Respir. Med and Res 88 (2025) 101201

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Original article

Increasing sleep apnoea burden in the elderly in Finland from 1996 to 2018: A national registry study

Hannele Hasala [a,*], Tiina Mattila [b], Hanna-Riikka Kreivi [b], Heidi Avellan-Hietanen [b], Tuula Vasankari [c,d], Fredrik Herse [e], Riikka-Leena Leskelä [e], Sanna Toppila-Salmi [f,g], Marina Erhola [h], Tuija Jääskeläinen [i], Tari Haahtela [j,k]

[a] Department of Respiratory Medicine, Tampere University Hospital, The Wellbeing Services County of Pirkanmaa, PO Box 2000 33521 Tampere, Finland
[b] Department of Pulmonary Diseases, Heart and Lung Center, Helsinki University Hospital and University of Helsinki, Meilahti Triangle Hospital, 6th floor, PO Box 372 00029 HUS, Helsinki, Finland
[c] University of Turku, Department of Pulmonary Diseases and Clinical Allergology, PO Box 52 20521 Turku, Finland
[d] Finnish Lung Health Association (FILHA), Sibeliuksenkatu 11 A 1 00250 Helsinki, Finland
[e] Nordic Healthcare Group, Vattuniemenranta 2 00210 Helsinki, Finland
[f] Department of Otorhinolaryngology, University of Eastern Finland, Joensuu and Kuopio, Finland and Wellbeing services county of Pohjois-Savo, Kuopio, Finland
[g] Department of Allergology, Inflammation Center, Helsinki University Hospital and University of Helsinki, Helsinki, Finland
[h] The Wellbeing Services County of Pirkanmaa, PO Box 2000 33521 Tampere, Finland
[i] Finnish Institute for Health and Welfare, PO Box 30 00271 Helsinki, Finland
[j] Skin and Allergy Hospital, Helsinki University Hospital, Helsinki, PO Box 160 00290, Finland
[k] University of Helsinki, Helsinki, Finland

ARTICLE INFO

Keywords:
Sleep apnoea
Obesity
Elderly
CPAP

ABSTRACT

Background: In many countries, obstructive sleep apnoea is causing an increased burden on healthcare. In Finland (population 5,5 million), the diagnoses of the condition have raised 7-fold from 1996 to 2018. Here, we present register-based data on sleep apnoea in the elderly Finnish people (aged ≥ 60 years) during the 23-year period.
Methods: Two cohorts were explored. The first cohort included all Finns who used public health services during the 23-year period. The data was collected from the Register for Health Care, Statistics Finland. The second cohort consisted of patients treated in the respiratory outpatient clinics from 2010 to 2019 in Tampere and Helsinki University Hospitals with a population of about 1,3 million.
Results: In people aged 60−69 years, the diagnoses of sleep apnoea per 100 000 persons have increased 9-fold, from 0.26 % (1996) to 2.3 % (2018). In those aged ≥ 70 years, the increase has been 23-fold, from 0.06 % to 1.4 %. Obesity is a growing risk factor. During the follow up, the direct healthcare costs of sleep apnoea increased from about €1 million (1996) to nearly €16 million (2018). The cost increase was explained by the mounting outpatient care costs with CPAP-treatment (Continuous Positive Airway Pressure).
Conclusions: In Finland, the prevalence and costs of diagnosed sleep apnoea and CPAP treatment have been in alarming increase in the elderly. This reflects improved awareness and diagnostics, but a risk of over diagnostics and over treatment is obvious. CPAP-treatment must be better targeted to those in true need.

Introduction

Obstructive sleep apnoea (OSA) is an increasing public health problem that causes repeated upper airway collapse during sleep leading to oxygen desaturation and sleep fragmentation [1]. The risk factors of OSA include obesity, male sex, menopause, fluid retention, small upper airway lumen, and smoking [1].

There has been reported an almost 15-fold increase in sleep apnoea diagnoses between 1993 and 2010 in the United States [2] and a 7-fold increase between 1996 and 2018 in Finland [3]. In the United States, sleep apnoea incidence was associated with obesity prevalence and health insurance status [2]. In the elderly, sleep apnoea diagnoses have increased 16-fold between 1993 and 2011 in the United States [4]. In Europe, the prevalence of OSA after the age of 65 is estimated to be 90 % in men and 78 % in women [5,6].

Studies on sex differences among sleep apnoea patients are scarce. In a Japanese study, women with sleep disordered breathing tended to be older, less sleepy, and had milder sleep apnoea than men [7]. Fietze et al. found a positive linear association in AHI severity and prevalence of OSA with age until the age of 80 years for men as well as for women.

*Corresponding author at: Tampere University Hospital, Department of Respiratory Medicine, PO Box 2000 33521 Tampere, Finland.
E-mail address: hannele.hasala@pirha.fi (H. Hasala).

https://doi.org/10.1016/j.resmer.2025.101201
Received 9 January 2025; Revised 25 May 2025; Accepted 18 August 2025
Available online 23 August 2025

However, women had a later onset of OSA, and AHI severity did not increase until after the age of 50 years or older [8]

Generally, the diagnosis of OSA is based on symptoms and AHI in polygraphy (PG) or polysomnography (PSG). Sleep apnoea is considered mild with AHI of 5−15 / h, moderate with AHI of 16−30 / h, and severe when AHI exceeds 30 / h. [9] However, the role of AHI in diagnosing obstructive sleep apnoea in elderly patients has been questioned and the appropriate AHI cut point for making the diagnosis in this group of patients is not known [10]. It seems that AHI increases with age. It has been estimated in a meta-analysis that in healthy people aged 65 −79 years, the average AHI is 15,5 / h. Data on more elderly people is scarce. [11] However, there are no age-specific AHI limits and, therefore, we lack validated diagnostic and therapeutic tools for the elderly [10], which makes sleep apnoea diagnostics more complicated among them.

