



Universitat de Lleida

Addressing patient education gaps in obstructive sleep apnoea

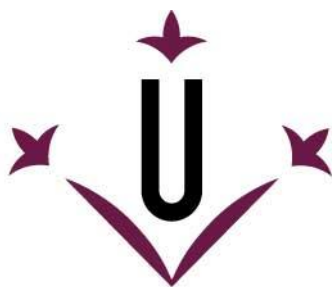
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Universitat de Lleida

TESI DOCTORAL

**Addressing patient education gaps in
obstructive sleep apnoea**

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Memòria presentada per optar al grau de Doctor per la Universitat de Lleida
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LIST OF ABBREVIATIONS



24-h ABPM	24-hour ambulatory blood pressure monitoring
AASM	American Academy of Sleep Medicine
AHI	Apnoea-Hypopnoea Index
BIPAP	Bilevel Positive Airway Pressure
BMI	Body Mass Index
BP	Blood Pressure
BQ	Berlin Questionnaire
CPAP	Continuous Positive Airway Pressure
CSA	Central Sleep Apnoea
CVD	Cardiovascular Disease
DISE	Drug-Induced Sleep Endoscopy
ECG	Electrocardiogram
ED	Erectile Dysfunction
EDS	Excessive Daytime Sleepiness
EEG	Electroencephalography
EQ-5D	Five-Dimensions Questionnaire
ERS	European Respiratory Society
ESS	Epworth Sleepiness Scale
FOSQ	Functional Outcomes of Sleep Questionnaire
HRP	Home Respiratory Polygraphy
HSAT	Home Sleep Apnoea Test
ICSD-3	International Classification of Sleep Disorders third version
MAD	Mandibular Advancement Device
MCI	Mild Cognitive Impairment

MMA	Maxillomandibular Advancement
MDD	Major Depressive Disorder
OCST	Out-of-Center Sleep Testing
OA	Oral Appliance
OR	Odds Ratio
OSA	Obstructive Sleep Apnoea
PAP	Positive Airway Pressure
PSG	Polysomnography
PSQI	Pittsburgh Sleep Quality Index
PTSD	Post-Traumatic Stress Disorder
RDI	Respiratory Disturbance Index
REM	Rapid Eye Movement
SAVE	Sleep Apnea Cardiovascular Endpoints
SF-36	36-item Short Form Health Survey
SDB	Sleep-Disordered Breathing
SHHS	Sleep Heart Health Study
SPO2	Oxygen Saturation
STOP-BANG	Snoring, Tiredness, Observed apnea, high blood Pressure- BMI, Age, Neck circumference, Gender
T2D	Type 2 Diabetes Mellitus

RESUMEN



RESUMEN

Objetivos: Esta tesis doctoral tuvo como objetivo investigar el papel de las enfermeras en el manejo de la apnea obstructiva del sueño y examinar las necesidades educativas y creencias, centrándose en los siguientes objetivos: 1) Revisar la literatura existente sobre los roles de las enfermeras en el manejo de la apnea obstructiva del sueño, con especial atención a la rentabilidad y efectividad de las intervenciones dirigidas por enfermeras. 2) Explorar las necesidades educativas, creencias y experiencias de las personas con apnea obstructiva del sueño, y 3) Proporcionar recomendaciones basadas en la evidencia para informar el desarrollo de materiales educativos e intervenciones. **Métodos:** Se empleó un enfoque de métodos mixtos, incluida una revisión de la literatura y entrevistas semiestructuradas presenciales con 11 personas con apnea obstructiva del sueño en Lleida, España. La revisión de la literatura evaluó el papel de las enfermeras, y el análisis cualitativo de las entrevistas empleó un enfoque temático. El Modelo de Creencias de Salud sirvió como marco teórico para la discusión. **Resultados:** La revisión de la literatura reveló que las enfermeras pueden contribuir al manejo de la apnea obstructiva del sueño en diversos aspectos, como el cribado, la evaluación y la educación del paciente. El estudio cualitativo identificó cuatro temas clave que arrojan luz sobre las diversas experiencias e impactos de la apnea obstructiva del sueño en la vida de las personas. **Discusión:** Los hallazgos de la revisión de la literatura y del estudio cualitativo demuestran que las intervenciones lideradas por enfermeras pueden mejorar significativamente el manejo de la apnea obstructiva del sueño y los resultados en los pacientes. Los temas identificados destacan la necesidad de materiales educativos e intervenciones centrados en el paciente que aborden las brechas de conocimiento y los desafíos que los pacientes pueden enfrentar en el manejo de la apnea obstructiva del sueño. Es necesario involucrar a nutricionistas y fisioterapeutas en el proceso y que el sistema de atención médica cubra los costos asociados con estos profesionales. Las conclusiones de este estudio enfatizan la importancia de las enfermeras, nutricionistas y fisioterapeutas en la atención de la apnea obstructiva del sueño y en la educación de los pacientes. Se proporcionan recomendaciones basadas en la

evidencia para orientar el desarrollo de materiales educativos e intervenciones destinadas a mejorar el manejo de la apnea obstructiva del sueño y los resultados en los pacientes. Esta tesis aporta valiosos conocimientos a los campos de la medicina del sueño y la enfermería, promoviendo un modelo de atención médica centrado en el paciente y eficiente. Palabras clave: Apnea obstructiva del sueño, atención de enfermería; roles de las enfermeras; educación del paciente; atención integral.

RESUM



RESUM

Objectius: Aquesta tesi doctoral va tenir com a objectiu investigar el paper de les infermeres en el maneig de l'apnea obstructiva del son i examinar les necessitats educatives i creences, centrant-se en els següents objectius: 1) Revisar la literatura existent sobre els rols de les infermeres en el maneig de l'apnea obstructiva del son, amb especial atenció a la rendibilitat i efectivitat de les intervencions dirigides per infermeres. 2) Explorar les necessitats educatives, creences i experiències de les persones amb apnea obstructiva del son, i 3) Proporcionar recomanacions basades en l'evidència per informar el desenvolupament de materials educatius i intervencions. **Mètodes:** Es va emprar un enfocament de mètodes mixtes, incloent una revisió de la literatura i entrevistes semiestructurades presencials amb 11 persones amb apnea obstructiva del son a Lleida, Espanya. La revisió de la literatura va avaluar el paper de les infermeres, i l'anàlisi qualitativa de les entrevistes va emprar un enfocament temàtic. El Model de Creences de Salut va servir com a marc teòric per a la discussió. **Resultats:** La revisió de la literatura va revelar que les infermeres poden contribuir al maneig de l'apnea obstructiva del son en diversos aspectes, com el cribratge, l'avaluació i l'educació del pacient. L'estudi qualitatiu va identificar quatre temes clau que llancen llum sobre les diverses experiències i impactes de l'apnea obstructiva del son en la vida de les persones. **Discussió:** Les troballes de la revisió de la literatura i de l'estudi qualitatiu demostren que les intervencions liderades per infermeres poden millorar significativament el maneig de l'apnea obstructiva del son i els resultats en els pacients. Els temes identificats destaquen la necessitat de materials educatius i intervencions centrats en el pacient que abordin les mancances de coneixement i els reptes que els pacients poden enfrontar en el maneig de l'apnea obstructiva del son. És necessari implicar a nutricionistes i fisioterapeutes en el procés i que el sistema d'atenció mèdica cobreixi els costos associats amb aquests professionals. Les conclusions d'aquest estudi enfatitzen la importància de les infermeres, nutricionistes i fisioterapeutes en l'atenció de l'apnea obstructiva del son i en l'educació dels pacients. Es proporcionen recomanacions basades en l'evidència per orientar el desenvolupament de materials

educatius i intervencions destinades a millorar el maneig de l'apnea obstructiva del son i els resultats en els pacients. Aquesta tesi aporta coneixements valiosos als camps de la medicina del son i la infermeria, promovent un model d'atenció mèdica centrat en el pacient i eficient.

Paraules clau: Apnea obstructiva del son, atenció d'infermeria; rols de les infermeres; educació del pacient; atenció integral.

ABSTRACT

Objectives: This PhD thesis aimed to investigate the role of nurses in managing obstructive sleep apnoea and to examine educational needs and beliefs, focusing on the following objectives: 1) To review the existing literature on nurses' roles in obstructive sleep apnoea management, and with a focus on the cost-effectiveness and effectiveness of nurse-led interventions. 2) To explore the educational needs, beliefs, and experiences of individuals with obstructive sleep apnoea, and 3) To provide evidence-based recommendations to inform the development of educational materials and interventions.

Methods: A mixed-methods approach was employed, including a literature review and face-to-face semi-structured interviews with 11 individuals with obstructive sleep apnoea in Lleida, Spain. The literature review assessed the role of nurses, and the qualitative data analysis of the interviews employed a thematic approach. The Health Belief Model served as the theoretical framework for the discussion.

Results: The literature review revealed that nurses can contribute to obstructive sleep apnoea management in various aspects, such as screening, assessment, and patient education. The qualitative study identified four key themes shedding light on the diverse experiences and impacts of obstructive sleep apnoea on individuals' lives.

