



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Risk of permanent social security benefits and overview of work participation among patients with obstructive sleep apnea

Fisker, Filip Yang; Udholm, Nichlas; Fuglsang, Milos; Lundbye-Christensen, Søren; Marshall, Nathaniel S.; Bille, Jesper; Nyboe, Camilla; Udholm, Sebastian

Published in:
Sleep Medicine

DOI (link to publication from Publisher):
[10.1016/j.sleep.2023.05.011](https://doi.org/10.1016/j.sleep.2023.05.011)

Creative Commons License
CC BY 4.0

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Fisker, F. Y., Udholm, N., Fuglsang, M., Lundbye-Christensen, S., Marshall, N. S., Bille, J., Nyboe, C., & Udholm, S. (2023). Risk of permanent social security benefits and overview of work participation among patients with obstructive sleep apnea. *Sleep Medicine*, 108, 16-21. <https://doi.org/10.1016/j.sleep.2023.05.011>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.



Risk of permanent social security benefits and overview of work participation among patients with obstructive sleep apnea



Filip Yang Fisker^a, Nichlas Udholm^a, Milos Fuglsang^a, Søren Lundbye-Christensen^b, Nathaniel S. Marshall^c, Jesper Bille^a, Camilla Nyboe^d, Sebastian Udholm^{a,*}

^a Department of Otorhinolaryngology, Head and Neck Surgery, Aarhus University Hospital, Aarhus, Denmark

^b Unit of Clinical Biostatistics, Aalborg University Hospital, Aalborg, Denmark

^c The Centre for Integrated Research and Understanding of Sleep (CIRUS), Woolcock Institute for Medical Research, Sydney, Australia

^d Department of Cardiothoracic and Vascular Surgery, Anaesthesia Unit, Aarhus University Hospital, Aarhus, Denmark

ARTICLE INFO

Article history:

Received 19 January 2023

Received in revised form

9 May 2023

Accepted 14 May 2023

Available online 30 May 2023

Keywords:

Unemployment

Retirement

Sickness

Disability

Work

Mental health

ABSTRACT

Background: In this nationwide study, we used Danish population registries to estimate the excess risk of receiving permanent social security benefits for patients with obstructive sleep apnea (OSA) and to track their labour force participation.

Methods: We identified all Danish citizens receiving a diagnosis of OSA between 1995 and 2015. As a reference cohort, we randomly selected 10 citizens for each patient, matched by sex and birth year. Using the Fine and Gray competing risk regression, we estimated the cumulative incidences of receiving permanent social security benefits. Cox proportional hazard models were used to compare the risk of receiving permanent social security benefits in patients with OSA compared to the reference cohort. The Danish Rational Economic Agents' Model (DREAM) database was used to identify the labour market status prior to diagnosis, at time of diagnosis, and after diagnosis.

Results: We identified 48,168 patients with OSA. A total of 12,413 (25.8%) patients with OSA had received permanent social security benefits, compared with 75,812 (15.7%) individuals in the reference cohort. Patients with OSA had a significantly increased risk of receiving permanent social security benefits when compared with the reference cohort (hazard ratio, 1.95; 95% CI, 1.88–2.02; and subhazard ratio, 1.92; 95% CI, 1.85–1.98). Work participation was lower for OSA patients compared to references at all time-points. **Conclusion:** Patients with OSA have a moderately increased risk of receiving permanent social security benefits in Denmark after controlling for available confounders.

© 2023 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Sleep disorders are a global health issue with obstructive sleep apnea (OSA) being one of the most frequent [1]. It has been reported that as many as 20% of men and 10% of women are affected by OSA in high-income countries [2]. Living with OSA is associated with an increased risk of various organic diseases, including cardiovascular disease, stroke, metabolic dysfunction, diabetes, and cognitive impairment [3–7]. In addition, OSA has been linked to psychiatric disorders with an increased likelihood of depression and an increased risk of dying from suicide [8–10].