Treatment of sleep apnoea in the elderly follows the same principles as in the general population: Continuous positive airway pressure (CPAP) is the first choice of treatment and oral appliances can be used when allowed by the dental situation. Adherence to CPAP therapy variates [6,12]. Data on the effect of CPAP treatment in the very elderly (i.e. > 80 years) or frail older population is scarce [13].

However, it is uncertain whether CPAP treatment is necessary for sleep apnoea in the elderly [6,14]. It is supposed that CPAP reduces sleepiness and is more cost effective than best supportive care alone by increasing the quality of life and cognition in elderly people [6]. However, in the elderly, the symptoms of obstructive sleep apnoea can be difficult to distinguish from symptoms of other conditions i.e., sedative effects of medications or underlying neurologic issues [15].

The aim of this registry study is to demonstrate the increase in the sleep apnoea burden and obesity in patients aged 60 years or over from 1996 to 2018 in Finland.

Materials and methods

The Finnish health care system has been thoroughly described in our previous publication [3]. Shortly, the Finnish health care system is mainly funded publicly. Wellbeing services counties provide public health care on their areas. Primary health care is provided by approximately 250 health care centres. Secondary care is provided in 26 hospitals including five university hospitals. The public primary care services are either free of charge or the patient pays a small fee. In public hospitals, a small visit fee is charged from the patients. CPAP-treatment is free of charge for the patient after the pulmonologist at the hospital has decided to initiate the treatment. The wellbeing services counties purchase the CPAP devices and supply them to the patients along with the necessary consumables.

Study population

This study includes two cohorts that have been described in detail in our previous publication [3]. Shortly, the first cohort includes all Finns who used public health services between January 1st, 1996, to December 31st, 2018. Their health service use was collected from the Care Register for Health Care [16]. The population of Finland was in 5.1 million in 1996 and 5.5 million in 2018.

The second cohort consists of people treated in secondary care outpatient clinics of respiratory diseases in the areas of Tampere University Hospital (TAYS) or Helsinki University Hospital (HUH, including areas of Helsinki and Hyvinkää hospital), from January 1st, 2010, to December 31st, 2019. The population around TAYS area was 409 454 inhabitants on December 31st, 2010, and 436 392 on December 31st, 2019, and, in the area of Helsinki and Hyvinkää, 774 951 and 851 364 inhabitants, respectively. These 1 287 756 subjects comprised 23 % of all Finns in 2019.

Study design

We report the change in the amount on sleep apnoea patients in the elderly in Finland in 1996−2018 and the simultaneous direct costs and hospital days of sleep apnoea. Moreover, we report CPAP-treatment initiations in the elderly in the two largest university hospital districts in Finland (TAYS and HUH) representing almost a quarter of the Finnish population. Additionally, based on the results from the Finnish health examination surveys, we report how the body mass index, prevalence of obesity (BMI over 30 kg/m2) and waist circumference have developed in Finland in those aged 60 years or over in 2000 - 2017 while obesity is one of the major risk factors of sleep apnoea.

Data

The Finnish public health care and social security system have comprehensive obligatory registers maintained by national authorities including a systematically collected register data from all the subjects who have used these services. For the nationwide cohort, we used data from the Care Register for Health Care: use of public inpatient and outpatient services with a separate data from primary and secondary care (inpatient services as the number of inpatient days and outpatient services as the numbers of visits) [16]. The Care Register for Health Care includes all episodes from secondary care but is deficient with some primary care data (episodes in private sector and occupational health care). We included only visits with primary diagnose code of sleep apnoea (G47.3) in this study.

For the hospital cohort, data was applied separately from the hospital discharge registers in the areas of TAYS and HUH. In both areas, the need for sleep apnoea treatment is assessed and treatment initiated in secondary care for almost all patients. CPAP treatment initiation criterions for diagnosed sleep apnoea remained the same during follow-up. We included only visits with primary diagnose code of sleep apnoea (G47.3).

HUH includes seven separate hospital areas. However, the statistics for the initiation of new CPAP treatments were only available from the areas of Helsinki and Hyvinkää. From TAYS area, data was available for all CPAP treatment initiations.

Data on obesity and waist circumference was based on the results from large Finnish population-based health examination studies organized by the Finnish Institute for Health and Welfare, the Health 2000 Surveys [17] and the FinHealth 2017 Study [18] and was only roughly analyzed. The definition of obesity is defined as body mass index (BMI) >30 kg/m^2 and the healthy limit for waist circumference is 100 cm in men and 90 cm in women [17,18].

Classification of diseases

Data was searched using the International Classification of Diseases 10 (ICD-10) code of sleep apnoea (G47.3). In Finland, it is usual clinical practise that polygraphy is only performed for patients that have sleep apnoea symptoms and the diagnosis of OSA is set if the AHI exceeds 5 / h [19].

Analysis methods

The annual prevalence of sleep apnoea was estimated according to the records in the Care Register for Health Care for secondary care since, in Finland, most decisions to treat sleep apnoea are made in secondary care. This prevalence data includes both those subjects that received sleep apnoea treatment and subjects that were not initiated CPAP or other treatment even though they were diagnosed with sleep apnoea. The yearly inpatient service use was accessible for the whole observation period from the Care Register for Health Care for primary and secondary care. The number of outpatient visits in secondary care was available from 1998. For the preceding years, the number of outpatient

visits were extrapolated according to the annual prevalence each year with missing data and the average number of visits per patient observed in the following years. For primary care, the number of outpatient visits was available only from 2013, and the average number of visits per patient in 1998−2012 was estimated from the average visits per patient in 2013−2018.

Yearly direct costs, including in- and outpatient care both in primary and secondary care, for those having sleep apnoea as their primary diagnosis were calculated according to the service use and unit costs for each service. The follow-up results for 23 years are presented in annual time series.