Discussion: Findings from the literature review and qualitative study demonstrate that nursing-led interventions can significantly improve obstructive sleep apnoea management and patient outcomes. The identified themes highlight the need for patient-centered education materials and interventions that address knowledge gaps and challenges patients may face in managing obstructive sleep apnoea. It is necessary that nutritionists and physical therapists be involved in the process, and that the healthcare system cover the costs associated with these professionals. The findings of this study emphasize the importance of nurses, nutritionists, and physical therapists in providing obstructive sleep apnoea care and providing education to patients. Evidence-based recommendations are provided to guide the development of educational materials and interventions aimed at improving obstructive sleep apnoea management and patient

outcomes. This thesis contributes valuable insights to both the fields of sleep medicine and nursing by promoting a patient-centered and efficient healthcare delivery model.

Keywords: Obstructive sleep apnoea, nursing care; nurses' roles; patient education; comprehensive care.

AN OVERVIEW OF THE THESIS

Obstructive sleep apnoea is a common sleep breathing disorder affecting a significant number of individuals worldwide. There are several health conditions associated with this chronic disease. As a result, obstructive sleep apnoea can have a profound impact on the individual quality of life, including their ability to work, to perform daily activities and to maintain social relationships. In the first chapter, an in-depth discussion of obstructive sleep apnoea is presented, including its risk factors, symptoms, comorbidities, and treatment options. This introduction provides a context for the rest of the thesis, enabling the reader to better understand the significance of the research, and demonstrating the potential impact of the research on the management of obstructive sleep apnoea.

To illustrate, it was important to emphasize the prevalence of the condition, as well as its impact on individuals, families, and the healthcare systems. There is also discussion of several risk factors that contribute to obstructive sleep apnoea, including obesity and aging. Among the topics discussed are obstructive sleep apnoea symptoms, such as snoring, daytime sleepiness, and fatigue, as well as obstructive sleep apnoea -related comorbidities, such as hypertension, and Chronic Obstructive Pulmonary Disease. The introduction chapter concludes by discussing the various treatment options for obstructive sleep apnoea, including lifestyle modifications such as weight loss and physical activity, positive airway pressure therapy, oral appliances, and surgery, as well as their advantages and disadvantages.

A literature review is devoted to the role nurses play in managing obstructive sleep apnoea both in sleep units and in primary care settings. Nursing plays a vital role in managing individuals with obstructive sleep apnoea, as they are often the first point of contact for individuals seeking treatment. Moreover, the review highlights the effectiveness of nursing-led interventions in the management of obstructive sleep apnoea, as well as the cost-effectiveness of managing obstructive sleep apnoea in primary care.

The review indicates that nurses play a variety of key roles in managing obstructive sleep apnoea, including screening, diagnosing, and managing individuals with obstructive sleep apnoea, and providing education about the importance of adhering to treatment and the potential effectiveness of using telemedicine, and their roles in monitoring any side effects related to treatment, such as irritation in the face from using the CPAP device. As well as the coordination of care between different healthcare providers.

In addition, the review highlights several studies that have demonstrated the effectiveness of nurse-led interventions in the management of obstructive sleep apnoea. Lastly, the review emphasized the cost-effectiveness of managing obstructive sleep apnoea in primary care settings.

The findings of the qualitative phase of the Moore4Medical project, which involved semi-structured interviews with individuals suffering from obstructive sleep apnoea. In total, eleven individuals with obstructive sleep apnoea participated in interviews conducted between May 2022 and December 2022 in Lleida, Spain. The analysis of the data adopted the thematic analysis done through using Atlas.ti.

The findings indicate a lack of knowledge about the basics of obstructive sleep apnoea, such as the risk factors, treatment options, as well as the need for information related to weight loss, physical activity, and sleeping habits.

The findings are discussed using the health belief model as a framework. The purpose of using the health belief model to discuss the findings of this study was to better understand how individuals with obstructive sleep apnea perceive their health and their condition and how those perceptions influence their attitudes and behaviors. Also, how this information may be used in the development of more effective educational interventions or resources to provide better support to this population. The qualitative study presented in the thesis highlights the importance of developing educational resources and interventions that address these knowledge gaps by identifying the need for more information related to these aspects of OSA. The findings of this study will be utilized to develop educational materials using the web-based platform, thereby allowing better management of the condition and improving quality of life.

INTRODUCTION



1. INTRODUCTION

The term sleep disordered breathing (SDB) refers to periodic disruptions in respiratory pattern or inadequate ventilation during sleep (1). In the literature, SDB is often used interchangeably with obstructive sleep apnoea (OSA), however, the focus of this thesis is on OSA. It is noteworthy that the term SDB is also referred to as primary or secondary central sleep apnea (CSA), Cheyne-Stokes respiration, periodic breathing at high altitude, nonobstructive hypoventilation, or hypoxemia resulting from pulmonary parenchymal, vascular, neuromuscular, or chest wall problems (1).

An OSA is a common and burdensome sleep disorder characterized by recurrent obstructions of the pharyngeal airway during sleep, which may or may not be accompanied by symptoms (2,3). Central sleep apnea, on the other hand, results from a malfunction of the respiratory control system during sleep (3). This thesis focuses specifically on OSA, rather than on sleep-related breathing disorders that are not obstructive. A distinct understanding of the unique features of each disorder is crucial in developing tailored diagnostic and therapeutic strategies for the individuals.

1.1. Prevalence of Obstructive Sleep Apnoea

OSA is a prevalent sleep disorder that affects a significant portion of the global population. However, OSA remains underdiagnosed and undertreated despite its high prevalence (4). The prevalence of OSA varies by country and region, with a global estimate of one billion adults aged 30 to 69 years suffering from the condition. Moreover, almost 425 million individuals may suffer from moderate to severe cases based on AHI cutoff value, for which treatment is recommended(4) . There are approximately 175 million people living with OSA in Europe, with approximately 90 million individuals suffering from moderate to severe OSA (5). OSA management varies across countries and depends upon individual symptoms manifestation. Healthcare systems should adopt effective diagnostic and management strategies to mitigate the adverse health effects of this condition (4). There have been significant advances in the diagnosis and management of OSA in well-resourced

environment (6). Despite this, most OSA cases remain undiagnosed and untreated(7), even in high-income countries. There is a lack of awareness surrounding OSA in low- and middle-income countries and diagnostic and treatment modalities are frequently unavailable or inadequately adapted to these settings (6).

Due to the associated comorbidities, potential public health implications, and long-term economic burden of untreated OSA, it is imperative to identify and manage these patients. Despite this, the demand for specialized sleep units and the waitlists for consultations in these facilities continue to rise. The chronic nature, prevalence, and long-term consequences of OSA make its effective management of paramount importance. It has been proposed that OSA can be managed in primary care settings through a comprehensive approach that encompasses a variety of clinical settings similar to other prevalent chronic diseases (8).

While specialized sleep units are often used for OSA management, it is important to recognize that this approach may not be feasible or necessary for many patients, and there is a significant shortage of sleep specialists to provide comprehensive care for this condition (9). There is evidence that primary care settings can offer cost savings and comparable efficacy (10).

1.2. Defining OSA: Apnoea and Hypopnoea

Studies of sleep are conducted to determine the frequency and severity of apnoeas and hypopnoeas. The term apnoea refers to a complete obstruction of the upper airway (>90%) lasting for more than 10 seconds, while hypopnoea refers to a partial obstruction of the upper airway (>30%) resulting in a decrease of at least 3% in blood oxygen saturation or sleep arousals (11,12). The number of events associated with OSA is usually five or more per hour of sleep for individuals with the condition of partial (hypopnoea) or total (apnoea) despite trying to breathe (11,12). The apnoea-hypopnoea index (AHI) is the most widely used measure to diagnose and classify the severity of OSA. The AHI is the average number of apnoea and hypopnoea events per hour of sleep. In terms of severity, an AHI of 5-15 is considered mild, 15-30 is moderate, and more than 30 indicates severe OSA (13). There are,

however, the AHI has limitations, such as not considering the degree of accompanying hypoxia or the length of respiratory events (13). See table which shows the AHI scoring according to the manual of 2012 from American Academy of Sleep Medicine (AASM)(12).

The International Classification of Sleep Disorders (ICSD-3) provides a broader definition of OSA incorporating clinical symptoms and complaints of diurnal sleepiness, or witnessed apnoeas by a partner, or cardiometabolic abnormalities and an AHI of >5 events per hour of sleep; or AHI ≥ 15 or more predominantly obstructive breathing events per hour of sleep (with no attendant symptoms or comorbidities specifically listed)(14).

An individual's sleeping position can also have an impact on the diagnosis of OSA. Due to the tendency for individuals to change their sleeping positions frequently during the night, there may be a difference in the proportion of time spent sleeping supine versus non-supine, which could have implications for the diagnosis of OSA based on the AHI (15).

