European Journal of Public Health, 2025, ckaf209

https://doi.org/10.1093/eurpub/ckaf209

A decade of change in age, sex distribution, and comorbidities of obstructive sleep apnoea in Finland

Marja Palomäki[1,*], Miika Linna[2], Ulla Anttalainen[3,4], Terhi Kolari[5], Markku Partinen[6,7], Tarja Saaresranta[3,4,‡], Jaana Keto[8,‡]

[1]Department of Pulmonary Diseases, Central Hospital for Central Ostrobothnia, Kokkola, Finland
[2]Department of Health and Social Management, University of Eastern Finland, Kuopio, Finland
[3]Department of Pulmonary Diseases, Division of Medicine, Turku University Hospital, Turku, Finland
[4]Sleep Research Centre, Department of Pulmonary Diseases and Clinical Allergology, University of Turku, Turku, Finland
[5]Department of Biostatistics, University of Turku and Turku University Hospital, Turun Yliopisto, Finland
[6]Department of Neurosciences, University of Helsinki, Helsinki, Finland
[7]Helsinki Sleep Clinic, Terveystalo Healthcare, Helsinki, Finland
[8]Department of Oral and Maxillofacial Disease, Faculty of Medicine, University of Helsinki, Helsinki, Finland

*Corresponding author: Department of Pulmonary Diseases, Central Hospital for Central Ostrobothnia, Mariankatu 16-20, Kokkola 67200, Finland. E-mail: makrip@utu.fi.
‡equal contribution

Abstract

There is limited information on changes over time in the incidence, age, sex, and comorbidities of obstructive sleep apnoea. We extracted data from the Finnish Secondary Care Register to assess the incidence of obstructive sleep apnoea, the age and sex distribution, and the prevalence of 26 comorbidities of incident obstructive sleep apnoea patients in Finnish specialized care in 2010 and 2020. Analyses were conducted for three age groups (18 – 39, 40 – 64, and ≥65 years), stratified by sex, and for the total population. From 2010 to 2020, the incidence of clinically diagnosed obstructive sleep apnoea increased from 1.7 to 6.1 per 1000 (from 2.4 to 7.6 per 1000 for men and from 1.0 to 4.6 per 1000 for women). The proportion of the youngest group increased from 11.0% to 12.7% and the oldest group from 20.2% to 27.2%. The largest increase in incidence was observed in the youngest group for both sexes. Among men, the prevalence of six comorbidities decreased, and of eight increased. Among women, the prevalence of seven comorbidities decreased, and of four increased. Obstructive sleep apnoea is being diagnosed increasingly in young adults and those aged 65 years and older. Changes in comorbidities suggest increased recognition and treatment of cardiovascular risk factors and, on the other hand, the ageing of the population. A decrease in some comorbidities suggests that incident obstructive sleep apnoea patients are less morbid despite their increased age.

Introduction

Obstructive sleep apnoea (OSA) is an increasing and global health problem. Most recent polysomnography-based prevalence estimates for moderate-to-severe OSA [defined as apnoea-hypopnoea index (AHI) ≥15/h] in a European population-based sample (age range 40–85) were 23.4% for women and 49.7% for men [1]. In Finland, the annual number of patients treated for OSA in secondary care increased by 610% and outpatient visits rose by 1160% between 1996 and 2018 [2]. By 2019, the estimated prevalence of clinically diagnosed OSA in Finland was ∼4% [3, 4] and the population-level incidence increased from 6 to 9 per 1000 persons between 2017 and 2020 [5]. In Canada, between 2003 and 2020, the prevalence of OSA in the adult population increased from 0.17% to 4.4% and the incidence of OSA increased from 2.1% to 3.5% between 2013 and 2020 [6].

The growing number of OSA patients challenges health care professionals to recognize those most likely to benefit from positive airway pressure (PAP) therapy or treatment with a mandibular advancement device (MAD) and those who can be treated with lifestyle modifications. OSA is associated with a burden of comorbidities and is an independent risk factor for some of these [4]. Benefits in quality of life and prognosis can be achieved with PAP or MAD therapy for OSA and some of the comorbidities. Studies of trends in OSA demographics and comorbidities can provide data for formulating public health strategies.

Data on possible changes in demographics and comorbidities of OSA patients in the 21st century are scarce.

In a recent French study, the prevalence of PAP treatment for OSA tripled between 2009 and 2018 [7]. The increase was more marked in women and the youngest and oldest age groups (average annual increase in the prevalence of CPAP treatment +17.8%, +17.2%, and +21.9%, respectively), suggesting possible changes in the demand for OSA diagnostics and treatment in these age groups. Overall, there is a gap in knowledge on changes in the age and sex distribution and comorbidities of OSA patients.

This study evaluated changes in the incidence, age and sex distribution, and comorbidities of newly diagnosed OSA in specialized health care in Finland between 2010 and 2020.

Methods

Study design

This is a nationwide, retrospective observational register study utilizing secondary data collected from health care records covering the entire population of Finland. The purpose of the study was to assess changes in the incidence and comorbidities of OSA by inspecting the age, sex, and comorbidity prevalences of the incident OSA cohorts of 2010 and 2020.

Patients

The study data were collected from the Finnish Secondary Care Register (HILMO), maintained by the Finnish Institute for Health and Welfare. HILMO contains nationwide comprehensive individual-level data on both inpatient and outpatient care in Finnish specialized care facilities, i.e. in secondary and tertiary care. Diagnostic codes according to the 10th revision of the International Classification of Diseases (ICD-10), as well as procedure/intervention codes for every patient contact, are registered in HILMO.