All costs are converted into 2018 prices by using Statistics Finland's consumer price index [20].

The burden of sleep apnoea in TAYS and HUH is visualized as annual numbers of initiated new CPAP treatments for sleep apnoea in outpatient clinics of respiratory diseases. All numbers are expressed per 100 000 inhabitants. Population was counted separately for each year according to each year's catchment area [20].

Ethical aspects

Data is derived from national statistical register data or hospital discharge register data without any personalizing identifiers. Because the data includes no personal identifiers and was applied before the GDPR regulation, licences were not generally needed. Permission was only needed and applied for the data from HUS (number HUS/628/2024 −17).

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The study was designed, data analysed and interpreted, and report written and submitted as a function of the authors' regular duties.

Results

Between 1996 - 2018, the number of patients with sleep apnoea has increased nearly 14-fold in patients aged 60−69 years whereas in patients aged ≥ 70 years, the number has increased over 38-fold (Fig. 1A). At the same time, the number of Finns aged 60−69 years and ≥ 70 years has only increased 1,5-fold and 1,7-fold, respectively [20]. Thus, the proportion of sleep apnoea patients per 100 000 persons within the same age category has increased 9,2-fold and 23-fold in age categories of 60−69 years and ≥ 70 years, respectively (Fig. 1B). The prevalence of sleep apnoea has increased from 0.26 % in 1996 to 2.3 % in 2018 in people aged 60−69 years and from 0.06 % to 1.4 % in those aged 70 years or over, respectively.

Based on the results from the Finnish population-based health examination surveys, the mean BMI seems to have increased between 2000 and 2017 especially in men and in women aged 80 years or over (Fig. 2A). Similarly, the prevalence of those with obesity (BMI ≥ 30 kg/m^2) seems to have increased among men aged 60−69 years and in women in the oldest age group (Fig. 2B).

Between 2000 and 2017, the proportion of people with waist circumference exceeding the healthy limit has increased in all age categories in men whereas among women, the increase has been more moderate (Fig. 2C). However, the older female population tends to have more abdominal obesity than similar male age groups (Fig. 2C).

During our 23-year follow up period, the direct costs of sleep apnoea increased 12,5-fold and 30-fold in the age categories of 60−69 years and 70 years or over, respectively (Fig. 3). At the same time, the hospital days decreased by 78 % in 60−69-year-old people whereas in people aged ≥ 70 years, the hospital days due to sleep apnoea increased slightly, by 14 % (Fig. 4). Consequently, the increase in costs cannot be explained by increased hospital days but is rather due to an increase in outpatient care costs.

In Finland, CPAP treatment is mainly initiated in respiratory or sleep outpatient clinics in secondary care hospitals and not much in primary care. Between the years 2012 and 2019, there was a marked increase in

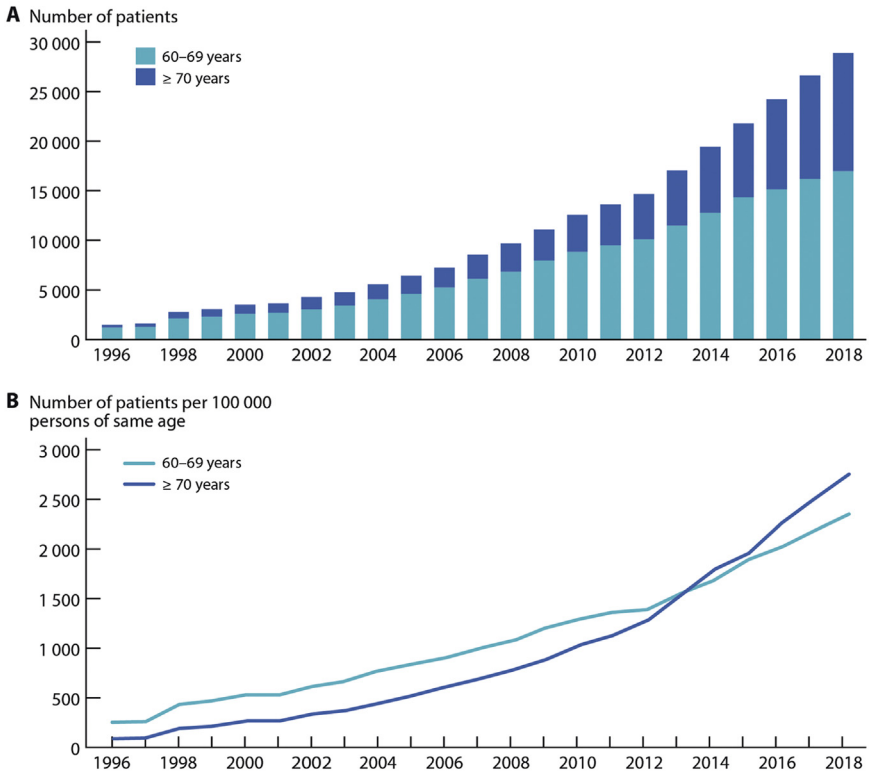

Fig. 1. A) The number of sleep apnoea patients aged 60 −69 years and ≥ 70 years in 1996 − 2018 in Finland. B) The proportion of sleep apnoea patients per 100 000 persons of same age in age categories 60−69 years and ≥ 70 years between 1996 − 2018.