Apnea (all criteria must be satisfied)	Hypopnea (all criteria must be satisfied)
In children, the respiratory event lasts for at least two missed breaths, determined by the baseline breathing pattern, or ≥ 10 seconds in adults.	The event is associated with a $\geq 30\%$ drop in airflow signal amplitude.
The event is associated with a $\geq 90\%$ drop in the airflow signal amplitude.	The respiratory event lasts for at least two missed breaths in children, determined by the baseline breathing pattern, or ≥ 10 seconds in adults.
To qualify as an obstructive apnea, the event must be associated with the presence of respiratory effort throughout the entire period of absent airflow.	There is a $\geq 3\%$ desaturation, or the event is associated with an arousal.

Table 1. The AHI scoring according to the manual of 2012 from American Academy of Sleep Medicine (AASM) (12).

1.3. A Global Perspective

OSA is a prevalent sleep disorder that affects a significant portion of the global population. However, OSA remains underdiagnosed and undertreated despite its high prevalence(4). The prevalence of OSA varies by country and region, with a global estimate of one billion adults aged 30 to 69 years suffering from the condition. Moreover, almost 425

million individuals may suffer from moderate to severe cases based on AHI cut-off value, for which treatment is recommended (4). There are approximately 175 million people living with OSA in Europe, with approximately 90 million individuals suffering from moderate to severe OSA (5).

1.4. Unpacking the Multifactorial Pathophysiology of Obstructive Sleep Apnoea

The pathogenesis of OSA is multifactorial. In addition to "anatomical" traits there are also "non-anatomical" traits. As such, OSA is likely to develop as a result of a combination of factors, whose combination may vary substantially from individual to individual (16). It has now been indicated that there are at least four critical traits that play a role in the pathogenesis of OSA (17,18). A key determinant is the presence of an anatomically narrow or collapsible upper airway anatomy (17,18). In this thesis section, similar to much of the literature, this trait is defined as 'impaired upper airway anatomy'. In spite of this, since OSA does not occur during wakefulness, it is evident that OSA is much more than an anatomical problem (17,18). Indeed, obesity and certain craniofacial properties can crowd the pharyngeal airway and contribute to the predisposition for OSA, the anatomical structures that surround the upper airway remain constant from wakefulness to sleep (17,18). It has been suggested that many individuals with OSA have an increase in fat within their tongues in comparison to equally obese individuals without OSA (19). Additionally, central adiposity may contribute to impaired upper airway anatomy and OSA (20).

Other traits, referred to as "non-anatomical factors", such as ineffective upper airway dilator muscle function during sleep, unstable respiratory control (high loop gain) and a low respiratory arousal threshold are play an important role in OSA pathogenesis for many individuals. Each of these phenotypes is a therapeutic target, and their relative contribution varies greatly between individuals (17,18).

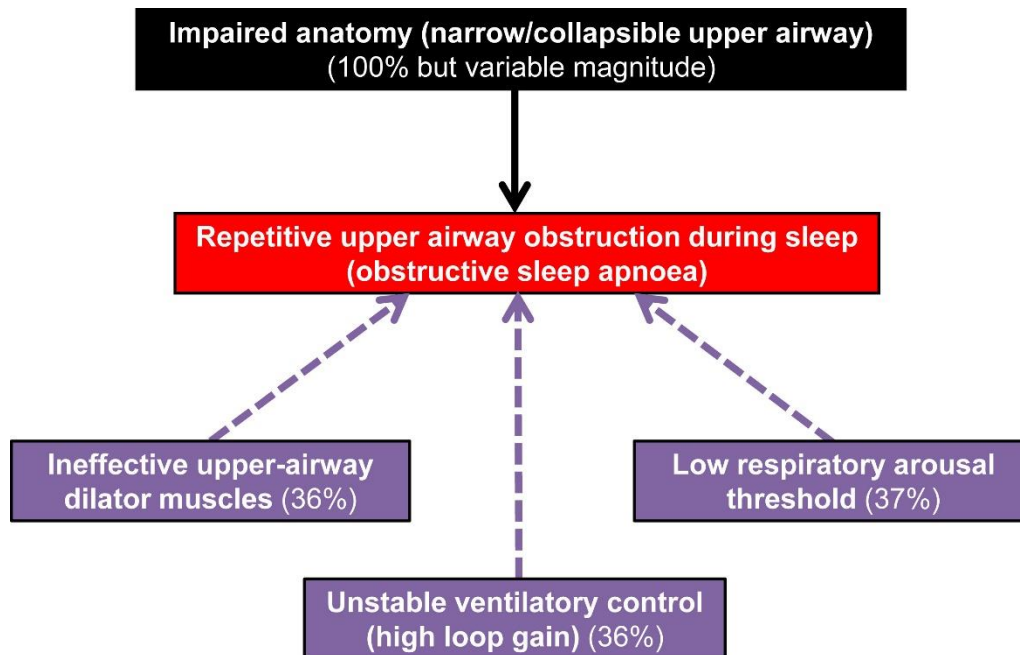


Figure 1. Schematic of the four key phenotypes that cause obstructive sleep apnoea. From (18).

It has been estimated that 70% of patients have anatomical factors in combination with one or more non-anatomical phenotypes (21). Thus, anatomical traits, and non-anatomical traits contribute to the development of OSA. There is a need for further research in order to better understand the underlying mechanisms of OSA and in order to develop more effective and individualized treatment plans.

1.5. The Multifaceted Nature of Obstructive Sleep Apnoea Symptoms and Consequences

There are a variety of symptoms, signs, and consequences associated with OSA. The most common symptoms of OSA include excessive daytime sleepiness, fatigue, lack of energy, tiredness, poor concentration, bad mood, morning headaches, snoring, and observed breathing pauses during sleep (22).

Furthermore, several sleep-related conditions can be associated with OSA and may be considered symptoms of the disorder themselves, although the causality remains unclear. Examples of such conditions include sleep-related movement disorders, insomnia, nocturia, xerostomia, and nocturnal esophageal reflux (23).

Moreover, OSA increases the risk of a motor vehicle crash by two to three times (24). It is important to note that individuals with OSA will not experience the same symptoms or consequences. In contrast to more severe OSA, mild OSA does not seem to be associated with excessive daytime sleepiness, mood disturbances, hypertension, and other cardiovascular consequences (25,26). Moreover, OSA without complaints of sleepiness may have different adverse consequences and treatments as compared to OSA with complaints of sleepiness (27).

1.6. Unmodifiable and modifiable Risk Factors for Obstructive Sleep Apnoea

The development of OSA is influenced both by unmodifiable and modifiable risk factors. The most important unmodifiable factors are advancing age, male gender, race and ethnicity, and family history of OSA (28–30). Among the modifiable risk factors are obesity, smoking, and alcohol consumption (29,30). A comprehensive approach addressing these factors is necessary to achieve positive health outcomes and improve the quality of life for individuals with OSA. Consequently, we will now delve into the most important risk factors associated with OSA, including both unmodifiable and modifiable factors.

Age: The prevalence of OSA tends to increase with age, although it can also be diagnosed in individuals younger than 40 years of age (31). It has been reported, however, that OSA is common in old adult individuals, whereas it is more severe in younger individuals (31,32). A number of hypotheses have been proposed and tested in an effort to explain the relationship between OSA and age. For instance, the relationship between increasing age and upper airway pathophysiology.

It is indicated that as a result of aging there is an increase in upper airway resistance, an increase in parapharyngeal fat, a decrease in pharyngeal size, and an impairment of pharyngeal muscle reflexes that are crucial to maintain upper airway patency, so this explains the relationship between OSA and aging (33–35).

Male Gender: It is important to note that the clinical presentation of OSA in females differs from that of males, as well as its association with age and physiological status, e.g., menopause and pregnancy (36). Compared to males, females appear to be more

symptomatic, with lower scores on the AHI. In addition, they may experience more prolonged partial upper airway obstruction, and may report insomnia as a symptom of OSA more frequently (36). It has been shown that males are at a higher risk for OSA due to structural and functional differences in the upper airway (37). In light of these differences in clinical presentation, females with SDB may be underdiagnosed and undertreated as compared to their male counterparts (36).

Race/ethnicity: The concept of ethnicity refers to a group of individuals who possess a common racial or cultural background, in medical research, ethnicity is usually used to investigate the distribution of diseases and to plan services for health care delivery (38). It is likely that ethnicity plays a role in OSA's complex etiology. It has been demonstrated in a recent review that studies which have explored different ethnic populations have indicated that Chinese have a higher prevalence of OSA and a greater severity than those who are of European descent (39). Furthermore, there are indications that Hispanic Americans show higher rates of OSA as compared with African Americans (39). For instance, in a cross-sectional study evaluating OSA prevalence among different ethnic groups, it was concluded that Hispanic American individuals had the greatest increase in AHI in comparison to African Americans (40). The findings of this study emphasize the importance of taking ethnicity into account when assessing OSA risk (40). However, the ethnic/racial differences in OSA prevalence and severity maybe explained partially as a result of environmental factors, such as living in disadvantaged neighborhoods (41).