Patients aged 18 years and older with the ICD-10 code G47.3 (sleep apnoea) marked as the primary diagnosis for a health care contact in specialized care were defined as individuals with OSA. The validity of the G47.3 coding in the Finnish Care Registers is over 98% [8]. To be considered an incident, i.e. newly diagnosed case, the patient had to have the G47.3 diagnostic code marked as the primary diagnosis between 1 January 2010 and 31 December 2010, for the incident cohort of 2010, and between 1 January 2020 and 31 December 2020, for the incident cohort of 2020. To ensure that the patients were newly diagnosed, we used a wash-out period of 4 years preceding the date of the G47.3 diagnosis. During the wash-out period, the patients had no health care contacts in specialized care with the G47.3 code as either primary or secondary diagnosis.

For the 2010 and 2020 incident cohorts, we extracted HILMO data on the prevalence of 26 comorbidities based on ICD-10 codes preceding OSA diagnosis by up to 4 years. These comorbidities were chosen due to their variable association with OSA, as previously described [4].

Procedures

To produce aggregated study data, individual-level data were stratified first by sex and then by age into three groups: 18 – 39, 40 – 64, and ≥65 years. The study data included frequencies of newly diagnosed OSA patients and 26 comorbidities.

Outcomes

The primary outcomes of the study were incidence rates per 1000 persons for OSA in 2010 and 2020, incidence rate ratios (IRRs), and changes in the prevalence of comorbidities in the incident OSA cohorts of 2010 and 2020.

Statistical methods

The incidence of OSA was calculated as the number of patients per 1000 persons, using the size of the adult population alive at the end of the calendar year as the denominator, as reported by Statistics Finland (www.stat.fi). Age group-specific incidences for both sexes were calculated similarly. The rate difference (RD) was calculated as the absolute difference in incidence. Incidence rate ratios (IRRs) were calculated by dividing the incidence of 2020 by the incidence of 2010. Changes in age and sex distributions were analysed using the Chi-square test. The prevalence of comorbidities was presented as a percentage of cases in both years. Changes in prevalence of comorbidities were analysed using risk ratios with 95% confidence intervals, calculated with MedCalc's relative risk calculator (https://www.medcalc.org/calc/) [9]. We set the statistical significance level at 0.05. Graphs were created in R version 4.2.1, utilizing ggplot2 and forestplot packages.

Ethical issues

The Finnish Social and Health Data Permit Authority (Findata) granted the data permit and did not require an ethics statement or consent collection. The study followed relevant guidelines and regulations outlined in the Declaration of Helsinki.

Results

We found 7170 newly diagnosed OSA patients (30.9% women) in 2010 and 27 216 (38.9% women) in 2020. The number of subjects in three age groups and their respective percentages are presented in Fig. 1. These numbers translate to an OSA incidence of 2.4 per 1000 men and 1.0 per 1000 women in 2010, and 7.6 per 1000 men and 4.6 per 1000 women in 2020 within Finnish specialized health care. For both sexes combined, the incidence increased from 1.7 to 6.1 per 1000 persons. Age group-specific incidences are presented in Table 1. In both sexes, the youngest age group had the largest relative increase in incidence.

Both age and sex distributions changed significantly from 2010 to 2020 ($P < .0001$ for both comparisons). The proportion of women rose from 30.9% to 38.9%. The proportion of subjects aged 65 years and older increased from 20.2% to 27.2%, and that of those 40–64 years decreased from 68.8% to 60.1% between 2010 and 2020, respectively. The proportion of subjects 18–39 years increased from 11.0% to 12.7%. The change in age group distribution was parallel in both sexes.

The prevalence of 26 comorbidities in 2010 and 2020 and prevalence ratios with 95% confidence intervals comparing 2020 to 2010 are shown in Fig. 2 for men, in Fig. 3 for women, and in the Supplementary Figs S1–S6 for the three age groups. In men, we found a decrease in the prevalence of 6, an increase in 8, and no change in 12 comorbidities when all age groups were analysed together. The largest decrease was for chronic obstructive pulmonary disease (COPD), and the largest increase was for glaucoma. Changes in prevalences differed between age groups, with the least changes in the youngest age group and the most changes in those 40 – 64 years. In women, a decrease in the prevalence was found in 7, an increase in 4, and no change in 15 comorbidities. The largest decrease was again for COPD, and the largest increase was for thyroid diseases. In women, differences in the number of changes showed less inconsistency between age groups.

Discussion

In this nationwide register study, we observed a 3.6-fold increase in the incidence of OSA in Finnish specialized health care. Nearly quadrupling the number of OSA patients in 10 years would challenge any health care system. As has been previously reported, in 2020, 39 769 subjects received a new OSA diagnosis in Finland at any health care level [5]. From these figures, it can be concluded that ∼68% of those diagnosed with OSA in Finland in 2020 received treatment in specialized health care. We found an increase in the proportion of women from 31% to 39%, and a widening of the age distribution at both ends in 10 years. Our results are parallel with the results of the French nationwide study, indicating that OSA nowadays is a significant disorder increasingly in women, the elderly, and young adults [7]. The increase in the proportion of women and the youngest age group raises concerns about the long-term impact of OSA on health and work ability. OSA severity assessment based on AHI values underestimates systemic inflammation in women, and untreated OSA is associated with various maternal and foetal complications [10, 11].