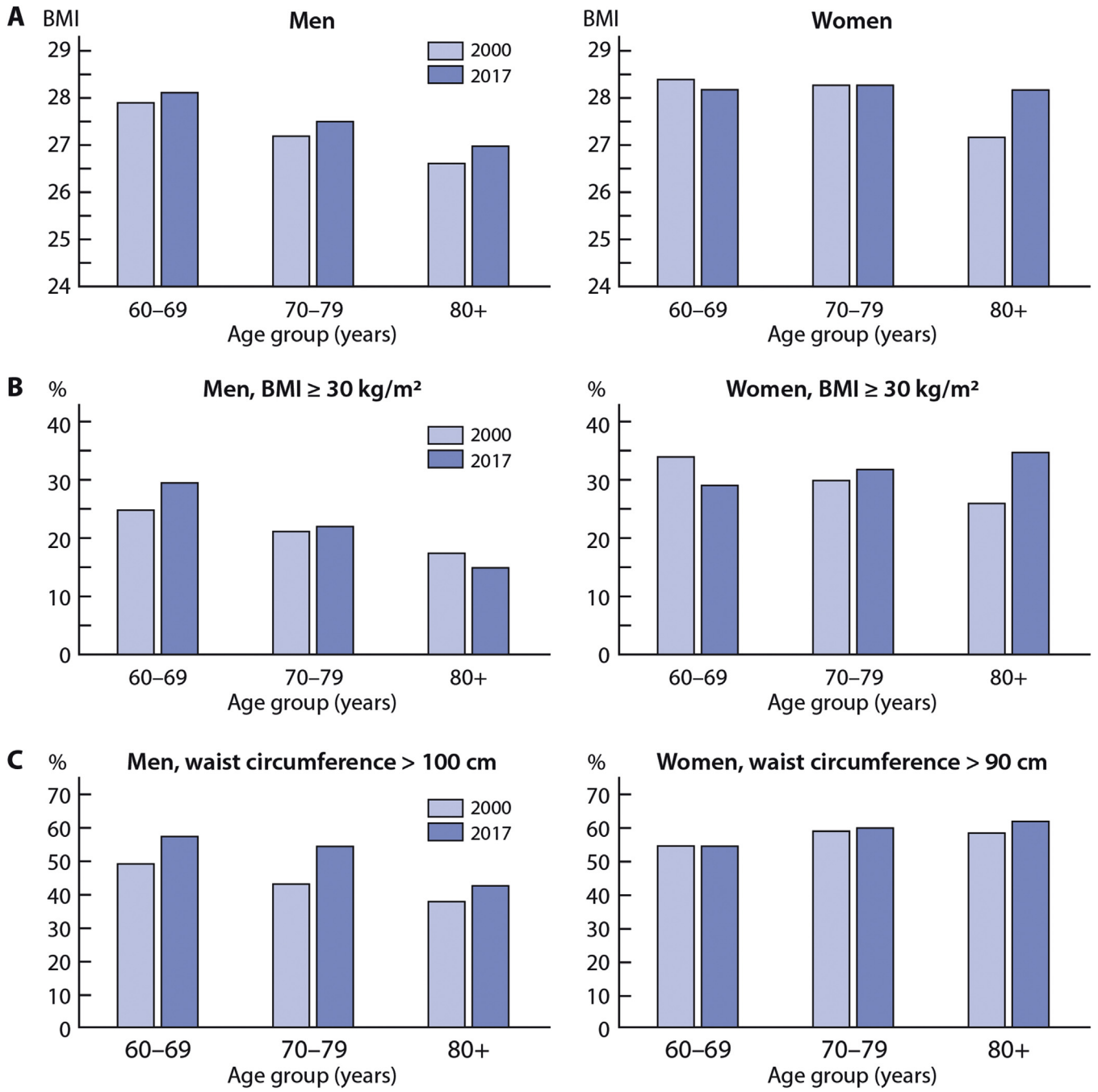

Fig. 2. A) The mean body mass index (BMI) in different age categories in men and women in 2000 and in 2017. B) The proportion (%) of obese (BMI > 30) persons in different age categories in men and women in 2000 and in 2017. C) The proportion (%) of persons with waist circumference exceeding the healthy limit (> 100 cm in men and > 90 cm in women) in different age categories in men and women in 2000 and in 2017.

CPAP treatment initiations in elderly patients in TAYS ja HUH areas (Fig. 5). In men, there was a 5,5-fold increase in new CPAP treatments whereas in women, this increase was even higher, 6,7-fold (Fig. 5). This contributes to the increased directs costs of sleep apnoea in age groups of 60−69 years and ≥ 70 years (Fig. 3).

Discussion

Our study reveals that there is a significant increase in elderly sleep apnoea patients in Finland from 1996 to 2018. The number of patients with sleep apnoea has increased nearly 14-fold in patients aged 60−69 years and over 38-fold in patients ≥70 years of age. Among people aged 65 years or over in the United States, sleep apnoea diagnoses have been reported to increase 16-fold between 1993 and 2011 [4], which is a quite similar increase, but our follow-up was four years longer. Previously, we reported that the number of sleep apnoea patients in secondary care increased over 7-fold between the years 1996 and 2018 in Finland [3]. In other words, the change among the elderly has been even more drastic. Consequently, the direct costs of sleep apnoea have increased 12,5-fold and 30-fold in patients aged 60−69 years and ≥ 70 years, respectively. In our previous study we reported that the total costs for sleep apnoea tripled during the 23-year follow-up [3], so the relative increase in costs is even greater in the older population. At the same time, the proportion of those aged 60 years or older has increased from 19.1 % to 28.4 % in Finnish population [20].

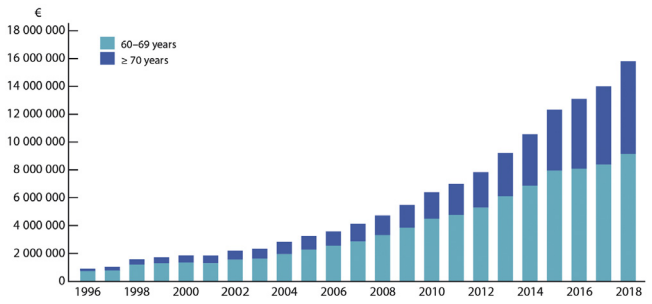

Fig. 3. The direct costs on sleep apnoea in Finland during 1996–2018 in age groups of 60–69 years and ≥ 70 years.