Other adverse effects of OSA and sleep disorders in general have been described, as studies have found an increased incidence of involuntary job loss, reduced productivity, increased health care costs, and a higher rate of workplace accidents among patients with OSA [11–13]. Conflict management, coping with challenges, and maintaining a healthy social interaction in a work-based environment have also been shown to be negatively affected by insomnia [14]. These effects have negative consequences for patients' labour marked participation. In Denmark this could ultimately lead to receiving permanent social security benefits. Indeed, a study by Jennum et al. included data from all Danish patients diagnosed from 1998 to 2006 with sleep-disordered breathing (defined as snoring, sleep apnea, and obesity hypoventilation syndrome) in Denmark, demonstrating that these disorders lead to lower levels of employment and income [15]. In the present study, we extend this study population in size and duration and extend the outcomes

* Corresponding author. Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Skejby, DK 8200, Aarhus N, Denmark.

E-mail address: udholm@clin.au.dk (S. Udholm).

to the risk of receiving permanent social security benefits and an overview of work participation using the Danish Rational Economic Agents' Model (DREAM) database. To our knowledge these data have not been investigated in patients with OSA. We used the unique Danish registries to estimate the risk of receiving permanent social security benefits in a national cohort of patients with OSA covering 25 years of follow-up. Furthermore, we investigated the work participation of patients with OSA prior to their diagnosis, at the time of diagnosis, and after their diagnosis. We hypothesise, that patients with OSA are more likely to receive permanent social security benefits than a matched reference cohort, that continuous positive airway pressure (CPAP) treatment will have an impact on this risk, and that OSA affect work participation negatively.

2. Methods

This study was approved by The Central Denmark Region Research Committee (1-16- 02- 558–20), September 28th 2020. The requirement for informed consent was waived given the nature of the study using already routinely collected and then de-identified data.

2.1. Study population

We used several medical registries in this nationwide descriptive cohort study. Registration and collection of data from all hospitals and outpatient clinics in Denmark is mandatory, with linkage of different registers made possible by the use of the unique personal identification number, the civil registration number, assigned to all Danish individuals at birth or immigration [16]. The Danish healthcare system is publicly financed, with equal accessibility for all registered Danish residents. We used the Danish National Patient Registry (DNPR) to identify all Danish citizens older than 15 years of age receiving a diagnosis of OSA between 1995 and 2015 [17]. The DNPR contains information on all inpatient or outpatient hospital contacts in Denmark, dates of admission and discharge, surgical procedures, and discharge diagnoses coded according to the International Classification of Diseases, Tenth Revision (ICD-10). To identify patients with OSA, we used the ICD-10 codes DG473 (sleep apnea) and DG4732 (obstructive sleep apnea). To identify patients with OSA treated with CPAP we used the code ZZ3915. As adjusting covariates, we used Statistics Denmark to get information on comorbidities: Diabetes, hypertension, and cerebrovascular events. A random reference sample matched by sex and birth year with the included patients with OSA was drawn using the Danish Civil Registration System, ensuring a ratio of 10 control participants per OSA case. To address the risk of immortal time bias, where participants in the exposed group cannot experience the outcome, date of diagnosis was used as the index-date between patients with OSA and their references.

2.2. Assessment of permanent social security benefits and work participation

We linked the study population with the DREAM database using civil registration numbers. This data source contains information on all paid social security benefits (except short-term sick leave) registered on a weekly basis from 1991 to 2020 [18]. These social security benefits and services are government funded and available to all Danish citizens in need, regardless of affiliation to the labour market. The eligibility criteria for permanent social security benefits in Denmark are based on a range of factors, including the individual's medical condition, work history, and income. The system is administered electronically by social security workers. If the citizen is employed, short-term sickness is paid by the employer,

whereas the municipality pays long-term sickness. In unemployed citizens the municipality also cover short-term sickness. Long-term sick leave is covered for both employees and self-employed citizens. We used the DREAM database to identify the first time an individual received permanent social security benefits and to categorize their labour market status into the following six groups: (1) Work (including maternity leave and education), (2) unemployed (all citizens including both those with and without private insurance), (3) long-term sick leave (paid by the municipality), (4) permanent social security benefit, including disability pension and flexi-job (a job created for persons with limited and permanently reduced working capacity), (5) early retirement, and (6) dead or retired [18].