The rapid increase in the number of OSA patients underlines the importance of understanding how much the increase is demand-driven and how much supply-driven. Ageing and obesity trends of the population during our review period can reflect a demand-driven change in incidence. OSA incidence can be seen as an indicator of the BMI of a population. Since the ageing and obesity trends are comparable throughout Europe [12, 13], it is reasonable to assume that the phenomenon we observed is not unique to Finland. Another driver for the demand-induced increase in OSA is the increased awareness of OSA. In 2002, a national guideline was issued in Finland for the prevention and treatment of OSA [14]. This and from 2010 onwards, the regularly updated national current care

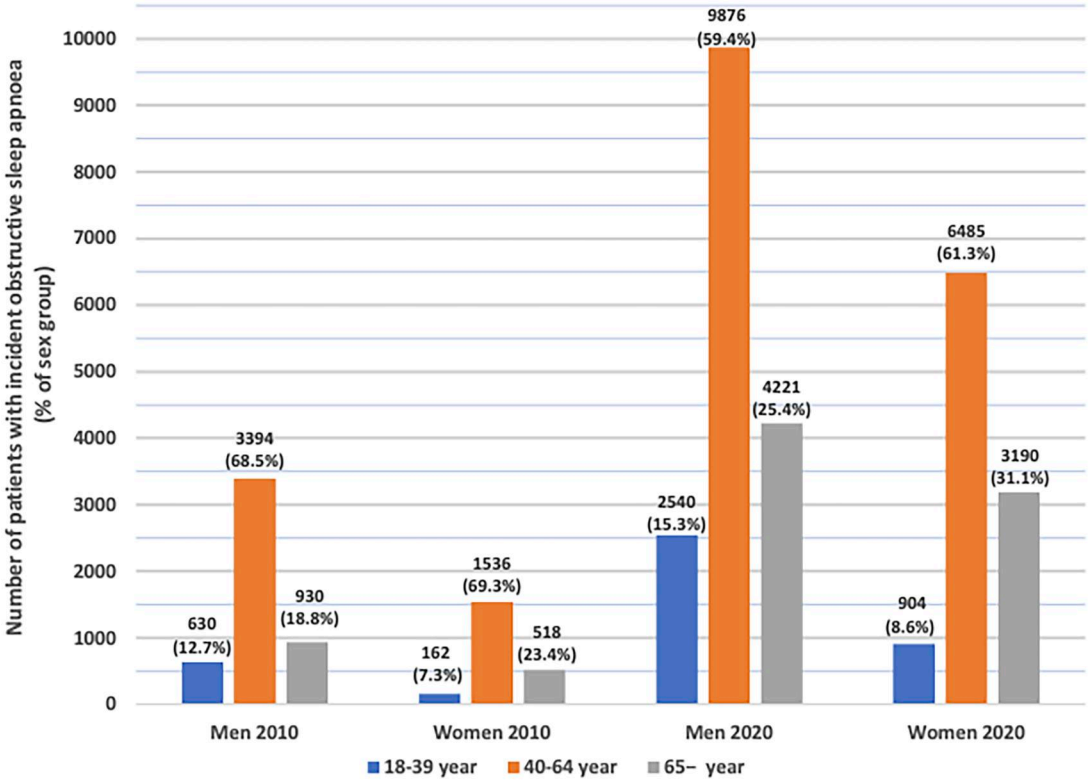

Figure 1. Patients with incident obstructive sleep apnoea in Finland 2010 and 2020.

Table 1. Incidence of obstructive sleep apnoea in Finland in 2010 and 2020 by sex and age group.

Sex	Age group	OSA incidence per 1000		Rate difference	Incidence rate ratio
		2010	2020		
Men	18–39 years	0.8	3.3	2.5	4.12
	40–64 years	3.6	11.3	7.7	3.14
	≥65 years	2.4	7.6	5.2	3.17
Women	18–39 years	0.2	1.2	1.0	6.00
	40–64 years	1.6	7.5	5.9	4.69
	≥65 years	0.9	4.5	3.6	5.00

guidelines for OSA (https://www.kaypahoito.fi/hoi06030) have prompted increased recognition of OSA. This resulted in increased referrals to specialized care and improved diagnostics and care resources. The increased demand led to a need to perform diagnostic tests also in primary health care, again enhancing the supply of diagnostics and increasing the need for OSA treatment. As the changes in the population's age and BMI distribution in Finland are not large enough to solely explain the increase in OSA incidence, we suppose that the supply-driven mechanism accounts for most of the increase. Part of the increase in the incidence of OSA in Finland is attributable to the 2012 change in hypopnoea scoring criteria, which has been estimated to have led up to a 20% higher rate of OSA diagnoses [15, 16].

Based on our results and limited health care resources, it is necessary to re-evaluate the most cost-effective supply allocation for OSA treatment. Primary health care is mainly responsible for lifestyle counselling in OSA treatment, whether alone or combined with other treatments. A recent Spanish study compared diagnostic and therapeutic decisions for OSA between primary care physicians and sleep unit specialists and found around 70% agreement on diagnostic classification and over 80% agreement on treatment decisions. The authors concluded that coordinated work between primary care and specialized units would be feasible, identifying patients who can be managed in primary care and those needing specialized care, avoiding unnecessary referrals [17]. As non-severe OSA is often treatable by lifestyle modifications and as the benefits of PAP therapy in the oldest age group are controversial [18], shifting care from specialized clinics to primary health care might be reasonable, especially for the elderly with multimorbidity, and for those with non-severe OSA, minimal symptoms and well-controlled comorbidities [19]. Regardless of the patient's age and comorbidity status, a comprehensive and patient-centred treatment plan, such as the one introduced in Sweden, could help in treatment decisions. The Swedish model gives a supportive matrix for first-line treatment decision in OSA depending on the patient's symptoms, age, AHI, and cardiometabolic comorbidity [20].