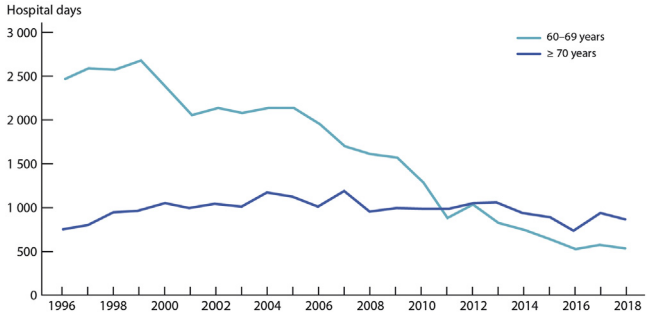

Fig. 4. The hospital days in secondary care inpatient wards with the primary diagnosis of obstructive sleep apnea (ICD G47.3) during 1996–2018 in age groups 60–69 years and ≥ 70 years.

We acknowledge that one of the reasons for increasing OSA diagnoses is the change in AASM scoring criteria during the follow-up period of our study. Previously, it has been shown that change from AASM 2007 scoring criteria to AASM 2012 scoring criteria has increased OSA diagnoses [21]. Implementing these new scoring criteria also in our clinics increased the number of our OSA diagnoses. However, the treatment initiation criteria for diagnosed OSA have not changed during the study period.

We report here the change in hospital days with the primary diagnosis of obstructive sleep apnoea (ICD G47.3) during 1996–2018 in age groups 60–69 years and ≥ 70 years. Our data includes only visits with sleep apnoea as the primary diagnosis, and therefore, the decrease in inpatient visits describes the outpatient emphasized changes in diagnosing and treating sleep apnoea. The smaller change in hospitalization days in the older population aged ≥ 70 years is probably explained by the unsuitability of the older population for outpatient visits.

Based on the Finnish health examination surveys [17,18], the prevalence of people with obesity and abdominal obesity have mainly increased between the years 2000 and 2017 in Finland also in the elderly. This may partly explain the increase in the number of sleep apnoea patients in the elderly. However, the increase in the number of elderly sleep apnoea patients is so rapid that other factors besides obesity probably partly explain it, for example enhanced public awareness of sleep apnoea or the easiness of diagnostics [3]. The use of the same AHI cut points as in younger or middle-aged people may also exaggerate sleep apnoea diagnoses in the elderly since each increasing decade in age also increases the average AHI [11]. Thus, AHI > 30 / h in over 80-year-old population may not demonstrate true severe sleep apnoea syndrome that requires treatment.

We previously reported that the number of new CPAP-treatments increased 3,5-fold from 2010 to 2019 in TAYS and HUH areas [3]. Now we demonstrate that in the elderly people, new CPAP-treatments have been initiated even more eagerly from 2010 to 2019. In age category of 60–69 years, new CPAP-treatments have increased 4,5-fold in men and 6,1-fold in women. In ≥ 70-year-old patients, CPAP-initiations have increased 8-fold and 6,6-fold in men and women, respectively. The benefits of this development, i.e., the increase in sleep apnoea diagnoses and it's treatment by CPAP in the elderly warrants more studies to be reasonable.

There are few studies on the symptoms and consequences of sleep apnoea in the elderly. The symptoms are mostly similar as in the general population [22]. In a follow-up study, a small but significant decline in attention was observed in persons with severe sleep apnoea [23]. In a study of approximately 82-year-old women, it was noticed that sleep-disordered breathing (AHI > 15 / h in average) increased the risk of developing cognitive impairment or dementia compared to women without sleep-disordered breathing [15]. Additionally, the decrease in cognitive function may associate with hypoxemia during the night in the elderly [15,24]. In the elderly, the association of untreated obstructive sleep apnoea with cardiovascular events has not been documented as well as in younger people [25,26] while the association with ischemic stroke has been documented [27].

It is unclear if sleep apnoea in the elderly needs CPAP treatment [6,14]. Some studies recommend it [6] and some state it uncertain [14]. There are a couple of reports addressing the benefits of CPAP treatment on the quality of life, anxiety or depression, day-time sleepiness, or cognitive functions in the elderly. McMillan et al. recommend CPAP therapy in senior patients with obstructive sleep apnoea and they showed in a randomized trial that CPAP reduces sleepiness and is marginally more cost effective than best supportive care alone [6]. Notably, the median CPAP usage was only 1 h 52 min per night at 3 months and 2 h 22 min per night at 12 month-follow-up [6] whereas the usual target is to use CPAP treatment for at least 4 h per night and 70 % of days [28]. CPAP treatment was shown to increase the quality of life and cognition in elderly people [6].

In a randomized study on over 70-year-old patients with severe sleep apnoea (AHI > 30 / h), CPAP treatment was found to improve quality of life, sleep-related symptoms, anxiety and depression and some

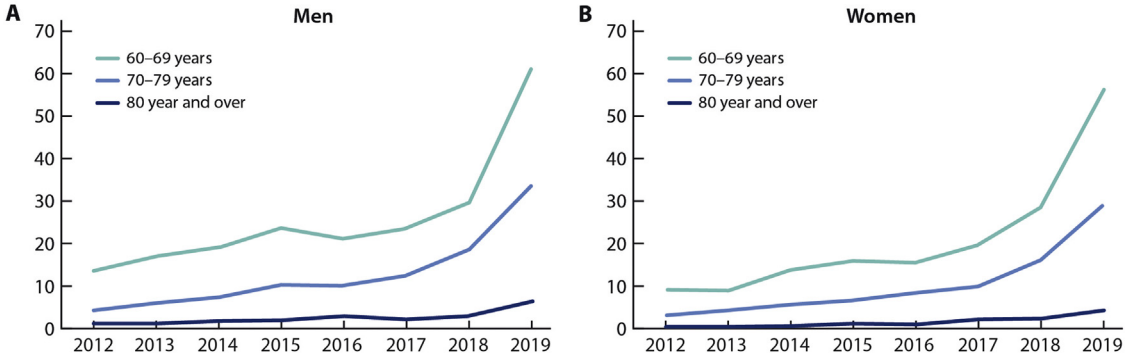

Fig. 5. New CPAP-treatments in elderly men (A) and women (B) (i.e. age groups 60–69 years, 70–79 years and 80 years or older) between 2012 and 2019 in TAYS and HUH catchment areas.