2.3. Analysis

Categorical baseline variables were summarized by percentages or frequencies. Comparisons of categorical characteristics between patients and the reference cohort were performed by Fisher's exact test. Similarly, continuous baseline variables were reported as mean and standard deviation (SD). Comparisons of means were performed by unpaired *t*-test. We followed patients with OSA from their first hospital contact, inpatient or outpatient, with an OSA diagnosis until death, or December 31, 2020 (whichever came first). Comparisons of incident permanent social security benefits between patients with OSA and their matched references were performed in our main analysis by Cox regression with age as time scale. In each matching cluster, individuals entered the risk set at the age the patient was at the time of diagnosis with OSA. Standard errors (SE) were calculated taking matching clusters into account. The cause-specific hazard ratio is provided with the subhazard ratio, with death and retirement age (>65 years of age in Denmark) being the competing risk, as suggested by Latouche et al. [19] By reporting both the cause-specific hazard ratio and the sub-hazard ratio, the effect of the competing risks on the incidence of the events becomes evident. Through the matching and choice of time scale, the analyses are adjusted for sex, attained age, and birth year. Furthermore, we adjusted for comorbidities as binary variables at baseline (diabetes, hypertension, and cerebrovascular events). We estimated the cumulative incidence of permanent social security benefits in patients with OSA and compared them with the reference cohort using the Fine and Gray competing risk regression [20]. Additionally, we made a sub-analysis comparing patients with OSA treated with and without CPAP with their respective references to estimate the effects of CPAP treatment. Finally, we calculated the proportion of weeks in either of the six categories —work, unemployment, long-term sick leave, permanent social security benefit, early retirement, and dead/retired — for patients with sleep apnea and their references for five different years: 5 years prior to diagnosis, 2 years prior to diagnosis, year of diagnosis, 2 years after diagnosis, and 5 years after diagnosis. Another sub-analysis was made to illustrate the potential impact of CPAP treatment at the different time points. Statistical significances were defined as those with *p*-values below 0.05. All analyses were performed using Stata 17 (StataCorp LP, TX).

3. Results

The Danish cohort of patients with OSA diagnosed between 1995 and 2015 is composed of 48,168 patients (mean age, 64 years; 78% male). The reference cohort was composed of 481,680 individuals from the general population (also mean age, 64 years and 78% male). Baseline characteristics are presented in Table 1.

Table 1
Characteristics of patients with OSA and matched references.

Variable	Cases n = 48,168	References n = 481,680	p-value
Age, year, mean (SD)	64.2 (13)	64.2 (13)	0.968
Sex, male (%)	77.7	77.7	–
Age at time of inclusion, years, mean (SD)	52.7 (12.8)	52.7 (12.8)	0.968
Follow-up, y (min-max)	12.4 (5–25)	12.6 (5–25)	<0.0001
CPAP, n (%)	12,875 (26.7)	–	–
Dead during follow-up, n (%)	7009 (14.6)	64,515 (13.4)	<0.0001
Age at death, years, mean (SD)	69.4 (11.3)	70 (10.7)	<0.0001
Socioeconomic status at time of inclusion			
- Owner of business or employee with high income, n (%)	4870 (10.1)	64,654 (13.4)	<0.0001
- Employee with middle or low income, n (%)	12,901 (26.8)	129,499 (26.9)	0.635
- Unemployed, social benefits, students or pensioners, n (%)	28,887 (60.0)	255,164 (53.0)	<0.0001
- Other, n (%)	1326 (2.8)	30,077 (6.2)	<0.0001
- Missing, n (%)	184 (0.4)	2286 (0.5)	0.004
Comorbidity			
- Diabetes Mellitus, n (%)	5748 (11.9)	22,172 (4.6)	<0.0001
- Hypertension, n (%)	5913 (12.3)	26,284 (5.5)	<0.0001
- Cerebrovascular events, n (%)	3736 (7.8)	26,165 (5.4)	<0.0001

Mean follow-up was 12.5 years, with a maximum follow-up of 25 years. Among patients with OSA, 7009 (14.6%) had died, compared with 64,515 (13.4%) deaths in the reference cohort.