Nationwide health care registers are rare outside the Nordic countries, and we are unaware of similar studies elsewhere. The closest comparison is the Swedish OSA registry SESAR, which has collected clinical data since 2010 but was only recently integrated with national health care databases, potentially causing a bias due to manual data entry. The SESAR dataset from 2021 to 2022 ($n = 25\ 144$) reported prevalence for six comorbidities [21]. Compared to our 2020 incident OSA patients, the Swedish OSA patients had a higher prevalence of hypertension, asthma and COPD, a lower prevalence of stroke, and a similar of atrial fibrillation. Differences in population-level prevalence of comorbidities and data documentation contribute to variations in OSA comorbidities between the

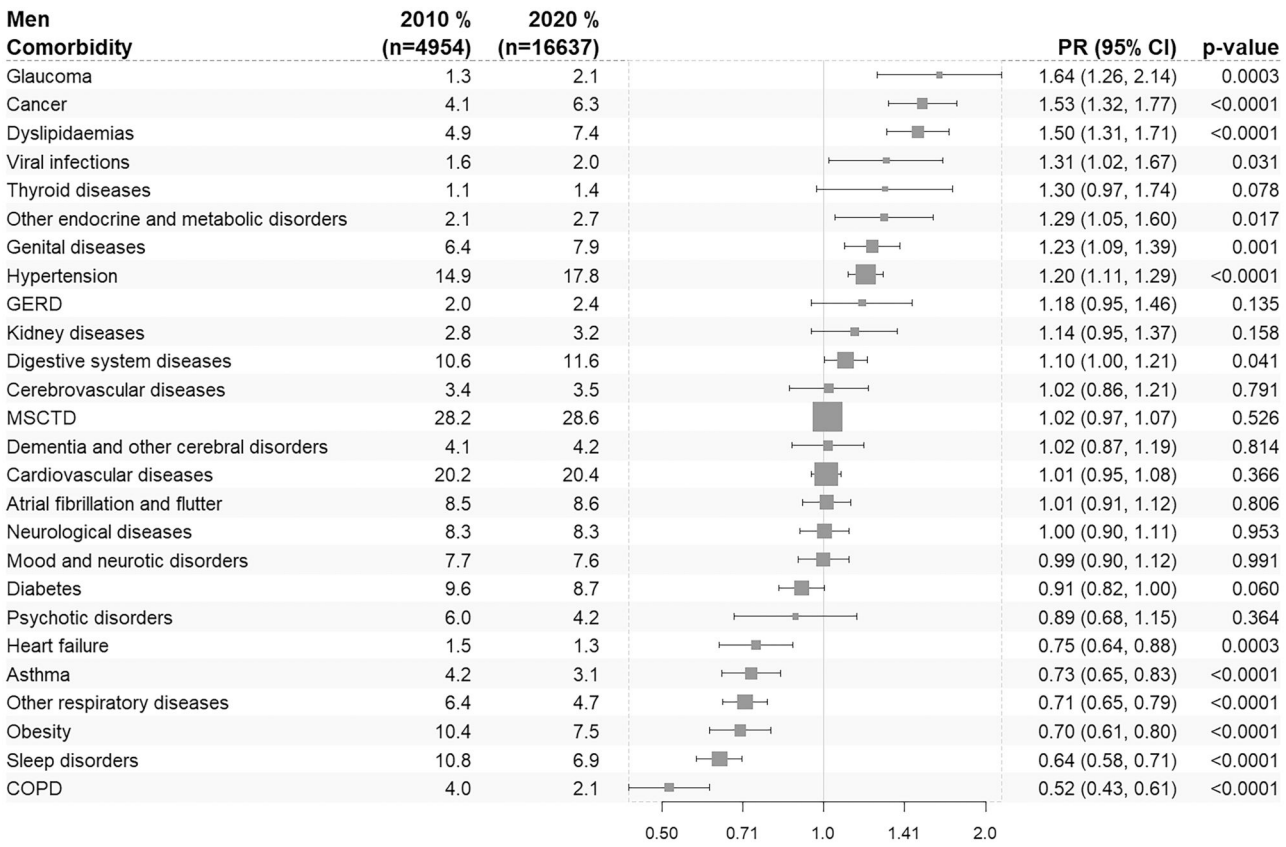

Figure 2. Prevalence of comorbidities and prevalence ratios (2020 vs. 2010) with 95% confidence intervals in men diagnosed with incident obstructive sleep apnoea in 2010 and 2020. Abbreviations: GERD = gastro-oesophagal reflux disease, MSCTD = musculoskeletal and connective tissue diseases, COPD = chronic obstructive pulmonary disease, PR = prevalence ratio, CI = confidence interval.