neurocognitive aspects [29]. In another randomized study in patients aged ≥ 65 years with newly diagnosed severe obstructive sleep apnoea, CPAP treatment resulted in an improvement in memory and executive function [30]. In a randomized trial in over 70-year-old patients with moderate obstructive sleep apnoea (AHI 15−29.9 / h), CPAP treatment resulted in an improvement in the ESS and quality of life scores and alleviated some sleep-related symptoms but not on anxiety or depression [31]. However, in the very elderly (over 80 years), CPAP treatment did not seem to have an effect on the ESS score, quality of life, cognitive function, or mood in patients with moderate or severe sleep apnoea in a post-hoc pooled analysis of two clinical trials [32]. Some think that age should not be considered as a barrier to assess and treat sleep disordered breathing [13]. However, the general data suggests that CPAP treatment may not be useful in treating the symptoms of moderate-to-severe obstructive sleep apnoea in very elderly patients (≥ 80 years) but slightly younger elderly patients may benefit.

Cardiovascular and other comorbidities are more common also in elderly patients with sleep apnoea and may play a role in leading to its diagnosis [33]. A recent report from a large European OSA cohort (ESADA cohort) has provided data on the clinical characteristics and the role of CPAP treatment in the elderly. The elderly patients were less obese, less sleepy, had more insomnia symptoms and less severe OSA, but were rated to be more ill compared to the middle-aged patients. Elderly patients adhered to CPAP therapy as well as middle-aged patients, but low global functioning predicted poorer CPAP adherence. [34] The authors conclude that when assessing the feasibility of CPAP therapy for an elderly patient, the clinician's overall assessment of functional ability and general health is crucial, and elderly people with OSA and good overall wellbeing may be considered for CPAP therapy [34].

Data is scarce on the effects of CPAP treatment on blood pressure, cardiovascular events, or mortality in the elderly sleep apnoea patients. Most authors agree that untreated OSA is a risk factor for stroke or worse stroke prognosis. However, the association between OSA and coronary heart disease is usually less pronounced than between OSA and stroke, especially in the elderly [35]. Among over 70-year-old patients with moderate sleep apnoea, CPAP treatment did not improve blood pressure [31]. Moreover, blood pressure improvement by CPAP was not found either on over 80-year-old patients with moderate to severe sleep apnoea [32]. In a prospective cohort study of 130 elderly patients (mean age: 77.8 ± 6.2 years) with moderate to severe obstructive sleep apnoea, CPAP treatment was found to reduce mortality and the incidence of cardiovascular events [36]. In addition, it has also been reported that CPAP treatment enhances the survival of over 80-year-old sleep apnoea patients [37]. Thus, in elderly sleep apnoea patients, there is some data supporting the use of CPAP treatment in reducing mortality and cardiovascular complications.

A great concern in the future is the increasing BMI as well as the decreasing fitness and performance in the elderly. Weight loss should be recommended as adjunctive therapy in addition to any nocturnal therapy. Weight loss interventions are associated with improvements in OSA severity, cardiometabolic comorbidities and the quality of life [38]. Exercise reduces AHI regardless of significant reduction in BMI [39]. Treating only sleep apnoea by CPAP does not affect this greatly increasing public health problem. As obesity is currently increasing especially among middle-aged and younger people [17,18] in Finland, it is likely that obesity will become an even bigger problem among the elderly in the future leading to even more increased sleep apnoea burden. Thus, the most important question is how to address obesity and lack of physical activity, reduce the use of medication that affects the central nervous system and not to steer too easily towards sleep apnoea diagnostics and treatment in the elderly. However, as significant weight loss especially in the very elderly may result in a decrease of muscle mass and thus worsen the overall functional capacity, weight loss interventions should be directed mainly to the younger adult population.

In the future, more studies are needed to elucidate the correct diagnostic AHI-limits and the benefits of CPAP treatment in elderly sleep apnoea patients. Some positive effects of CPAP treatment have been reported on the symptoms and quality of life as well as on the prognosis of elderly sleep apnoea patients. However, as the number of elderly sleep apnoea patients and the costs of sleep apnoea are steeply increasing, it is extremely relevant to know if we are diagnosing and treating the right target group that will benefit from these investments. Our health care system has only limited resources and we are obligated to target our resources in producing maximal health benefits also in this rapidly growing group of sleep apnoea patients.

Our cohorts were comprehensive including most Finnish subjects. Weaknesses in our data are the same as generally associated with register data. It is likely that treatment methods and compiling statistics in the registers may have changed during our follow-up and may affect results. We also acknowledge that our data may include some patients who were counted more than once due to follow-up visits occurring in different years. Unfortunately, we do not have access to anonymized individual-level data, which makes it impossible to exclude the same patients with primary OSA diagnosis during different years in these figures. This constitutes a limitation of our study. However, we believe that the number of patients who continue follow-up visits for sleep apnea over several years is very small and unlikely to significantly affect our results. Finally, there may be some differences between areas in treating sleep apnoea and in the criteria for initiating CPAP treatment. Still, most Finnish hospitals and doctors likely followed the Finnish national guideline for sleep apnoea [19].

