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CLINICAL REVIEW

Prevalence of obstructive sleep apnea in the general population: A systematic review

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SUMMARY

With this systematic review we aimed to determine the prevalence of obstructive sleep apnea (OSA) in adults in the general population and how it varied between population sub-groups. Twenty-four studies out of 3807 found by systematically searching PubMed and Embase databases were included in this review. Substantial methodological heterogeneity in population prevalence studies has caused a wide variation in the reported prevalence, which, in general, is high. At ≥5 events/h apnea-hypopnea index (AHI), the overall population prevalence ranged from 9% to 38% and was higher in men. It increased with increasing age and, in some elderly groups, was as high as 90% in men and 78% in women. At ≥15 events/h AHI, the prevalence in the general adult population ranged from 6% to 17%, being as high as 49% in the advanced ages. OSA prevalence was also greater in obese men and women. This systematic review of the overall body of evidence confirms that advancing age, male sex, and higher body-mass index increase OSA prevalence. The need to a) consider OSA as having a continuum in the general population and b) generate consensus on methodology and diagnostic threshold to define OSA so that the prevalence of OSA can be validly compared across regions and countries, and within age-/sex-specific subgroups, is highlighted.

Introduction

Obstructive sleep apnea (OSA) is a condition characterized by repeated episodes of partial or complete obstruction of the respiratory passages during the sleep [1–3]. The body's response to obstructed breathing leads to arousal of the brain, sympathetic activation, and oxygen desaturation in the blood (12). Repeated episodes of upper airway obstruction during sleep may result in sleep fragmentation and non-restorative sleep. Those who have OSA may complain of tiredness, excessive day-time sleepiness, insomnia, or morning headaches, but many are asymptomatic [4–6]. The main metric for diagnosing OSA is the apnea hypopnea index (AHI). This reflects the average number of significant breathing disturbances per hour of sleep and is measured during some form of polysomnography (sleep study). While either laboratory-based, attended polysomnography (i.e., type 1 sleep study) or home based full polysomnography (type 2 sleep study) remains the 'gold-standard' of diagnosis, it has been suggested that other simpler diagnostic methods using measures such as nasal airflow, respiratory effort and/or events of oxygen desaturation in blood during sleep (type 3 or 4 sleep studies) also render reasonably accurate diagnostic results [7]. Screening questionnaires are sometimes used to detect those who are at high risk of OSA, who

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Abbreviations

AASM	American academy of sleep medicine
AHI	apnea-hypopnea index
AI	apnea index
BMI	body-mass index
CI	confidence interval
MeSH	medical subject headings
ODI	oxygen desaturation index
OSA	obstructive sleep apnea
OSAS	obstructive sleep apnea syndrome
RDI	respiratory disturbance index
SDB	sleep disordered breathing
SHHS	sleep heart health study
WSCS	Wisconsin sleep cohort study

subsequently may undergo sleep studies [8,9]. OSA is emerging as a major health problem, particularly in high income countries. Its high disease burden is related to both the health care costs attributable to OSA alone and to its contribution as an independent risk factor for cardiovascular, metabolic, and psychiatric disorders such as hypertension, stroke, diabetes, and depression [3,7] which are global health priorities [10,11].

Many studies have demonstrated that OSA is a highly prevalent disorder, both in the general population and in specific disease-related and population sub-groups [6,12–16]. The reported prevalence of OSA has increased over time, in part due to increasing rates of obesity. Obesity is recognized as a major risk factor for OSA [17,18] and there has been an enormous increase in rates of obesity throughout the world over the past 25 y [19–23]. However, some of this increase in prevalence of OSA can be attributed to changes in measurement techniques and definitions for classifying respiratory events (predominantly hypopneas, the partial obstructions to breathing), which have changed over this same period [24,25]. Current measurement techniques and respiratory scoring rules are more sensitive at detecting respiratory disturbances than older measures and rules [12,26], leading to higher AHI [4,27,28]. Within this changing context, there are no published data available to date that are derived from systematically synthesizing evidence related to the population prevalence of OSA. Accurate determination of population prevalence is essential to estimate the true burden of OSA, which is vital when considering population-based health policies and intervention strategies.

The aim of this systematic review was to determine the prevalence of OSA in adults in the general population. Further aims were to determine how prevalence estimates: a) varied according to measurement criteria used for OSA b) were changing over time with rising obesity and; varied between populations and age- and sex- specific sub-groups.

Methodology

All authors discussed and agreed upon the protocol for the systematic review prior to commencement.

Search strategy

Our search strategy is given in Table S1. Using this pre-defined search strategy, we searched PubMed and Embase (on Ovid) from their inceptions to the 3rd March 2016. We searched the selected terms in the fields of Title/Abstract and medical sub-heading (MeSH) terms in PubMed and Title/Abstract and Subject headings in Embase.

Screening of articles

We combined the articles found from both databases and removed the duplicates. One of us (CS) screened the titles and abstracts of the remaining articles to select those that were eligible for the full-paper review and subsequently assessed the selected full papers to determine their inclusion or exclusion. Another (BC) assessed the selected full papers for inclusion or exclusion independently. When there were doubts at either stage of screening, these were referred to another author (SD) for resolution.

Eligibility criteria

We included the cross-sectional studies and the cross-sectional components of longitudinal studies that objectively measured OSA in adults using laboratory instruments. The studies that reported OSA or sleep disordered breathing (SDB) in terms of the number of apneas and/or hypopneas, respiratory disturbance index, thermistor measurements or oxygen desaturation were included, even when the study population had been pre-selected using screening tools prior to administration of sleep studies. Only human studies and studies that were in English were eligible.

Studies based solely on questionnaires were excluded. We also excluded studies that were not based on the general population or the age- or sex-specific subgroups thereof, such as the studies on occupational sub-groups and clinical subgroups (see Table S2). Both these groups are not representative of the general population due to their morbidity profiles and other phenomena such as healthy worker effect [29], and comparing them with studies based on general population is challenging.

Quality assessment of the selected papers

To assess the papers we selected, we used a quality assessment tool [30] specifically designed to assess prevalence studies [31] and which has been widely used to assess the methodological quality of included articles in other systematic reviews on prevalence studies [32–39]. We rated the selected studies using this tool's eight components, namely, randomness of the sample, suitability of sampling frame, adequacy of sample size, use of standard measurement, use of unbiased assessors, adequacy of response rate and description of non-respondents, reporting of confidence intervals and prevalence for subgroups, and description of study subjects. Each component was given one point if the criterion was fulfilled and zero if not. When the relevant criterion was partially fulfilled, half-a-point was given. Thus the maximum score for any component was one (maximum score of eight points for a paper) [30]. Two of us (CS and BC) independently assessed and rated the articles, and referred to another (SD) when there were disputes.

Data extraction

CS and BC independently extracted and tabulated the data. Any unresolved differences were referred to SD for resolution. The extracted data included name/s of author/s, year of publication, study setting and country, sample size, sampling method/s, source population, methods used to measure OSA (including type of instrument), type of scorer/s, response rate and non-respondents, definition of OSA, and reported prevalence (including in subgroups).

When the required information had not been directly reported in the article but could be derived using the reported data (e.g.,