensen:** Writing – review & editing, Writing – original draft, Conceptualization. **Morten Kjøbek Lamberts:** Writing – review & editing, Supervision, Conceptualization. **Michael Ibsen:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Rikke Ibsen:** Writing – review & editing, Supervision, Methodology, Formal analysis. **Jakob Kjellberg:** Writing – review & editing, Supervision, Conceptualization. **Poul Jørgen Jennum:** Writing – review & editing, Supervision, Resources, Project administration, Investigation, Conceptualization.

Disclosure

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Data availability statement

The data used in this study are derived from Statistics Denmark. Due to Danish data protection regulations (GDPR), individual-level data cannot be shared or made publicly available. Access to the data can be granted only through Statistics Denmark.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

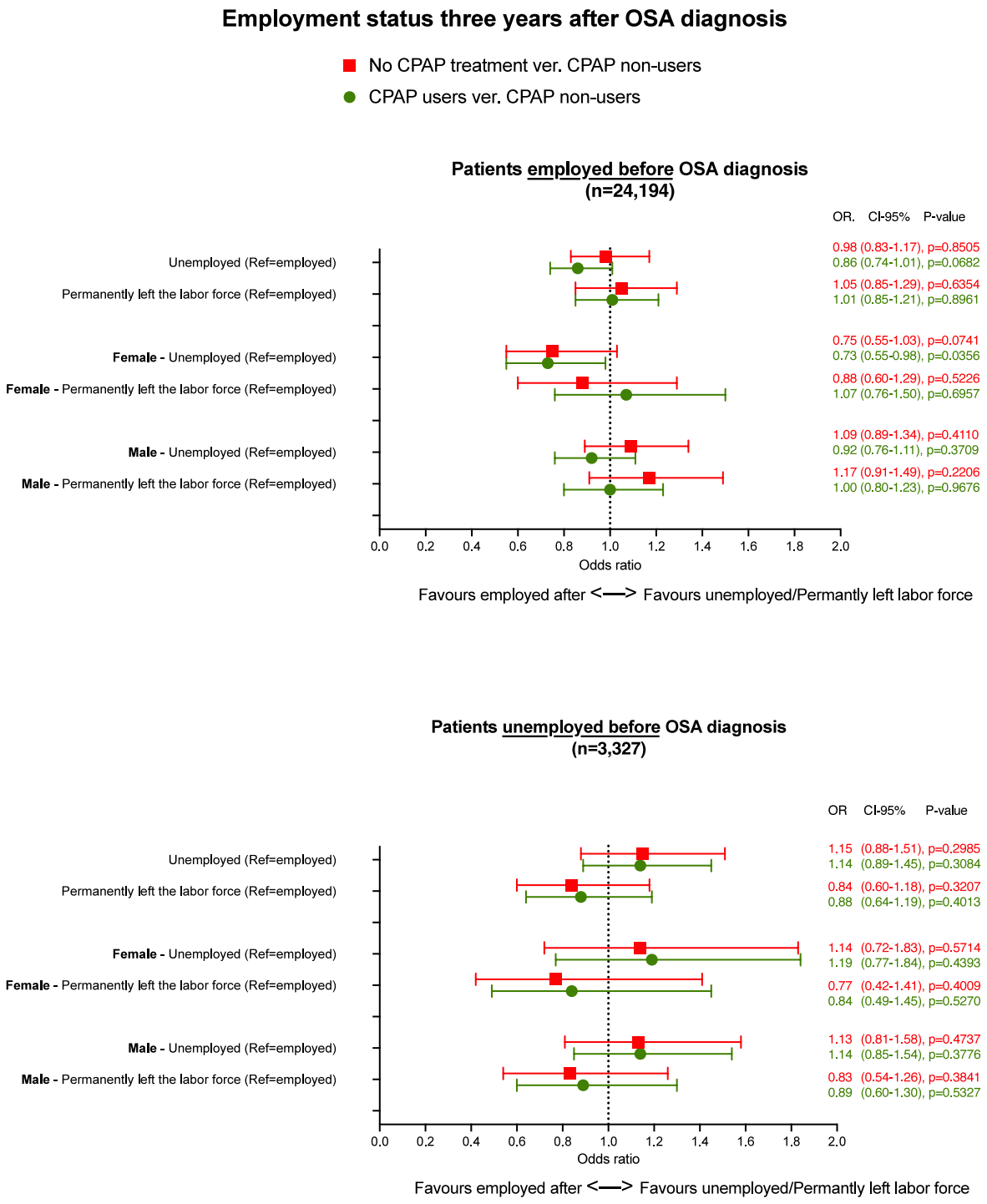


Fig. 4. Odds Ratios for employment status in year 3 after diagnosis overall and by sex (A *).
Results were based on logistic regression models adjusted for sex, age, spouse status, education, Charlson Comorbidity Index, calendar year and region.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2026.108893.

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