Conclusion

As a conclusion, we found that the prevalence of sleep apnoea and CPAP treatment is increasing in the elderly. However, there is a risk for over diagnostics and over treatment while the aim of CPAP treatment should be in decreasing symptoms and increasing the quality of life, not in decreasing AHI. Additionally, special attention should be given to the prevention of obesity also among the elderly.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Hannele Hasala reports a relationship with Resmed Finland Oy that includes: speaking and lecture fees. Hannele Hasala reports a relationship with Boehringer-Ingelheim that includes: speaking and lecture fees. Sanna Toppila-Salmi reports a relationship with ALK-Abelló that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with AstraZeneca that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with Clario that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with ERT that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with GlaxoSmithKline that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with Novartis that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with Sanofi Pharma that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with OrionPharma that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with Roche Products that includes: consulting or advisory. Sanna Toppila-Salmi reports a relationship with GlaxoSmithKline that includes: funding grants. Sanna Toppila-Salmi reports a relationship with Sanofi that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank Helena Schmidt for finalizing the figures.

References

[1] Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. Lancet 2014;383:736–47. doi: 10.1016/S0140-6736(13)60734-5.

[2] Namen AM, Chatterjee A, Huang KE, Feldman SR, Haponik EF. Recognition of sleep apnea in increasing. Analysis of trends in two large, representative databases of outpatient practice. Ann Am Torac Soc 2016;13:2027–34. doi: 10.1513/AnnalsATS.201603-152OC.

[3] Mattila T, Hasala H, Kreivi HR, Avellan-Hietanen H, Bachour A, Herse F, 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. doi: 10.1016/j.lanepe.2022.100338.

[4] Namen AM, Forest DJ, Huang KE, Feldman SR, Hazzard WE, Peters SP, et al. Physicians report sleep apnea infrequently in older and older vulnerable adults. J Am Geriatr Soc 2017;65:2023–8. doi: 10.1111/jgs.14929.

[5] Sforza E, Gauthier M, Crawford-Achour E, Pichot V, Maudoux D, Barthélémy JC, et al. A 3-year longitudinal study of sleep disordered breathing in the elderly. Eur Respir J 2012;40:665–72. doi: 10.1183/09031936.00133011.

[6] McMillan A, Bratton DJ, Faria R, Laskawiec-Szkonter M, Griffin S, Davies RJ, et al. Continuous positive airway pressure in older people with obstructive sleep apnoea syndrome (PREDICT): a 12-month, multicentre, randomised trial. Lancet Respir Med 2014;2:804–12. doi: 10.1016/S2213-2600(14)70172-9.

[7] Mieno Y, Hayashi M, Sakakibara H, Takahashi H, Fujita S, Isogai S, et al. Gender differences in the clinical features of sleep apnea syndrome. Intern Med 2018;1:2157–63. doi: 10.2169/internalmedicine.7570-16.

[8] Fietze I, Laharnar N, Obst A, Ewert R, Felix SB, Garcia C, et al. Prevalence and association analysis of obstructive sleep apnea with gender and age differences - results of SHIP-trend. J Sleep Res 2019;28:e12770. doi: 10.1111/jsr.12770.

[9] American Academy of Sleep Medicine. International Classification Of Sleep Disorders. 3. edition Darien IL: American Academy of Sleep Medicine; 2014. p. 53.

[10] Posadas T, Oscullo G, Zaldívar E, Garcia-Ortega A, Gómez-Olivas JD, Monteagudo M, et al. Treatment with CPAP in elderly patients with obstructive sleep apnoea. J Clin Med 2020;9:546. doi: 10.3390/jcm9020546.

[11] Boulos MI, Jairam T, Kendzerska T, Im J, Mekhael A, Murray BJ. Normal polysomnography parameters in healthy adults: a systematic review and meta-analysis. Lancet Respir Med 2019;7:533–43. doi: 10.1016/S2213-2600(19)30057-8.

[12] Woehrle H, Graml A, Weinreich G. Age- and gender-dependent adherence with continuous positive airway pressure therapy. Sleep Med 2011;12:1034–6. doi: 10.1016/j.sleep.2011.05.008.

[13] McMillan A, Morrell MJ. Sleep disordered breathing at the extremes of age: the elderly. Breathe 2016;12:50–60. doi: 10.1183/20734735.003216.

[14] Senaratna CV, Perret JL, Lodge CJ, Lowe AJ, Campbell BE, Matheson MC, et al. Prevalence of obstructive sleep apnea in the general population: a systematic review. Sleep Med Rev 2017;34:70–81. doi: 10.1016/j.smrv.2016.07.002.

[15] Yaffe K, Laffan AM, Harrison SL, Redline S, Spira AP, Ensrud KE, et al. Sleep-disordered breathing, hypoxia, and risk of mild cognitive impairment and dementia in older women. JAMA 2011;306:613–9. doi: 10.1001/jama.2011.1115.

[16] Care Register for Health Care (HILMO). National Institute for Health and Welfare, Helsinki, Finland. https://thl.fi/fi/tilastot-ja-data/ohjeet-tietojen-toimittamiseen/hoitoilmoitusjarjestelma-hilmo. Date last accessed June 28th, 2023.

[17] Aromaa A, Koskinen S. Health And Functional Capacity In Finland: Baseline Results Of The Health 2000 Health Examination Survey [Internet]. Helsinki, Finland: National Public Health Institute; 2014. Available from: www.julkari.fi/handle/10024/78534 Date last accessed October 16th, 2023.

[18] Koponen P, Borodulin K, Lundqvist A, Sääksjärvi K, Koskinen S. Health, Functional Capacity And Welfare In Finland – Finhealth 2017 Study. Helsinki: THL; 2018. (Report 4/2018. National Institute for health and welfare. (In Finnish, part of report in English) Available from: www.julkari.fi/handle/10024/136223 Date last accessed October 16th, 2023.