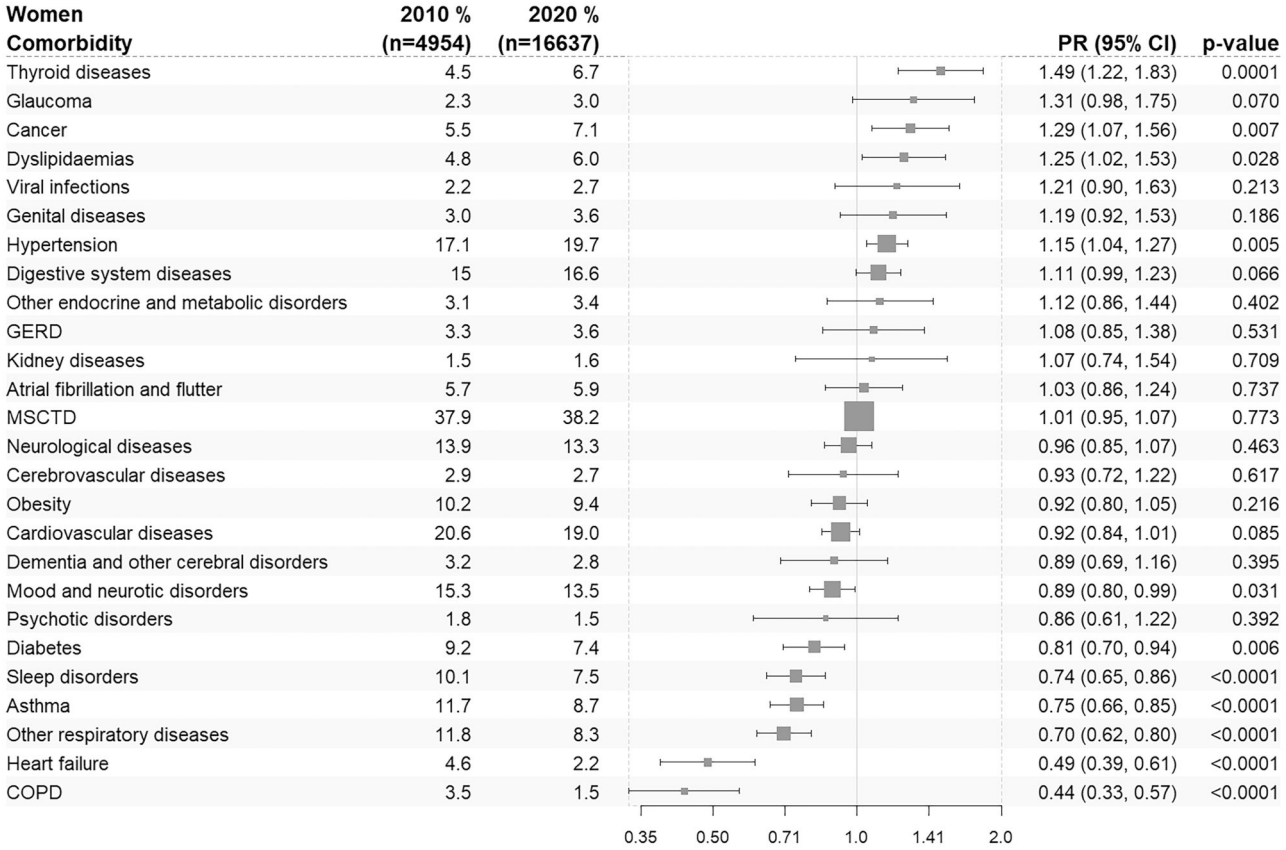

Figure 3. Prevalence of comorbidities and prevalence ratios (2020 vs. 2010) with 95% confidence intervals in women diagnosed with incident obstructive sleep apnoea in 2010 and 2020. GERD = gastro-oesophagal reflux disease, MSCTD = musculoskeletal and connective tissue diseases, COPD = chronic obstructive pulmonary disease, PR = prevalence ratio, CI = confidence interval.

countries [22]. Compared with a pan-European real-life OSA cohort, our study's prevalence estimates of major comorbidities appear lower. The ESADA cohort has reported cardiovascular, metabolic, and pulmonary comorbidities in 49.1%, 32.9%, and 14.2% of patients, respectively [23]. Differences in patient selection, reimbursement criteria for OSA treatment, or smoking prevalence may explain the discrepancy.

The prevalence of hypertension and dyslipidaemia increased in both sexes. In the early 1970s, Finland launched a cardiovascular disease prevention program to reduce mortality by addressing risk factors like hypertension and high serum cholesterol [24]. Despite this, in 2017, 54% of Finnish men and 60% of women over 30 had serum total cholesterol ≥5 mmol/L, and about half of Finns over 30 met the criteria for hypertension or were on antihypertensive medication [25]. The increase in hypertension and dyslipideamia diagnosis in OSA patients in 2020 may reflect the national Finnish treatment guidelines for hypertension and dyslipidaemia, which were updated between 2010 and 2020 recommending lower limit values for treatment, as well as the increased obesity.

There is accumulating evidence of OSA acting as a risk factor for cancer [26]. According to the Finnish Cancer Registry, during the 2010s, the age-adjusted incidence for all cancers in men has plateaued and shows only a minor increase in women. With the ageing population, an increase in the number of new cancers is expected [27]. We found an increased prevalence of cancer in both men and women of 40 – 64 years and in men ≥65 years. The increment was most obvious in men in the oldest age group.

Previous studies have shown that the majority of OSA patients are overweight or obese. We found a reduced prevalence of a diagnosis of obesity in men in 2020 compared to 2010, and no change in women. This result must be evaluated critically. According to the FinHealth 2017 Survey, the prevalence of obesity continued to rise in Finland during the 2010s, and in 2017, 23.2% of men and 22.7% of women were obese [body mass index (BMI) >30 kg/m^2]. Our study is based on medical records data only and not BMI measurements. Thus, our figures cannot be interpreted as reliable rates for a BMI >30 kg/m^2. The recording practices of obesity diagnosis are inconsistent, and the probability of recording obesity increases according to the severity [28]. On the other hand, our results may indicate that the threshold for OSA tests in normal-weight or only slightly overweight subjects is lower than before.

It has been estimated that in 2022, the prevalence of diabetes in the Finnish adult population was 14% in men and 11% in women when both diagnosed and undiagnosed cases were included. The number of new special reimbursement rights for diabetes medication expenses granted by the Finnish social security institution Kela decreased slightly in the 2010s and has been stable for the last 5 years [29]. In this study, the prevalence of diabetes in incident OSA patients decreased between 2010 and 2020, and in women, the change was statistically significant. As undiagnosed diabetes is prevalent in Finland, our figures probably underestimate the true prevalence of diabetes in the study population.