Genetics/ family history of OSA: OSA is a complex condition for which genetic and environmental factors contribute to its development. It is important to note that, although some underlying causes of OSA have been linked to genetics, suggesting a hereditary component, this contribution remains poorly understood (42). The landmark Cleveland Study investigated the genetic-epidemiological aspects of OSA, and it was found that the condition was more prevalent among relatives of index probands than in control subjects (43). In a meta-analysis of genetic association studies on OSA, the effect sizes were generally modest or small, with odds ratios (OR) of 0.87 to 1.3 (44). The small sample sizes of these studies, most of which included fewer than 100 cases and fewer than 60 controls,

made them underpowered to detect small or moderate genetic effects (44). Further research is required in order to understand the genetic component of OSA and its interaction with environmental factors.

Obesity: It is important to note that the etiology of OSA is complex, and obesity is one of the most prominent risk factors. It has been reported that approximately 70% of individuals with OSA have a body mass index (BMI) of ≥ 30 kg/m² (45). Moreover, OSA is present in 40% to 90% of individuals with a BMI of ≥ 40 kg/m², who are considered morbidly obese (45). Additionally, obese individuals are more likely to experience severe OSA due to the excess adipose tissue that surrounds the upper airway and makes it more prone to collapse (46).

It has been shown that central obesity reduces lung volume and tracheal traction forces, which can result in an increase in the collapsibility of the upper airway during sleep (47). Recent research by Kumar et al. (2020) suggests that non-obese individuals are more likely to have mild OSA AHI < 15 , while hypertension is more prevalent in obese individuals. Additionally, among non-obese individuals with OSA, the AHI is significantly lower, and minimum oxygen saturation above 90% is more common, while respiratory effort-related arousal is more frequent (48). These findings underscore the strong link between obesity and OSA, with obesity playing an important role in the development and severity of the condition. In light of this, managing obesity through lifestyle modifications and other interventions may be an integral part of treating and preventing OSA.

Smoking and alcohol consumption: The consumption of alcohol and the use of tobacco have been identified as potential risk factors for OSA and other metabolic diseases (49,50). The results of a systematic review have established a significant association between smoking behavior and OSA. In particular, heavy smokers with a long history of smoking are at a greater risk of OSA. Furthermore, individuals with severe OSA exhibited a significant association with smoking, as compared to those with mild or moderate OSA (51). The prevalence of smoking is higher among individuals with OSA as compared to those without OSA (52).

A study conducted in Warsaw, Poland investigated the impact of smoking on the severity of OSA among 3613 individuals who had been diagnosed with OSA by polysomnography between 2007 and 2017 (53). The study found that active smokers were more likely to develop OSA at a younger age and that OSA might be more severe in current smokers (53).

The consumption of alcohol may increase the risk of OSA since it decreases the genioglossal muscle tone, which increases the risk of upper airway collapse as well as increasing airway resistance (54). Alcohol consumption contributes to dietary energy intake, and subsequently to a high BMI, which is also a risk factor for OSA (55). A systematic review has also found an association between alcohol consumption and OSA (49). Overall, the findings indicate that alcohol and smoking can contribute to OSA and should be considered in the diagnosis and treatment of the condition.

1.7. An Exploration of Comorbidities Associated with Obstructive Sleep Apnoea: Implications for Diagnosis and Treatment

OSA is associated with a number of comorbid conditions that affect a variety of organ systems. The evidence indicates that OSA increases the risk of cardiovascular diseases, such as hypertension, arrhythmias, heart failure, coronary artery disease, stroke (56,57), and metabolic disturbances such as insulin resistance and type 2 diabetes (56).

Additionally, OSA is associated with cognitive impairment, including deficits in memory, attention, as well as an increased risk of developing dementia (58–60). Additionally, OSA has been associated with an increased incidence of certain cancers, such as colorectal, and breast cancer through different complex pathophysiological pathways (61). Furthermore, OSA is associated with other comorbidities, including depression (62–65), erectile dysfunction (ED) (66,67), chronic obstructive pulmonary disease (COPD) (68), and even COVID-19 (69,70).

Identifying individuals at increased risk for adverse health outcomes and developing effective treatment strategies that mitigate these risks requires an understanding of the relationship between OSA and comorbidities.

Cardiovascular disease and obstructive sleep apnoea: OSA has been associated with a number of cardiovascular complications, including hypertension, atrial fibrillation (AF), other arrhythmias, heart failure, coronary artery disease, stroke, pulmonary hypertension, metabolic syndrome, and cardiovascular mortality (71).

There is also evidence that OSA can be associated with negative feedback in which it can enhance conditions that may exacerbate OSA (e.g., OSA accompanied by hypertension)(71). The prevalence of OSA in individuals with hypertensive is high, with an estimated 30% to 50% of individuals will have comorbid OSA (72) and particularly high in individuals with resistant hypertension, among whom up to 80% may have OSA (73). Several studies have shown an association between OSA and cardiovascular disease (74–77). In a meta-analysis by Dong et al. (74), it was found that moderate to severe OSA significantly increased cardiovascular risks, particularly stroke risks.

As part of an efforts to assess the independent contribution of OSA to cardiovascular disease, the Sleep Heart Health Study (SHHS) was initiated in 1994 as a multi-center, prospective cohort study of the cardiovascular consequences of OSA (76). In order to minimize the risk of referral bias resulting in a spurious relationship between OSA and cardiovascular disease, this study was conducted in a community-based sample. The sample included ethnically diverse women and men (76). A cross-sectional data from the SHHS baseline examination revealed that OSA was associated with a greater prevalence of self-reported cardiovascular disease after adjusting for demographic and multiple cardiovascular risk factors (75).

In an observational study comparing fatal and non-fatal cardiovascular events among simple snorers, individuals with untreated OSA, individuals treated with CPAP (will be discussed later), and healthy individuals recruited from the general population, the results indicate that in untreated individuals with severe OSA, the risk of fatal and non-fatal cardiovascular events is increased (77). It has been suggested that there is a relationship between the severity of OSA and the risk of cardiovascular disease (77).

Overall, these findings emphasize the importance of identifying and treating OSA in individuals with cardiovascular risk factors to reduce their risk of cardiovascular disease

and related complications. Nevertheless, RCTs failed to demonstrate a positive effect of CPAP treatment on secondary cardiovascular disease prevention (78–80). Endotyping patients with OSA and cardiovascular disease could improve the management of these patients identifying subgroups that would be affected by the deleterious consequences of OSA and where the potential positive effect of CPAP treatment should be explored in future studies (81).

Metabolic disturbances: The presence of OSA is closely related to obesity, insulin resistance, type 2 diabetes (T2D), non-alcoholic fatty liver disease, and other metabolic diseases (82). The presence of obesity, however, has been identified as a major risk factor for the development and progression of OSA as discussed previously (29,45–48).

It is likely that intermittent hypoxemia, sleep fragmentation and circadian misalignment are causal pathways leading to metabolic dysfunction (82,83). The prevalence of the metabolic syndrome in individuals with OSA was estimated to range between 23% and 87% (84). It has been reported that individuals with OSA are more likely than those without OSA to develop T2D, and that more than half of the individuals with T2D have OSA (85). There is a relationship between OSA and insulin resistance in individuals who are not obese as well (82). AHI has been shown to be an independent risk factor for insulin resistance and T2D (82). A study conducted between 2009 and 2013 where anthropometric variables, metabolic indicators, and sleep parameters were collected from 2,046 participants (86). As a result of the findings, it has been concluded that insulin resistance, obesity, and the lipid profile are independently and strongly correlated with metabolic syndrome in individuals with OSA (86).

Further, OSA and its severity have been reported to be positively associated with T2D incidence, independent of adiposity, BMI, and age (85). It has also been corroborated in a retrospective study conducted on 1,206 Chinese adults in Hong Kong from 2006 to 2013 to examine the relationship between OSA and incident T2D (87). The study found that OSA severity independently predicted T2D incident (87). Additionally, it is estimated that type 1 diabetes accounts for between 5% and 10% of all diabetes cases and differs in its

pathogenesis from T2D (88). There is no evidence of incidence relationship between OSA and type 1 diabetes (88).

A non-alcoholic fatty liver disease now accounts for 25 % of all liver diseases worldwide (56). The mechanisms underlying dysmetabolism are of interest. Insulin resistance and obesity appear to play an important role in the development of both hepatic steatosis and non-alcoholic steatohepatitis, the two stages of this disease progression (89). It has been demonstrated that OSA is independently associated with different pathological features associated with non-alcoholic fatty liver disease, such as visceral obesity and abnormal lipid metabolism (90), and thus OSA may contribute to the exacerbation of the non-alcoholic fatty liver disease (56).

Based on these findings, OSA screening and treatment may play a crucial role in managing and preventing metabolic disturbances, particularly in individuals with obesity or T2D.