[19] Sleep Apnoea (obstructive sleep apnoea in adults). Current care guidelines. working group set up by the finnish medical society duodecim, the finnish respiratory society and the finnish sleep research society. Helsinki: the finnish medical society duodecim (referred September 17th, 2024). Available from: www.kaypahoito.fi; 2022.

[20] Statistics Finland, statistics Available from: https://www.stat.fi/; 2023 Date last accessed June 28th.

[21] Duce B, Milosavljevic J, Hukins C. The 2012 AASM respiratory event criteria increase the incidence of hypopneas in an adult sleep center population. J Clin Sleep Med 2015;11:1425–31. doi: 10.5664/jcsm.5280.

[22] Young T, Finn L, Peppard PE, Szklo-Coxe M, Austin D, Nieto FJ, et al. Sleep disordered breathing and mortality: eighteen-year follow-up of the Wisconsin Sleep cohort. Sleep 2008;31:1071–8.

[23] Martin MS, Sforza E, Roche F, Barthélémy JC. Thomas-Anterion C; PROOF study group. Sleep breathing disorders and cognitive function in the elderly: an 8-year follow-up study. The proof-synapse cohort. Sleep 2015;38:179–87. doi: 10.5665/sleep.4392.

[24] Blackwell T, Yaffe K, Harrison SL, Redline S, Spira AP, Ensrud KE, et al. Associations between sleep-disordered breathing, nocturnal hypoxemia, and subsequent cognitive decline in older community-dwelling men: the osteoporotic fractures in men sleep study. J Am Ger Society 2015;63:453–61. doi: 10.1111/jgs.13321.

[25] Punjabi NM, Caffo BS, Goodwin JL, Gottlieb DJ, Newman AB, O'Connor GT, et al. Sleep-disordered breathing and mortality: a prospective cohort study. PLoS Med. 2009;6:e1000132. doi: 10.1371/journal.pmed.1000132.

[26] Gottlieb DJ, Yenokyan G, Newman AB, O'Connor GT, Punjabi NM, Quan SF, et al. Prospective study of obstructive sleep apnea and incident coronary heart disease and heart failure: the sleep heart health study. Circulation 2010;122:352–60. doi: 10.1161/CIRCULATIONAHA.109.901801.

[27] Redline S, Yenokyan G, Gottlieb DJ, Shahar E, O'Connor GT, Resnick HE, et al. Obstructive sleep apnea-hypopnea and incident stroke: the sleep heart health study. Am J Respir Crit Care Med 2010;182:269–77. doi: 10.1164/rccm.200911-1746OC.

[28] Kribbs NB, Pack AI, Kline LR, Smith PL, Schwartz AR, Schubert NM, et al. Objective measurement of patterns of nasal CPAP use by patients with obstructive sleep apnea. Am Rev Respir Dis 1993;147:887–95. doi: 10.1164/ajrccm/147.4.887.

[29] Martínez-García MÁ, Chiner E, Hernández L, Cortes JP, Catalán P, Ponce S, et al. Obstructive sleep apnoea in the elderly: role of continuous positive airway pressure treatment. Eur Respir J 2015;46:142–51. doi: 10.1183/09031936.00064214.

[30] Dalmases M, Solé-Padullés C, Torres M, Embid C, Nuñez MD, MÁ Martínez-Garcia, et al. Effect of CPAP on cognition, brain function, and structure among elderly patients with OSA: a randomized pilot study. Chest 2015;148:1214–23. doi: 10.1378/chest.15-0171.

[31] Ponce S, Pastor E, Orosa B, Oscullo G, Catalán P, Martinez A, et al. The role of CPAP treatment in elderly patients with moderate obstructive sleep apnoea: a multicentre randomised controlled trial. Eur Respir J 2019;54:1900518. doi: 10.1183/13993003.00518-2019.

[32] Martínez-García MÁ, Oscullo G, Ponce S, Pastor E, Orosa B, Catalán P, 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. doi: 10.1016/j.sleep.2021.11.009.

[33] Young T, Skatrud J, Peppard PE. Risk factors for obstructive sleep apnea in adults. JAMA 2004;291:2013–6. doi: 10.1001/jama.291.16.2013.

[34] Lammintausta A, Anttalainen U, Basoglu ÖK, Bonsignore MR, Gouveris H, Grote L, et al. Clinical characteristics and PAP adherence among elderly European sleep apnoea patients from the ESADA cohort. ERJ Open Res 2023:00506–2022. doi: 10.1183/23120541.00506-2022.

[35] Catalan Serra P, Soler X. Obstructive sleep apnea and cardiovascular events in elderly patients. Expert Rev Respir Med 2022;16(2):197–210. doi: 10.1080/17476348.2022.2030225.

[36] Ou Q, Chen YC, Zhuo SQ, Tian XT, He CH, Lu XL, et al. Continuous positive airway pressure treatment reduces mortality in elderly patients with moderate to severe obstructive sleep apnea: a cohort study. PLoS One 2015;10:e0127775. doi: 10.1371/journal.pone.0127775.

[37] López-Padilla D, Alonso-Moralejo R, MÁ Martínez-García, De la Torre Carazo S, Díaz de Atauri MJ. Continuous positive airway pressure and survival of very elderly persons with moderate to severe obstructive sleep apnea. Sleep Med 2016;19:23–9. doi: 10.1016/j.sleep.2015.10.015.

[38] Meurling IJ, O'Shea D, Garvey JF. Obesity and sleep: a growing concern. Curr Opin Pulm Med 2019;25:602–8. doi: 10.1097/MCP.0000000000000627.

[39] Aiello KD, Caughey WG, Nelluri B, Sharma A, Mookadam F, Mookadam M. Effect of exercise training on sleep apnea: a systematic review and meta-analysis. Respir Med 2016;116:85–92. doi: 10.1016/j.rmed.2016.05.015.