Despite the increased proportion of subjects over 64 years, we found a significant decrease in the prevalence of heart failure, asthma, and COPD in both sexes. Our results do not directly correlate with the epidemiology of these diseases at the population level in Finland. They may rather signal that middle-aged and elderly subjects with incident OSA are somewhat less ill in 2020 than they were in 2010, and that OSA suspicion is nowadays more easily raised also in less morbid populations. Also, in 2010, the majority of cardiorespiratory polygraphies were performed in respiratory outpatient clinics, likely to bias patient selection for OSA tests. By 2020, the availability of OSA tests in primary health care had expanded significantly, reducing this bias and consequently reducing the prevalence of asthma and COPD in OSA patients.

Results from the National FINRISK Studies and FinHealth 2017 Survey have reported reductions in cardiovascular risk factors, translating into a major decrease in cardiovascular disease morbidity and mortality in Finland during the last three decades [24, 30]. We found a significant reduction in cardiovascular comorbidity in incident OSA patients ≥65 years of age. For heart failure, a significant decrease was seen in the two oldest age groups. This likely mirrors the reduction in cardiovascular diseases, mainly ischaemic heart disease. In atrial fibrillation and flutter, a decrease was seen in men ≥65 and women 40 – 64 years of age, but not in other groups. OSA is a well-known risk factor for stroke and is highly prevalent in stroke patients. Stroke prevalence in Finland was 1.5% in 2009 [31]. In Finland, the age-adjusted incidence of first-ever stroke or transient ischaemic attack has remained stable in the 2010s, in line with our results [32]. However, for both sexes, the stroke prevalence in our study was above the average stroke prevalence in the Finnish population.

The reduction in the prevalence of COPD is explained by the reduction in smoking, in line with the declining smoking trend in Finland. In 2017, the self-reported percentage for a COPD diagnosis in the age group 60–69 was 5% in men and 2% in women and 9% in men and 4% in women for those over 80 [25]. As the OSA-COPD overlap syndrome is associated with poor prognosis [33], a reduction in the prevalence of COPD in new OSA patients is good news.

Asthma has a bidirectional relationship with OSA, and the two conditions have shared risk factors [34]. In Finland, the increase in prevalence of asthma has levelled off during the last 10 years [35, 36]. In this study, the prevalence of asthma in incident OSA patients decreased in both sexes and all age groups. This probably reflects a change in referral practices and increased availability of OSA diagnostics in primary care.

The decreased prevalence of sleep disorders, other than sleep apnoea, was seen in both sexes. Between 1972 and 2005, the prevalence of chronic insomnia disorder in the Finnish working-age population remained quite stable and was circa 8% in 2005 [37]. Most recent data obtained during the COVID-19 pandemic show insomnia symptoms in 28.9% and probable insomnia disorder in 13.6% of adult Finns [38]. Our figures for sleep disorders are considerably lower, likely because insomnia is mostly treated in primary care and due to incomplete use of ICD-10 codes.

Musculoskeletal disorders are common in the population. In the FinHealth 2017 Survey, back pain during the last 30 days was reported by 44% of men and 48% of women [25]. Musculoskeletal and connective tissue diseases were prevalent in incident OSA patients, with no significant change in their prevalence between 2010 and 2020.

Hypothyroidism increases the risk for OSA and is more prevalent in women than in men. In 2007, the 1-year prevalence of hypothyroidism in Finland was 5.9% in females and 1.2% in males [39]. We found a statistically significant increase in the prevalence of hypothyroidism in women in 2020 compared to 2010 and a small but statistically insignificant increase in men. It seems reasonable to presume that hypothyroidism as a risk factor for OSA is better recognized and translates to an increased prevalence.

Increased prevalence of glaucoma and genital diseases was found in men but not in women. Ageing is a strong risk factor for glaucoma, with an increasing prevalence in the elderly population. In Finland, the prevalence of glaucoma increased from 2.3% to 2.6% between 2000 and 2011, and was higher in women both years [40]. Accordingly, in this study, the prevalence of glaucoma was higher in women, but a significant change was only seen in men. The increased prevalence of genital diseases seen in men likely reflects an increased prevalence of diseases of the prostate, mainly benign prostatic hyperplasia. In men, a small but statistically significant increase in the prevalence of digestive system diseases and viral infections when all age groups were analysed jointly. Our data did not include COVID-19 diagnoses, as this disease did not exist in 2010.

The study's main strengths are its large nationwide population and novel findings. It uniquely examines changes in comorbidities and age-sex distribution in clinically diagnosed OSA. However,

using only specialized health care data limits generalization to primary care OSA patients. Registry data may have documentation shortcomings and lack detailed patient information, preventing conclusions on associations with OSA incidence or comorbidities.

To conclude, we found a significant increase in OSA incidence and notable changes in sex and age distribution, with more young adults, those aged 65 and older, and women, over 10 years. The prevalence of several major chronic diseases, including cardiovascular diseases in the aged, heart failure, asthma, and COPD, decreased, while the prevalence of cancer, dyslipidaemias, and hypertension increased. These findings suggest that the age distribution and comorbidity profile of OSA patients have changed. The trends are likely generalizable to Western European countries with similar health care systems. New resource allocation strategies and updated treatment guidelines for OSA are needed to ensure adequate treatment.

Supplementary data

Supplementary data are available at *EURPUB* online.

Conflict of interest: None declared.

Funding

This work was supported by The Ida Montin Foundation, The Foundation of the Finnish Anti-Tuberculosis Association, The Väinö and Laina Kivi Foundation, The Tampere Tuberculosis Foundation, The Jalmari and Rauha Ahokas Foundation, The Research Foundation of the Pulmonary Diseases, and The Finnish Sleep Research Society.