Depression and obstructive sleep apnoea: psychological symptoms such as depression and anxiety are commonly reported in individuals with OSA. The association between OSA and depressive symptoms has been demonstrated in several studies (62–65). A number of popular scales, including the Beck Depression Inventory, and Minnesota Multiphasic Personality Inventory, have questions about sleep symptoms that are common to both OSA and psychiatric conditions, including insomnia and fatigue (91,92). The prevalence of depression symptoms in individuals with OSA has been reported to be 20% to 40% (63–65).

A systematic review has been indicated that OSA is more common among individuals with major depressive disorder (MDD) and post-traumatic stress disorder (PTSD)(62). those with severe depression being five times more likely to develop OSA than the general population (93). The effects of sleep fragmentation, biological disorders, metabolic syndrome, mental diseases of the central nervous system, as well as certain psychotic drugs may also influence OSA and depression in a multidirectional manner (62). However, there is a debate regarding whether OSA and major depression are causally

related (94). Depressive symptoms may also be a consequence of OSA rather than its cause (95).

Erectile dysfunction and obstructive sleep apnoea: there is a significant correlation between ED and OSA, with a greater prevalence of ED in individuals with severe OSA. For instance, it has been demonstrated that a prevalence of OSA with ED was 64.52%, and the prevalence of severe OSA with ED was 73.02% (96). A literature review (97) reports that 40.9% to 80% of OSA individuals suffer from ED, and ED risks in individuals without OSA are significantly lower than those individuals with OSA. Moreover, Chen's study (98) demonstrated that ED prevalence was 9.44 times greater in OSA individuals than in non-OSA individuals and that OSA was an independent risk factor for ED. It has been reported by Smith (99) that OSA and ED are closely related to individual psychological status, such as depression and anxiety.

Additionally, the prevalence of OSA With ED increases with age and BMI (96). It is possible that intermittent hypoxia causes ED due to damage to the vascular endothelium (100), and inhibition of sex hormone secretion (101), primarily suppressing central gonadal organ response, reducing testosterone and luteinizing hormone levels, and affecting libido (102). It has been shown that elevated estradiol and serum leptin in obese individuals can cause decreased testosterone secretion and ED (103). Additionally, it has been shown that testosterone, dehydroepiandrosterone sulfate, dehydroepiandrosterone and prolactin levels in the serum of individuals with OSA have decreased, reducing testosterone's bioavailability and causing erectile dysfunction (102). The present findings emphasize the importance of screening for ED among individuals with OSA, particularly those with severe OSA, in order to provide appropriate medical intervention and improve the quality of life of these individuals.

Chronic obstructive pulmonary disease and obstructive sleep apnoea: COPD is characterized by persistent, usually progressive airflow limitation (104). COPD is primarily caused by exposure to first- or second-hand tobacco smoke (105). There are several additional environmental factors that may pose a risk, such as pollution indoors and

outdoors, dust, and hazardous fumes (105). Clinical manifestations of dyspnoea, cough, and chronic expectoration are caused by changes in lung mechanics (106).

As a result of the association between COPD and OSA, the condition is referred to as an "overlap syndrome" (107). It has been estimated that 10% - 30% of individuals with COPD also complains from OSA (108). There is no conclusive evidence that either COPD or OSA predisposes individuals to a higher incidence of the other (109); however, both conditions can influence one another in terms of pathophysiology (110). Both COPD and OSA are associated with similar physiological and molecular changes, such as hypoxia and systemic inflammation, which contribute to cardiovascular diseases and other comorbidities, and pulmonary hypertension is a common occurrence among patients with overlap syndromes (108). It has been recommended that individuals with COPD should have a risk assessment for OSA, and those with risk factors such as older age, obesity, severe COPD or recurrent exacerbations resulting in hospitalization may benefit from formal screening using validated questionnaires and formal polysomnography to determine whether there is OSA-COPD overlap (111). The overlap between OSA and COPD results in more severe respiratory symptoms and a reduced quality of life, as well as an increased risk of exacerbations, hospitalizations (111).

Based on a study by Naranjo et al. involving 256 individuals hospitalized with acute exacerbations of COPD who were screened for OSA by means of a validated sleep questionnaire, the majority of the individuals underwent overnight pulse oximetry or portable sleep monitoring (112). As a result of overnight sleep study evaluation, 46.6% of individuals were identified as having OSA, 28.6% as mild, 9.7% as moderate, and 8.4% as severe. Those with OSA-COPD overlap had significantly higher BMIs and heart failure prevalence rates (112). It was found that the likelihood of a readmission within 30 days was linearly related to the severity of OSA, with an OR of 2.1 times for mild OSA, 6.7 times for moderate OSA, and 10 times for severe OSA (112). The two conditions OSA and COPD are associated with high morbidity and mortality particularly when they co-occur (113).

An analysis of cross-sectional data from the National Health and Nutrition Examination Survey (NHANES) reveals that COPD and COPD-OSA overlap syndrome

groups have a significantly higher risk of death than those without either disease (114). As compared with individuals without either condition, OSA-COPD individuals had an adjusted hazard ratio of 2.4 for all-cause mortality, and COPD patients alone had an adjusted hazard ratio of 1.5 for all-cause mortality (114).

Based on the findings of these studies, preventative strategies such as lifestyle modifications, including weight loss interventions, and smoking cessation, can aid in reducing the severity of both conditions and improving overall health outcomes. Individuals with COPD and OSA may benefit from early identification and appropriate management in order to reduce the burden of hospitalizations and improve their quality of life.

Cognitive impairment and obstructive sleep apnoea: Individuals with OSA display a range of neuropsychological deficits as well as impaired motor functions and memory, sleep fragmentation as well as intermittent nocturnal hypoxia likely to contribute to the cognitive impairment (115–117). The relationship between OSA and cognitive impairment was first recognized in the 1980s (118,119). It is often thought that mild cognitive impairment (MCI) represents a prodromal stage of Alzheimer's disease (AD) and can progress to dementia. OSA has been shown to be highly prevalent among individuals with MCI and AD, and there is growing evidence that OSA is a risk factor for preclinical AD (120).

It has been reported that OSA is associated with MCI, with a 25% prevalence of cognitive dysfunction in those with OSA (120). Nevertheless, there is still a debate about the association between OSA and cognitive impairment. As a result, a meta-analysis found that SDB is associated with cognitive deficits across several domains (121). Among the most commonly affected cognitive domains are attention, vigilance, episodic memory, working memory, and executive function, while psychomotor abilities, language, and visuospatial function are less seriously affected (121), and other meta-analysis confirmed that those with AD are five times more likely to develop OSA than those of similar age who are not cognitively impaired (122). However, other studies have not indicated a positive relationship between OSA and cognitive impairment risk (59,60,123,124).

In a retrospective cohort study assessed the risk of AD in individuals with OSA with or without treatment (125). The study included individuals who were first diagnosed with OSA between 1997 and 2012 and were followed until death or until the end of 2013 (125). It was found that OSA was independently and significantly associated with a higher incidence of Alzheimer's disease (adjusted hazard ratio, 2.12), further, AD was first detected 5.4 ± 3 years after the diagnosis of OSA (125).

A single-center study examined the influence of untreated OSA on cognitive decline and cognitive subdomains in individuals with mild-to-moderate AD (60). It was demonstrated in the study that individuals with OSA performed as well as non-OSA individuals in terms of global cognition and specific cognitive domains after 12 months of follow-up (60). The cognitive evolution of individuals with OSA did not appear to be clinically worse than that of their non-OSA counterparts after three years of follow-up (60). The reason for inconsistent results may be attributed to differences in study designs, population characteristics, and cognitive outcomes, as well as the duration of follow-up in longitudinal studies (120). Therefore, the relationship between OSA and cognitive impairment requires further research, as well as the exploration of possible interventions to mitigate the negative effects of OSA on cognitive function.

Cancer and obstructive sleep apnoea: There has been a lack of unified consensus among clinical studies concerning the association between OSA and cancer incidence in prior literature. It has been shown that OSA is associated with incidence of cancer and there is a positive correlation between cancer and OSA severity in two retrospective cohort studies (126,127).

For instance, a multicentre, clinical cohort study was conducted in seven Spanish teaching hospitals between 2003 and 2007 to investigate whether OSA was associated with increased cancer incidence. A total of 4,910 participants were included and the participants had a mean follow up time of 4.5 (interquartile range, 3.4-5.2) years (127). It was found that elevated AHI was not significantly associated with cancer incidence after adjustments for age, sex, BMI, smoking status, alcohol intake, type of sleep study, and center (Hazard Ratio 1.17; 95% CI 0.84-1.65; P=0.33). Based on the stratification into younger and older cohorts

(age \geq 65 years, n=1,203 and age < 65 years, n =3,707), severe OSA (AHI >43) was found to be independently associated with cancer (Hazard Ratio 1.66; CI 1.04-2.64; P = 0.032) in the younger cohort (127). According to the findings, increased overnight hypoxia, a surrogate of OSA severity, was associated with increased cancer incidence. Nevertheless, the association appeared to be limited to men and individuals younger than 65 years of age (127).