3.1. Risk of permanent social security benefits

A total of 12,413 (25.8%) patients with OSA had received permanent social security benefits, compared with 75,812 (15.7%) individuals in the reference cohort. Patients with OSA had a significantly increased risk for receiving permanent social security benefits when compared with the reference cohort (adjusted hazard ratio, 1.95; 95% CI, 1.88–2.02; and adjusted subhazard ratio, 1.92; 95% CI, 1.85–1.98; see Table 2).

Fig. 1 plots the cumulative incidence of permanent social security benefits by time since OSA diagnosis is shown.

To address a potential effect of CPAP treatment on the risk of receiving permanent social security benefits, patients with OSA treated with and without CPAP was compared with their respective references (Table 2). Both patient groups were found to have a significantly increased risk of receiving permanent social security benefits compared to the references; however, the risk among patients treated with CPAP was substantially lower when estimated with the competing risk analysis (adjusted subhazard ratio 1.78; 95% CI, 1.66–1.90 vs. 1.96; 95% CI, 1.89–2.03).

3.2. Labour market status

The proportion of individuals working was lower for patients with OSA compared to references at all time points, as shown in the overview of labour market status in Fig. 2 (please see supplementary file 1 for numerical values).

The same figure demonstrates that more patients with OSA received permanent social security benefits, were unemployed, or on long-term sickness leave. The proportional difference between the two groups in receiving permanent social security benefits were found to increase after time of diagnosis (Fig. 3).

Prior to diagnosis the proportion of patients with OSA receiving

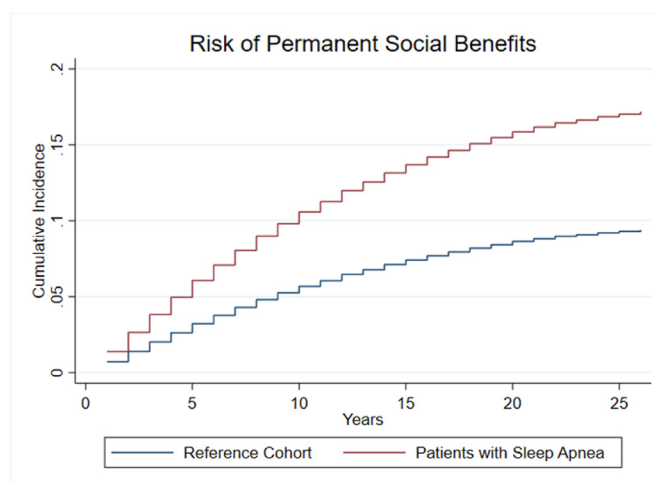


Fig. 1. Cumulative incidence of permanent social security benefits by time of diagnosis among patients with obstructive sleep apnea Characteristics of OSA patients who were and were not treated with CPAP is shown in Table 3.

benefits who were treated later with CPAP was higher than OSA patients receiving benefits who did not receive CPAP, however, two years after time of diagnosis the proportions became similar (Fig. 4).

4. Discussion

In this nationwide study, we estimated the risk of receiving permanent social security benefits in a large cohort of patients with OSA covering a long-term follow-up period of up to 25 years in

Table 2
Risk of permanent social benefits in patients with OSA compared with matched references.

Variable	No. of cases	Subhazard ratio (95% CI) ^a	Hazard ratio (95% CI)
Permanent Social Benefits			
Reference cohort	75,812	1.00 (ref)	1.00 (ref)
Patients with sleep apnea	12,413	1.92 (1.85–1.98)	1.95 (1.88–2.02)
-Patients with CPAP	3219	1.78 (1.66–1.90)	2.12 (1.97–2.29)
-Patients without CPAP	9194	1.96 (1.89–2.03)	1.90 (1.84–1.98)

^a Analysis with death and retirement age as competing risk.