Data availability

The original data used in this study is available for researchers by application from the Finnish Social and Health Data Permit Authority Findata at: https://findata.fi/en/.

Key points

- OSA incidence nearly quadrupled in 10 years.
- Age and sex distribution in incident OSA changed, with an increased proportion of women, young adults, and those ≥65 years.
- The comorbidity profile of incident OSA patients shows changes that are partly attributable to the increased proportion of ≥65 years.
- Some changes in comorbidity profile suggest a less morbid incident OSA population.
- The increased incidence and changes in the age and gender distribution of OSA and comorbidities emphasize the need to renew OSA treatment protocols.

References

1 Heinzer R, Vat S, Marques-Vidal P *et al.* Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. *Lancet Respir Med* 2015;**3**:310–18.

2 Mattila T, Hasala H, Kreivi H-R *et al.* Changes in the societal burden caused by sleep apnoea in Finland from 1996 to 2018: a national registry study. *Lancet Reg Health Eur* 2022;**16**:100338.

3 Strausz S, Havulinna AS, Tuomi T *et al.* Obstructive sleep apnoea and the risk for coronary heart disease and type 2 diabetes: a longitudinal population-based study in Finland. *BMJ Open* 2018;**8**:e022752.

4 Palomäki M, Saaresranta T, Anttalainen U *et al.* Multimorbidity and overall comorbidity of sleep apnoea: a finnish nationwide study. *ERJ Open Res* 2022;**8**:00646–2021. https://openres.ersjournals.com/content/8/2/00646-2021

5 Palomäki M, Kolari T, Saaresranta T *et al.* Increase in the incidence of sleep apnea and notable regional differences. *Suomen Lääkärilehti* 2024;**79**:1176. https://www.laakarilehti.fi/tieteessa/alkuperaistutkimukset/uniapnean-ilmaantuvuus-kasvoi-alueelliset-erot-merkittavia/en

6 Pendharkar SR, Sharpe H, Rosychuk RJ *et al.* Temporal and regional trends in obstructive sleep apnea using administrative health data in Alberta, Canada. *Ann Am Thorac Soc* 2023;**20**:433–9. https://doi.org/101513/AnnalsATS202209-789OC

7 Mandereau-Bruno L, Léger D, Delmas MC. Obstructive sleep apnea: a sharp increase in the prevalence of patients treated with nasal CPAP over the last decade in France. *PLoS One* 2021;**16**:e0245392.

8 Strausz S, Ruotsalainen S, Ollila HM *et al.*; FinnGen. Genetic analysis of obstructive sleep apnoea discovers a strong association with cardiometabolic health. *Eur Respir J* 2021;**57**:2003091. www.finngen.fi/en/access_results.ThefullgenotypingandimputationprotocolforFinnGenisdescribedathttps://doi-org.libproxy.helsinki.fi/10.17504/protocols.io.nmndc5e

9 Altman DG. *Practical Statistics for Medical Research*. 1st edn. New York: Chapman and Hall/CRC, 1990.

10 Gouveris H, Bahr K, Jahn C *et al.* The apnea–hypopnea index underestimates systemic inflammation in women with sleep-disordered breathing. *J Womens Health* 2018;**27**:920–6.

11 Lee Y-C, Chang Y-C, Tseng L-W *et al.* Continuous positive airway pressure treatment and hypertensive adverse outcomes in pregnancy: a systematic review and meta-analysis. *JAMA Netw Open* 2024;**7**:e2427557.

12 Population Projections in the EU. 2023. Luxembourg, Luxembourg: Eurostat.

13 The European Food Information Council (EUFIC). Europe's obesity statistics: figures, trends & rates by country [Internet]. 2024. https://www.eufic.org/en/healthy-living/article/europes-obesity-statistics-figures-trends-rates-by-country (16 January 2025, date last accessed).

14 Laitinen L, Anttalainen U, Pietinalho A *et al.*; Expert Advisory Group Listed in Foreword. Sleep apnoea: Finnish national guidelines for prevention and treatment 2002-2012. *Respir Med* 2003;**97**:337–65.

15 Berry RB, Budhiraja R, Gottlieb DJ *et al.* Rules for scoring respiratory events in sleep: update of the 2007 AASM manual for the scoring of sleep and associated events. *J Clin Sleep Med* 2012;**08**:597–619.

16 Mansukhani MP, Kolla BP, Wang Z *et al.* Effect of varying definitions of hypopnea on the diagnosis and clinical outcomes of sleep-disordered breathing: a systematic review and meta-analysis. *J Clin Sleep Med* 2019;**15**:687–96.

17 Peñacoba P, Llauger MA, Fortuna AM *et al.*; PASHOS Working Group. Primary care and sleep unit agreement in management decisions for sleep apnea: a prospective study in Spain. *J Clin Sleep Med* 2020;**16**:1579–89.

18 Martinez-Garcia MA, Oscullo G, Ponce S *et al.* Effect of continuous positive airway pressure in very elderly with moderate-to-severe obstructive sleep apnea pooled results from two multicenter randomized controlled trials. *Sleep Med* 2022;**89**:71–7.

19 Randerath W, Bassetti CL, Bonsignore MR *et al.* Challenges and perspectives in obstructive sleep apnoea. *Eur Respir J* 2018;**52**:1702616. http://erj.ersjournals.com/content/52/3/1702616.abstract

20 Grote L, Anderberg C-P, Friberg D *et al.* National Knowledge-Driven management of obstructive sleep apnea—the Swedish approach. *Diagnostics* 2023;**13**:1179. https://www.mdpi.com/2075-4418/13/6/1179/htm

21 Grote L, Jonzon YA, Barta P *et al.* The swedish sleep apnea registry (SESAR) cohort – "real world data" on a national level. *Sleep Med* 2024;**124**:362–70.