Further, a recent meta-analysis found that OSA has a significant association with the increasing incidence of cancers, however, a subgroup analysis of OSA severity revealed that the incidence of cancers did not linearly increase with the severity of OSA as defined by AHI (128). It has been concluded that more than half of the individuals with cancer also developed OSA (128). Additionally, individuals with OSA are 1.53 times more likely to suffer from cancer when compared to individuals without OSA (128).

Other studies did not find a significant association between OSA and cancer, they found an enhanced risk of new-onset cancer (129,130).

For example, a cohort study examined the association between OSA severity and prevalent and incident cancer, after adjusting for known cancer risk factors (130). In 10 149 individuals with possible OSA who underwent a sleep study, 520 (5.1%) had a cancer diagnosis at the time of the study. A median follow-up of 7.8 years, 627 (6.5%) of the 9629 individuals who were free of cancer at baseline had incident cancer (130). The results showed that OSA severity was not independently associated with cancer incidence when OSA was assessed by AHI the follow-up (130). Additionally, it has been suggested that certain cancer types, such as melanoma, colorectal, and breast cancer, have increased incidence among individuals with OSA, while lung cancer and colorectal cancer were with lower incidence, suggesting that some malignancies are less prominent among individuals with OSA (131).

In a meta-analysis, OSA has been associated with an increased overall risk of cancer (132). Further, another meta-analysis found that moderate-to-severe OSA was independently associated with all types of cancer, and the connection with specific types of cancers was not significant (133).

In light of these findings, OSA and cancer incidence remain controversial topics in clinical studies. In some studies, there has been a positive correlation between OSA severity and cancer incidence, while other studies have not found this correlation to be significant. According to these findings, OSA may increase the risk of developing certain types of cancer, but the association between specific types of cancer has not been consistent across studies. Consequently, it is essential to remain vigilant during the management of OSA for the possibility of cancer among those with the condition.

1.8. Overview of Screening Tools for Obstructive Sleep Apnoea

In light of the high prevalence of OSA that is undiagnosed, an effective, reliable, and easy-to-use screening tool is required. Screening tools for OSA provide the information needed to identify patients who will benefit from downstream management decisions, such as onward referral for objective sleep testing and subsequent treatment if a full diagnosis of OSA is confirmed. In order to address this need, several tools, including the Berlin Questionnaire and the STOP-BANG questionnaire, have been widely adopted (134). Health care providers can quickly and reliably identify individuals at risk of severe OSA and prioritize them for sleep testing by using these questionnaires.

1.8.1. Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS), originally designed to assess daytime sleepiness, based on data collected from healthy subjects and individuals with a variety of sleep disorders, the ESS was developed in 1991 to describe “the general level of daytime sleepiness and not feelings of sleepiness in a particular time (135). This tool includes a questionnaire that assesses the attitudes of the individual regarding falling asleep (136). The participants are asked to rate, on a four-point scale, their usual chances of falling asleep in eight different situations that reflect the various levels of "somnificity" they experience as part of their daily lives (135). Basically, somnificity can be defined as propensity of a posture, activity, or situation to promote sleep onset in most individuals (137).

The ESS is an easy-to-use instrument that is inexpensive, easy to administer, easy to complete, and easy to score (137). In the ESS, the total score is the sum of all item scores; the higher the score, the higher a person's level of daytime sleepiness (137). Individuals with an ESS score of >10 is typically categorized as having Excessive Daytime Sleepiness ED. There is a need to emphasize that the majority of individuals experiencing OSA will not have an ESS ≥ 8 (138).

In spite of its simplicity, affordability, and wide applicability, the ESS is not well correlated with OSA severity at an individual level, nor does it correlate with objective measures of excessive daytime sleepiness, and it is also susceptible to reporting bias and confounding factors such as age, gender, psychological factors, and fatigue (137). In light of this, the ESS should not be used alone as a screening tool for identifying patients at high risk of OSA. The ESS, used alongside an OSA screening questionnaire, can help identify high-risk individuals with symptomatic disease who may benefit from treatment (139).

1.8.2. Berlin Questionnaire

The Berlin Questionnaire (BQ) is a widely recognized screening tool for OSA. It comprises ten questions that evaluate snoring, daytime sleepiness, hypertension, age, sex, body weight, and height, and is primarily validated in primary care setting (140). The questionnaire is divided into three categories that assess the risk of OSA. Individuals are classified into high-risk and low-risk groups based on their responses to individual items and symptom categories setting (140).

The first category contains five items related to snoring, the second category consists of three items related to daytime sleepiness, and the third category includes one item evaluating hypertension and information about BMI. Positive responses to the first two categories indicate frequent symptoms occurring more than three to four times per week, while a positive response to the third category is indicative of a history of hypertension or a BMI > 30 Kg/m² (140). The overall score is calculated by tallying the responses to the three categories. Individuals are considered high-risk for OSA if they have

positive scores in two or more categories, whereas those with scores in only one or no category are considered low risk setting (140).

A study conducted in Norway aimed to estimate the prevalence of OSA in the general population by evaluating the BQ's usefulness in screening for OSA (141). The study found that 24% of respondents were high-risk for OSA based on the Berlin Questionnaire. The final sample had a mean age of 48 years, with 45% being female, and a mean BMI of 28 and median AHI of 6.4 (141). However, the study revealed that the accuracy of the BQ for screening AHI 5 or greater was suboptimal (sensitivity, 37%; specificity, 84%), as well as for screening AHI 15 or greater (sensitivity, 43%; specificity, 80%) (141).

Another study evaluated the BQ's accuracy in an unselected sample of 43 adults with T2D recruited from a general internal medicine clinic in the US (142). The sample had a majority of females (53%) and a mean BMI of 38.3 along with a mean AHI of 31.2. The study assessed the accuracy of the BQ for mild (AHI 5-14), moderate (AHI 15-29), and severe (AHI > 30) events per hour for OSA (142). The results showed that the BQ had suboptimal specificity for each of these categories of OSA severity (mild, 0%; moderate, 31%; severe, 26%). However, the sensitivity was higher for moderate OSA (89%) and severe OSA (93%) than for mild OSA (80%) (142).

Despite the fact that the BQ is a useful tool for screening OSA, its accuracy should be interpreted cautiously in conjunction with other diagnostic tests. A future study could investigate the possibility of modifying or supplementing the BQ with other measures in order to improve its accuracy.

1.8.3. STOP-BANG Questionnaire

The STOP-BANG questionnaire is a validated and widely used screening tool for OSA populations (143,144). There are eight dichotomous (yes/no) questions, with 1 point assigned for each affirmative response. The acronym stands for Snore, Tired, Observed apnoeas, Pressure, BMI, Age, Neck circumference, and Gender (145).

It should be noted that a score of 0-2 indicates a low risk, a score of 3-4 indicates a moderate risk, and a score of 5 or higher indicates a high risk of OSA (146). The

questionnaire is easy to use and can be completed in 1-2 minutes, with a response rate of 90-100% (144).

It has been shown that the STOP-BANG questionnaire has a sensitivity of 79.5% to detect an AHI of 30 events per hour, and a specificity of 48.6%. By adding four additional factors (BMI, age, neck circumference, and sex), the sensitivity increases to 100%, but the specificity decreases to 37% (146). A STOP-BANG questionnaire has been shown to be effective in detecting moderate to severe OSA in Korean adults, with moderate sensitivity and specificity for mild to severe OSA (147).

It has been found, however, that the STOP-BANG questionnaire has modest sensitivity and specificity in detecting severe OSA in patients with mild AD (148). In addition, it has been shown to be less effective than the BQ and ESS in detecting mild, moderate, and severe OSA, according to a meta-analysis of two factors (149). In summary, the STOP-BANG questionnaire is a valuable tool for identifying OSA quickly and efficiently, however its limitations should be considered when interpreting the results.

1.9. Diagnosis of Obstructive Sleep Apnoea

The diagnosis of OSA is based on a combination of clinical and physical manifestations of the disease, as well as objective data obtained from a sleep study (Figure 2)(71). OSA is highly prevalent, and if left untreated, it can have serious consequences for social, economic, and health wellbeing. The diagnostic tests are classified according to how many channels are monitored during the test. The gold standard test for diagnosing OSA is an in-lab sleep study or polysomnography (PSG). If PSG is not feasible, out-of-center sleep testing (OCST) or home sleep apnea testing (HSAT) are acceptable alternatives (150).