Table 3
 Characteristics of patients with OSA treated with or without CPAP and the risk of permanent social benefits compared between the two groups.

	CPAP n = 12,875	No CPAP n = 35,293	p-value
Age, mean (SD)	62.7 (12.7)	64.7 (13.4)	<0.0001
Dead during follow-up, n (%)	1263 (9.8)	5746 (16.23)	<0.0001
Age at death, years, mean (SD)	69.5 (11.3)	69.4 (11.29)	0.813
Permanent Social Benefits, n (%)	3219 (25)	9194 (26.05)	0.057

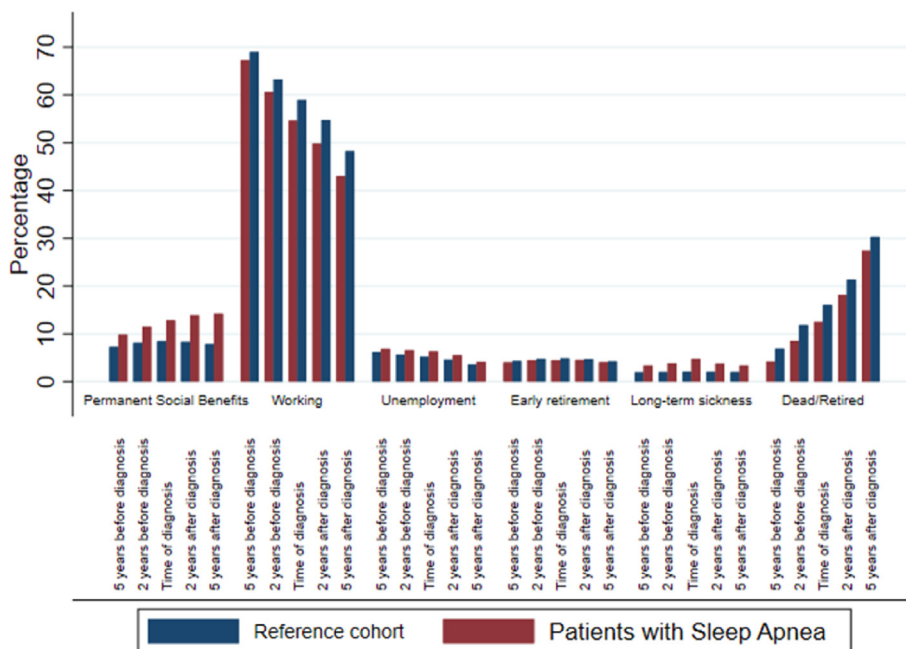


Fig. 2. Complete overview of labour market status in percentage.

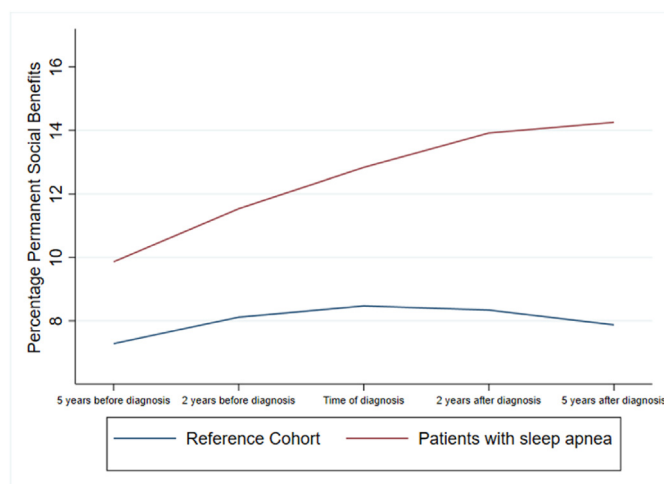


Fig. 3. Proportions of patients and references on permanent social security benefits at different time points.