22 Hansen S, von Bülow A, Sandin P *et al.* Prevalence and management of severe asthma in the nordic countries: findings from the NORDSTAR cohort. from. *ERJ Open Res* 2023;**9**:00687. https://publications.ersnet.org/content/erjor/9/2/00687-2022

23 Hedner J, Grote L, Bonsignore M *et al.* The european sleep apnoea database (ESADA): report from 22 european sleep laboratories. *Eur Respir J* 2011;**38**:635–42. https://pubmed.ncbi.nlm.nih.gov/21622583/

24 Jousilahti P, Laatikainen T, Salomaa V *et al.* 40-Year CHD mortality trends and the role of risk factors in mortality decline: the North Karelia project experience. *Glob Heart* 2016;**11**:207–12. https://pubmed.ncbi.nlm.nih.gov/27242088/

25 Koponen P, Borodulin K, Annamari L *et al.*. *Health, functional capacity and welfare in Finland—FinHealth 2017 study*. Helsinki, 2017 https://www.julkari.fi/bitstream/

handle/10024/136223/Rap_4_2018_FinTerveys_verkko.pdf? sequence=1&isAllowed=y (7 November 2024, date last accessed).

26 Palm A, Theorell-Haglöw J, Isakson J *et al.* Association between obstructive sleep apnoea and cancer: a cross-sectional, population-based study of the DISCOVERY cohort. *BMJ Open [Internet]* 2023;**13**:e064501. https://pubmed.ncbi.nlm.nih.gov/36868588/

27 Pitkäniemi J, Malila N, Seppä K. *Cancer 2022. Statistical report on cancer in Finland*. Helsinki, 2024. https://syoparekisteri.fi/assets/themes/ssy3/factsheets/syopa_2022_tilastoraportti.html (7 November 2024, date last accessed).

28 Pantalone KM, Hobbs TM, Chagin KM *et al.* Prevalence and recognition of obesity and its associated comorbidities: cross-sectional analysis of electronic health record data from a large US integrated health system. *BMJ Open* 2017;**7**:e017583.

29 *Type 2 diabetes. Current Care Guidelines. Working Group Set up by the Finnish Medical Society Duodecim, the Finnish Association for Internal Medicine and the Finnish Diabetes Association*. Helsinki: The Finnish Medical Society Duodecim, 2024. www.kaypahoito.fi.

30 Laatikainen T, Härkänen T, Borodulin K *et al.* Changes in major risk factors of cardiovascular diseases in Finland 1992–2017. *Lääkärilehti [Internet]* 2019;**74**:1886–93. https://www.laakarilehti.fi/tieteessa/alkuperaistutkimukset/sydan-ja-verisuonitautien-riskitekijat-1992-ndash-2017-laskusuunta-jatkunut-mutta-hidastunut/en

31 Meretoja A, Roine RO, Kaste M *et al.* Stroke monitoring on a national level: perfect stroke, a comprehensive, registry-linkage stroke database in Finland. *Stroke [Internet]* 2010;**41**:2239–46. https://www.ahajournals.org/doi/10.1161/STROKEAHA.110.595173

32 *Stroke Transient Ischemic Attack. Current Care Guidelines. Working Group Set Up by the Finnish Medical Society Duodecim and the Finnish Neurological Society*. Helsinki: The Finnish Medical Society Duodecim, 2024. www.kaypahoito.fi.

33 Brennan M, McDonnell MJ, Walsh SM *et al.* Review of the prevalence, pathogenesis and management of OSA-COPD overlap. *Sleep Breath* 2022;**26**:1551–60. https://link-springer-com.ezproxy.utu.fi/article/10.1007/s11325-021-02540-8

34 Wang R, Mihaicuta S, Tiotiu A *et al. Asthma and Obstructive Sleep Apnoea in Adults and Children an Up-To-Date Review*. 2021. https://doi.org/10.1016/j.smrv.2021.101564 (6 January 2024, date last accessed).

35 Pelkonen MK, Notkola ILK, Laatikainen TK *et al.* 30-year trends in asthma and the trends in relation to hospitalization and mortality. *Respir Med* 2018;**142**:29–35.

36 Asthma Current Care Guidelines. *Working Group Set Up by the Finnish Medical Society Duodecim, the Finnish Respiratory Society, the Finnish Paediatric Society and the Finnish Society for Clinical Physiology*. Helsinki: The Finnish Medical Society Duodecim, 2022. www.kaypahoito.fi.

37 Kronholm E, Partonen T, Laatikainen T *et al.* Trends in self-reported sleep duration and insomnia-related symptoms in Finland from 1972 to 2005: a comparative review and re-analysis of finnish population samples. *J Sleep Res* 2008;**17**:54–62.

38 Morin CM, Bjorvatn B, Chung F *et al.* Insomnia, anxiety, and depression during the COVID-19 pandemic: an international collaborative study. *Sleep Med* 2021;**87**:38–45.

39 Virta LJ, Eskelinen SI. Prevalence of hypothyroidism in Finland-a nationwide prescription study. *Eur J Clin Pharmacol* 2011;**67**:73–7. https://link.springer.com/article/10.1007/s00228-010-0884-4

40 Purola PKM, Nättinen JE, Ojamo MUI *et al.* Prevalence and 11-year incidence of common eye diseases and their relation to health-related quality of life, mental health, and visual impairment. *Qual Life Res* 2021;**30**:2311–27. https://doi.org/10.1007/s11136-021-02817-1

European Journal of Public Health, 2025, 00, 1–7
https://doi.org/10.1093/eurpub/ckaf209
Original Manuscript