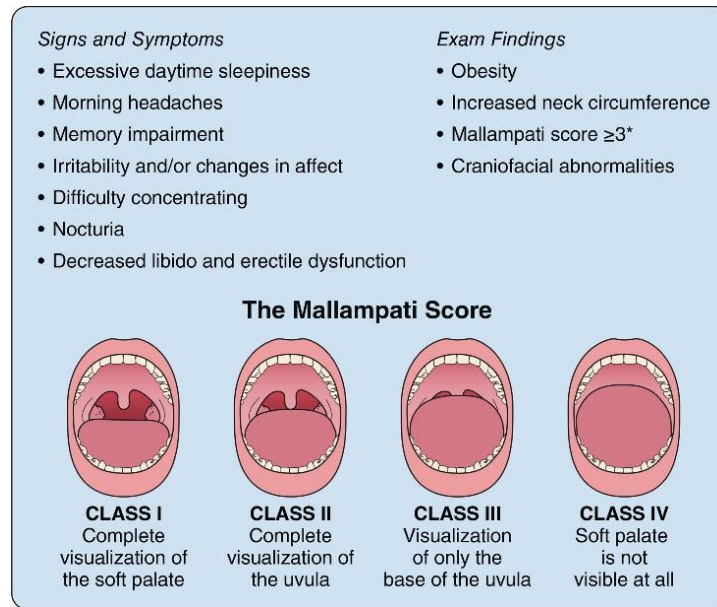


Figure 2. Obstructive sleep apnoea symptoms and diagnosis from (71).

1.9.1. Polysomnography- Gold Standard Diagnostic Test

OSA diagnosis is traditionally made using overnight (PSG) performed in a sleep unit (151). This is done in order to determine the frequency of episodes of obstructed breathing during sleep-apneas and hypopneas (151). Currently, AHI is used to define and categorize the severity of OSA. It has been reported that AHI is the most significant statistical predictor of cardiovascular mortality and all-cause mortality (152). Additionally, other parameters besides AHI are reported in PSG, such as oxygen desaturation, sleep architecture, position statistics, and periodic leg movements. Furthermore, these parameters are known to be independently related to the outcome of the disease (153–155).

It should be noted, however, that this test has some limitations. First, PSG requires the attachment of several electrodes to the body in order to determine the pattern of sleep (156) Therefore, the patient may feel uncomfortable or sleep poorly, leading to inaccurate results on the test (156). Additionally, testing in an unfamiliar environment such as a hospital may increase waking time and rapid eye movement latency (156,157). There are numerous efforts being made to address these problems, including portable PSG, to reduce or eliminate the number of sensors attached to the patient. There have also been recent advancements in non-contact methods used to assess respiratory status during sleep (156).

According to the International Classification of Sleep Disorders (ICSD), the diagnosis of OSA requires a record of 15 or more predominantly obstructive respiratory events per hour of sleep during a PSG or per hour of monitoring using a portable device (14). However, there is significant cost associated with evaluating all individuals suspected of having OSA with PSG. Further, there also may be limited access to in laboratory testing in some areas. HSAT, which has limitations, is an alternative method to diagnose OSA in adults, and may be less costly and more efficient in some populations (158).

According to AASM guidelines, PSG is recommended as a method for validating an OSA diagnosis. It is not recommended to use clinical tools, questionnaires, or prediction algorithms alone in order to establish a diagnosis of OSA.

Below is a table that summarizes AASM's recommended diagnostic criteria for obstructive sleep apnoea in adults. This criterion is derived from the International Classification of Sleep Disorders, third edition (14).

Either	
AHI > 5	Presence of at least one typical symptom: <ul style="list-style-type: none"> • Daytime sleepiness (ESS > 10), unrefreshing sleep, fatigue, or insomnia • The patient wakes up holding his breath, gasping, or choking • The bedpartner reports loud snoring, breathing interruption or both during sleep.
	AND
	Polysomnographic recording show more than 5 obstructive scoreable respiratory events per hour.
OR	
AHI > 15	Polysomnographic recording shows 15 or more scoreable respiratory events (apnea or hypopnea) per hour of sleep.

Table 2. AASM algorithms of the two pathways to an OSA diagnosis.

Alternatives to Polysomnography: To meet the increasing need to diagnose OSA, simple diagnostic tools that can be performed at home have been developed and validated (151). HSAT is also known as portable monitoring (159), or out-of-center testing (160) and offer a simple technical solution for the diagnosis of OSA, with greater accessibility, and reasonable accuracy in subjects without other sleep or medical comorbidities (161). HSAT

devices, in contrast to PSG, generally do not include electroencephalographic, electrooculographic, or electromyographic sensors, which are essential for the determination of sleep versus wake. Unlike polysomnography, which measures sleep-disordered breathing severity based on sleep time (i.e., AHI), most HSAT devices measure sleep-disordered breathing severity based on monitoring time (respiratory event index). The limitations of an HSAT may lead to an underestimation of the severity of OSA (158).

An HSAT must be based on an individual's medical history and a face-to-face examination by a healthcare provider, either in person or via telemedicine, to determine whether it is necessary to diagnose OSA or evaluate treatment efficacy (162). HSAT is recommended for patients with a high pretest probability following a comprehensive sleep evaluation (150). It is not recommended to use the HSAT for general screening of asymptomatic populations; a diagnosis, assessment of treatment efficacy, and treatment decision should not solely be based on HSAT data that has been automatically scored, since this could result in suboptimal care (162).

Individuals suffering from comorbid severe pulmonary disease, congestive heart failure, neuromuscular disorders, or other sleep disorders such as periodic limb movement disorder, sleep apnea, or parasomnia the HSAT and should not be used as a screening tool (150). Should the HSAT be negative or technically inadequate, an in-lab PSG should then be performed in a symptomatic patient who exhibits a high index of suspicion for OSA (150).

Overall, the choice of diagnostic method for OSA should be based on individual characteristics and preferences, as well as local availability and resources. Further research is needed to develop more accurate and convenient diagnostic tools for OSA.

1.10. Tailored Treatment Approach for Obstructive Sleep Apnoea

A primary objective of OSA treatment is to reduce the signs and symptoms, improve the quality of sleep, and normalize apnea-hypopnea index. In order to address OSA effectively, it should be viewed as a chronic disease that requires long-term, multidisciplinary intervention.

Treatment of OSA may result in improved clinical outcomes (e.g., less daytime sleepiness), reduced health care utilization, and a reduction in cardiovascular morbidity and mortality (163).

Today, OSA is seen as a heterogeneous disease, which is characterized by a wide range of symptoms, anthropometric characteristics, polysomnographic patterns, long-term outcomes, and comorbid conditions (164)

In order to address these aspects, tailored treatment must be developed based on patient-reported outcome data, individual risk factors, and the available therapeutic options (164,165). The optimal treatment of asymptomatic individuals with mild to moderate OSA remains challenging (166). However, the management approach should be based upon the principle that individuals with different characteristics will be treated differently. Although each treatment option differs in its mode of action, it is common to all of these alternative approaches that efficacy tends to vary between individuals (165).



Figure 3. Current considerations on the heterogeneity of obstructive sleep apnoea (OSA). From (164).

There are a number of international organizations that have published clinical practice guidelines for the management of OSA in adults, including the American Academy of Sleep Medicine, the American Thoracic Society, and the American College of Physicians (26,167–169).

Based on the guidelines, in addition to behavioral modifications discussed in the following section, positive airway pressure (PAP) should be offered as the first treatment option for individuals diagnosed with OSA (26,167–169).

The use of oral appliances as an alternative therapy is recommended for patients with mild to moderate OSA who do not wish to use PAP or do not respond to it (170). Oral appliances have proven effective in improving OSA symptoms and may be better tolerated by some patients than PAP (170).

1.11. Patient Education

In accordance with the Clinical Guideline for the Evaluation, Management, and Long-term Care of Obstructive Sleep Apnea in Adults, it is recommended that OSA educational programs include discussions of OSA's pathophysiology, risk factors, natural history, and clinical consequences. The treatment options should be discussed in the context of the severity of the patient's OSA, their risk factors, any associated conditions, as well as their expectations (171). In addition, general education should be provided regarding the effects of weight loss, sleep position, avoiding alcohol, modifying risk factors, and managing medications. It is important that the patient be counseled on the risks of drowsy driving as well as its management (171). Education should be provided to patients as part of a multidisciplinary chronic disease management team that includes the sleep physician, the referring provider, and allied health professionals. Furthermore, videotapes, handouts, websites, and brochures can be used (171).

1.12. Behavioural Change Interventions

Lifestyle interventions that address diet, exercise-training, sleep hygiene, and/or tobacco/alcohol cessation are recommended in the management of OSA (172). It appears, however, that the effectiveness of interventions differs depending on their components and OSA severity. Those interventions that address weight management and exercise training may be the most effective treatments for individuals with mild to moderate OSA (172).

1.12.1. Weight Management

Weight management can be beneficial for individuals with OSA alone or in combination with conventional Therapy (173,174).

The American College of Physicians recommends weight loss for individuals with OSA who overweight or obese as behavioural treatment options for improving the apnoea-hypopnoea index (AHI) in obese individuals with OSA but does not mention pharmacological therapy or bariatric surgery (175). As recommended by the American Academy of Sleep Medicine (165) individuals with OSA who are overweight or obese should be educated about the relationship between weight and OSA, and they should be recommended to lose weight. However, no specific strategies are offered beyond consideration of bariatric surgery for achieving weight loss (165).