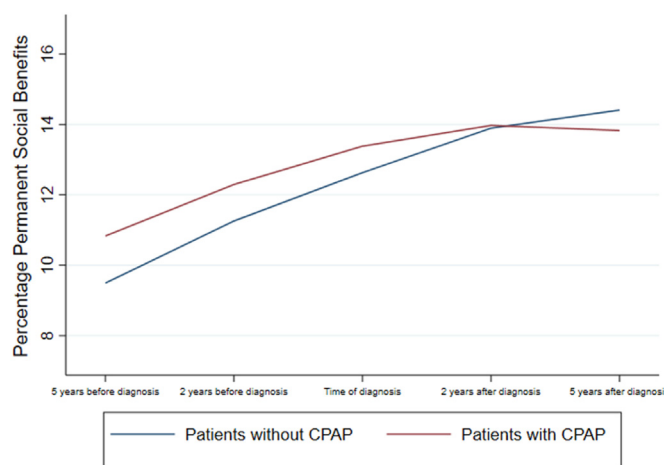


Fig. 4. Proportions of patients treated with and without continuous positive airway pressure (CPAP) on permanent social security benefits at different time points.

Denmark compared to matched controls. We found that the absolute risk of receiving permanent social security benefits was significantly higher in OSA patients. Patients with OSA treated with CPAP had a lower risk of receiving permanent social security benefits than patients with OSA not treated with CPAP when compared to matched references. Lastly, we found that a lower proportion of patients with OSA were working when compared to the reference cohort. These findings are all in support of our hypotheses.

Our data demonstrate that OSA may have a negative impact on patients' ability to achieve self-support and on work participation, adding further support for the notion that OSA has far-reaching consequences. Our results extend the findings by Jennum et al. who showed that the negative impact of sleep-disordered breathing on work capability is considerable [15]. The authors found that this effect was present even before the time of the diagnosis, concluding that "these disorders lead to significantly higher health-

related and social transfer costs and lower levels of employment and income" (page 565), thereby highlighting OSA's impact on the social gradient. The authors did not estimate the risk of permanent social security benefits, and estimated the production loss related to disease-related work disability measured by loss of income, whereas we had information on weekly work participation using the DREAM database. Regarding the causes behind our findings, we must expect that multiple factors influence labour market participation and the risk of receiving social security benefits. The list of somatic and psychiatric symptoms and diseases related to OSA are lengthy and several of the more frequent causes of affected work participation are related to or caused by OSA, including stress, depression, and fatigue [21,22]. These mental health issues often lead to social isolation and reduced work performance, impacting an individual's ability to network, find employment opportunities, and maintain employment. Additionally, somatic comorbid conditions as diabetes and cardiovascular diseases have been reported to have a negative impact on several outcomes indicating labour market participation [23]. Other symptoms often present in patients with OSA such as difficulty concentrating, sleepiness, irritability, and reduced short-term memory, are also likely have a negative effect on patient's ability to find and keep employment. While speculative, our results may be caused by a combination of the above-mentioned symptoms and conditions.

Patients with OSA treated with CPAP were found to have a lower risk of receiving permanent social security benefits compared to matched references than patients treated without CPAP when dead and pension were accounted for as competing risks. Interestingly, the prevalence of patients receiving permanent social security benefits were higher among patients who ended up being treated with CPAP prior to their diagnosis and at time of diagnosis than patients who were not treated with CPAP eventually. However, this changed two years after time of diagnosis when these rates became similar. As patients receiving CPAP treatment are expected to be the ones with moderate to severe OSA, and patients not receiving CPAP are more likely to have mild OSA, it could be theorized that the former would have had a higher prevalence of receiving permanent social security benefits.

Despite the adverse consequences of OSA suggested in our paper, caution is needed when extrapolating our findings directly to countries with vastly different labour market structure. Our results derive from the Danish labour market and the observational nature of our study does not provide the ability to determine causation. In Denmark, the welfare system is well-established, extensive, and provides a strong social and financial safety net. This system is protective of the general work force, and secures the way people are treated when encountering difficulties while employed and after a potential job loss. Further, the time-span from initially experiencing job-related problems to actually getting fired and receiving permanent social security benefits is probably rather wide in Denmark typically. Indeed, there are different ways of keeping an individual employed including counselling, job training, and relocation. Whether the Danish socioeconomic model causes us to over-or-underestimate the negative effect that OSA has on the risk of receiving permanent social security benefits is not known.

4.1. Limitations

The validity of our estimates depends on the accuracy of the OSA diagnosis. This again depends on the physicians generating the data; however, the validity of the diagnosis in the DNPR is considered moderate to high. We decided to only include patients with a primary diagnosis of OSA to strengthen the validity of our data. Additionally, as we choose to only include patients diagnosed

after 1995, the completeness of our cohort is higher as all patients diagnosed in an outpatient clinic is included.

Regarding external validity of our findings, we cannot, as mentioned, extrapolate our findings directly to countries with a vastly different labour market. Further, we cannot extrapolate our results to the large group of undiagnosed patients with OSA in the general population, as our cases are likely to suffer from clinical referral bias, given that many patients with OSA have other clinical conditions potentially associated with receiving social security benefits and work participation. This may consequently account for part of the significance of the association demonstrated in the present study.

Lastly, given the nature of the registries, we do not have detailed clinical information, e.g. apnea-hypopnea index, mandibular advancement devices, or therapy adherence. Further, we were not able to include potential important confounding undiagnosed conditions or lifestyle variables such as body mass index and smoking, as these variables are unavailable in central national registries. We decided not to adjust for socioeconomic status, given that this variable in the Danish registers is based on information on the main source of income or employment for the individual. As this is the outcome of our study, adjusting for it would be inappropriate as it would artificially drive our estimate towards a null finding.

5. Conclusion

We have estimated there is a moderately strong risk (i.e. nearly doubling) of receiving social security benefits in patients with OSA from time of diagnosis when compared with a large reference cohort. We further demonstrated that patients had lower work participation and that CPAP treatment might have a potential effect on the risk of receiving permanent social security benefits.

Financial support

This work received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

CRedit authorship contribution statement

Filip Yang Fisker: Writing – original draft. **Nichlas Udholm:** Conceptualization, Writing – review & editing. **Milos Fuglsang:** Conceptualization, Writing – review & editing. **Søren Lundbye-Christensen:** Conceptualization, Formal analysis, Writing – review & editing. **Nathaniel S. Marshall:** Formal analysis, Writing – review & editing. **Jesper Bille:** Conceptualization, Writing – review & editing. **Camilla Nyboe:** Conceptualization, Formal analysis, Writing – review & editing. **Sebastian Udholm:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of competing interest

Authors declare none.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2023.05.011>.

References

- [1] Benjafield AV, Ayas NT, Eastwood PR, et al. In: Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis, vol. 7; 2019. [https://doi.org/10.1016/S2213-2600\(19\)30198-5](https://doi.org/10.1016/S2213-2600(19)30198-5).

- [2] Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. *Lancet* (London, England) 2014;383(9918):736–47. [https://doi.org/10.1016/S0140-6736\(13\)60734-5](https://doi.org/10.1016/S0140-6736(13)60734-5).
- [3] Sarkar P, Mukherjee S, Chai-Coetzer CL, McEvoy RD. The epidemiology of obstructive sleep apnoea and cardiovascular disease. *J Thorac Dis* 2018;10(Suppl 34):S4189. <https://doi.org/10.21037/JTD.2018.12.56>.
- [4] Floras JS. Sleep apnea and cardiovascular disease: an enigmatic risk factor. *Circ Res* 2018;122(12):1741–64. <https://doi.org/10.1161/CIRCRESAHA.118.310783>.
- [5] Bassetti CLA, Randerath W, Vignatelli L, et al. EAN/ERS/ESO/ESRS statement on the impact of sleep disorders on risk and outcome of stroke. *Eur J Neurol* 2020;27(7):1117–36. <https://doi.org/10.1111/ENE.14201>.
- [6] Ponsaing LB, Lindberg U, Rostrup E, et al. Impaired cerebrovascular reactivity in obstructive sleep apnea: a case-control study. *Sleep Med* 2018;43:7–13. <https://doi.org/10.1016/j.sleep.2017.10.010>.
- [7] Kohli P, Balachandran JS, Malhotra A. Obstructive sleep apnea and the risk for cardiovascular disease. *Curr Atherosclerosis Rep* 2011;13(2):138–46. <https://doi.org/10.1007/s11883-011-0161-8>.
- [8] Udholm N, Fuglsang M, Lundbye-Christensen S, et al. Obstructive sleep apnea and risk of suicide and self-harm: a Danish Nationwide Cohort Study. *Sleep* 2022;45(2). <https://doi.org/10.1093/SLEEP/ZSAB286>.
- [9] Hobzova M, Prasko J, Vanek J, et al. Depression and obstructive sleep apnea. *Neuroendocrinol Lett* 2017;38(5):343–52.
- [10] Schröder CM, O'hara R. Depression and obstructive sleep apnea. OSA); 2005. <https://doi.org/10.1186/1744-859X-4-13>.
- [11] Magnavita N, Garbarino S. Sleep, health and wellness at work: a scoping review. *Int J Environ Res Publ Health* 2017;14(11):1347. <https://doi.org/10.3390/IJERPH14111347>.
- [12] Silva GE, Quan SF, McMorro T, et al. Association between obstructive sleep apnea and multiple involuntary job loss history among recently unemployed adults. *Sleep Heal* 2021;7(1):118–22. <https://doi.org/10.1016/J.SLEH.2020.08.002>.
- [13] Garbarino S, Guglielmi O, Sanna A, et al. Risk of occupational accidents in workers with obstructive sleep apnea: systematic review and meta-analysis. *Sleep* 2016;39(6):1211. <https://doi.org/10.5665/SLEEP.5834>.
- [14] Palmer KT, D'Angelo S, Harris EC, et al. Sleep disturbance and the older worker: findings from the Health and Employment after Fifty study. *Scand J Work Environ Health* 2017;43(2):136–45. <https://doi.org/10.5271/sjweh.3618>.
- [15] Jennum P, Kjellberg J. Health, social and economical consequences of sleep-disordered breathing: a controlled national study. doi:10.1136/thx.2010.143958.
- [16] Schmidt M, Pedersen L, Sørensen HT. The Danish civil registration system as a tool in epidemiology. *Eur J Epidemiol* 2014;29(8):541–9. <https://doi.org/10.1007/s10654-014-9930-3>.
- [17] Lyng E, Sandegaard JL, Rebolj M. The Danish national patient register. *Scand J Publ Health* 2011. <https://doi.org/10.1177/1403494811401482>.
- [18] Hjollund NH, Larsen FB, Andersen JH. Register-based follow-up of social benefits and other transfer payments: accuracy and degree of completeness in a Danish interdepartmental administrative database compared with a population-based survey. *Scand J Publ Health* 2007;35(5):497–502. <https://doi.org/10.1080/14034940701271882>.
- [19] Latouche A, Allignol A, Beyersmann J, et al. A competing risks analysis should report results on all cause-specific hazards and cumulative incidence functions. *J Clin Epidemiol* 2013. <https://doi.org/10.1016/j.jclinepi.2012.09.017>.
- [20] Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. *J Am Stat Assoc* 1999. <https://doi.org/10.1080/01621459.1999.10474144>.
- [21] Wong JL, Martinez F, Aguila AP, et al. Stress in obstructive sleep apnea. 2021 111 Sci Rep 2021;11(1):1–9. <https://doi.org/10.1038/s41598-021-91996-5>.
- [22] Chotinaiwattarakul W, O'Brien LM, Fan L, Chervin RD. Fatigue, tiredness, and lack of energy improve with treatment for OSA. *J Clin Sleep Med* 2009;5(3):222. <https://doi.org/10.5664/jcsm.27490>.
- [23] Pedron S, Emmert-Fees K, Laxy M, Schwettmann L. The impact of diabetes on labour market participation: a systematic review of results and methods 14 Economics 1402 Applied Economics. *BMC Publ Health* 2019;19(1):1–13. <https://doi.org/10.1186/S12889-018-6324-6/TABLES/2>.