It has been found that even a <5% weight loss can reduce respiratory events, but $\geq 5\%$ and ideally $\geq 10\%$ weight loss was necessary for reducing the prevalence of severe OSA. Weight loss is associated with both a decrease in AHI and an improvement in hypoxemia (176). To determine whether the initial benefit of intensive lifestyle intervention for weight loss is maintained at 10 years, a multicenter randomized controlled trial was conducted with 306 middle-aged to older adults with overweight or obesity and T2D (177). There were 264 participants with OSA at baseline who had an AHI equal or more of 5 events per hour, a mean age of 61.3 years, and a mean body mass index of 36 kg/m². Participants were randomized into one of two groups: intense lifestyle intervention intended to reduce weight by at least 10% within one year or diabetes education as part of standard care (control group)(177). At a 10-year follow-up, no statistically significant difference was found between the active intervention arm and the control intervention arm in terms of OSA severity; however, their overall conclusion clearly suggests that weight loss can reduce OSA severity in the long term, might be leading to remission in some cases (177).

The recommendation is that bariatric surgery should be considered when the BMI is greater than 35 kg/m² and there are obesity-related complications (e.g., hypertension, arthritis, sleep apnoea) or when the BMI is > 40 kg/m² without complications (178). As a result of bariatric surgery, the systemic hypertension has been found to improve following

bariatric surgery, but less than T2D. additionally, it has been found that the need for antihypertensive medications had decreased from 70% to 21% (179).

Long-term epidemiologic data indicate that bariatric surgery-induced weight loss is associated with improved mortality (180). However, the risks associated with bariatric surgery should not be underestimated, as it can lead to serious complications, it was found that 1338 subjects who had been followed for at least 10 years had the following rates of reoperations or conversion surgeries: banding, 31%; vertical-banded gastroplasty, 21%; and gastric bypass, 17% (180).

In relation to OSA, there is a significant reduction in sleep-related respiratory disturbances after bariatric surgery, as well as improvements in sleep efficiency (181). It was found in a meta-analysis study found that the overall effect size of the pooled, weighted data showed a reduction of 38.2 events per hour in the combined study results, a combined reduction of 71% in AHI. This is a substantial improvement, but it is important to note that residual disease is observed in the majority of patients (62%) following bariatric surgery, with a mean residual AHI more than 15 events per hour (182). Consequently, individuals undergoing bariatric surgery should not expect to be cured of OSA after surgical weight loss.

It has been shown that pharmacological interventions to reduce obesity can reduce upper airway collapsibility, and therefore OSA severity (183,184). As a result of this approach, a weight reduction of 10.2% was achieved compared to a weight loss of 4.3% in the placebo group (or an AHI reduction of 31.5 events per hour versus 16.6 events per hour) with phentermine/topiramate (184); a weight loss of 5.7% compared to 1.6% (or -12.2 versus -6.1 events per hour) with liraglutide compared to placebo (183).

Weight management can be difficult to achieve and even more difficult to maintain substantial weight loss. As such, given the range of health benefits associated with weight loss in addition to reducing OSA, weight loss should be incorporated into a treatment plan for overweight and obese individuals (185).

1.12.2. Physical Activity

The benefits of physical activity and exercise have long been recognized as key health determinants (186) in particular, they contribute to the prevention of chronic diseases (187). Exercise has been associated with improvements in cardiorespiratory fitness, daytime sleepiness, and sleep efficiency, as well as a reduction in OSA severity (188). Furthermore, walking and vigorous-intensity physical activity were associated with a decreased risk of OSA independent of other factors (186). As an example, it has been demonstrated that increased levels of physical activity are associated with lower cardiovascular diseases morbidity and mortality (189). There may be a difference in the effectiveness of exercise on reducing cardiovascular risk depending upon both the severity of OSA and the intensity of the exercise program (190).

In a randomised controlled trial, the aim was to assess the effectiveness of a 9-month exercise program undertaken outside of hospital as a treatment for moderate OSA, defined by reaching an AHI <15 events per hour at follow-up (191). According to the results, the exercise group demonstrated a significant reduction in AHI (-18% versus +6%; $p=0.007$)(191). Further, the intervention effect was significantly greater in obese individuals compared to individuals with a BMI <30 kg·m⁻² after adjustment for initial AHI ($p=0.037$)(191).

It has been shown that weight loss interventions reduce BMI the most (-4 kg·m/2), whereas exercise-only interventions (aerobic training, interval training, and muscle training) reduce BMI the least (-0.5 kg·m/2) (192). The combined weight loss and physical activity interventions would have a significant impact on reducing BMI, as shown by meta-analyses that found a significant reduction in BMI in both diet-only and combined diet and exercise analyses, but not in exercise-only analyses (192).

There may also be a small protective effect of physical activity on OSA development. The results of a study by Mônico-Neto indicate that people classified as "active" have a lower risk of developing OSA than those classified as "low active"; the relative risk is 0.877 (95% CI 0.780 to 0.986)(193). The results of a study utilizing data from the Ontario Health Study (n=155,448) provide evidence that physical activity may have a protective effect on

the prevalence of OSA (186). It was found that higher levels of physical activity, vigorous physical activity, and walking were all associated with a reduced prevalence of OSA (186). It has been indicated that the physical activity may have a role in OSA prevention as well (193). The precise mechanism by which physical activity prevents OSA is not well understood, but there are some indications that it may be able to do so. A hypothesis suggests that increased activation of the calf muscle pump may result in less fluid shifting from the legs to the neck during sleep, thereby reducing the possibility of upper airway collapse (190).

On the other hand, there are several barriers to exercise participation of individuals with OSA, including lack of time and motivation, which are two of the most commonly reported issues (194). Additionally, the primary symptoms of OSA (e.g., excessive daytime sleepiness and fatigue during the day) raise additional concerns. These OSA-related symptoms may make it difficult for the individuals to maintain a regular exercise program (194).

1.13. Positive Airway Pressure Therapy

The use of positive airway pressure (PAP) is widely used to treat OSA symptoms, it seems to be the most effective for improving symptoms of sleepiness and quality of life in individuals who have more symptoms but may offer little or no benefit to individuals with fewer symptoms (195,196). In individuals with OSA, it has been challenging to demonstrate improved cardiovascular outcomes with PAP use (195,196). As outlined in the American Heart Association/American Stroke Association guidelines (197), PAP is recommended for patients who have acute ischemic stroke or transient ischemic attack.

The lack of adherence to PAP remains a challenge, the individuals' adherence to PAP is determined by many factors, including their recognition of the disease, recognition of its symptoms, social support, and acceptance during the initial treatment period (164). The perception of both the disease-related risks and the benefits of CPAP could lead to improved adherence among individuals with OSA. The number of individuals who use the device for less than 4 hours per night varies substantially between 29% and 83% (198). The

recognition or identification of non-adherence is essential as this allows for the development of a variety of educational, behavioral, and trouble-shooting interventions, including optimal mask fitting and the use of telemedicine (199).

There are a variety of reasons for non-adherence to PAP treatment; however, most individuals who discontinue treatment complain of air leakages or skin irritation at the interface between the machine and the face (200). Moreover, individuals with OSA who use PAP devices experience nasal dryness, rhinorrhoea, congestion, as well as dry mouth and throat. In addition, it has been demonstrated that nasal side effects are related to prior nasal symptoms, and that treating these problems can reduce nasal side effects (201). The possibility exists that PAP devices and humidifiers may be contaminated with bacteria or viruses, increasing the risk of infection. It has been demonstrated that humidifiers can increase the risk of respiratory infections in mechanical ventilators (202). Using PAP devices has been reported to affect the voice and may cause vocal changes (203). Furthermore, psychological factors may contribute to non-adherence to PAP (204).

PAP administration can be performed in several forms, including continuous positive airway pressure (CPAP), which maintains a constant level of positive airway pressure throughout the respiratory cycle; autotitrating positive airway pressure (APAP), which adjusts PAP based upon changes in upper airway obstruction; and bilevel positive airway pressure (BiPAP)(205). CPAP was generally preferred as the first therapy, since it was the most familiar and well-studied (205). On the other hand, APAP appears to have the same effectiveness as CPAP, but supplies a lower mean pressure than CPAP (206). Further, both APAP and CPAP had similar effects on patient compliance and satisfaction (206). The selection of PAP device can be influenced by a variety of factors, including associated symptoms or comorbid conditions, and the utility of digital health and the availability of online data management (207).

In the following discussion, we will explore the impact of PAP therapy on a variety of health conditions, including metabolic syndrome, cognitive impairment, OSA-COPD overlap, and cancer. Furthermore, we will examine the potential challenges that COVID-19 may pose to the adherence and management of PAP therapy. Understanding the impact of

PAP therapy on these health conditions and the challenges to its adherence can provide valuable insights into optimizing OSA management and improving individuals' quality of life.

PAP therapy and cardiovascular disease: According to a relatively large multicenter randomized clinical trials examining the effects of PAP therapy on cardiovascular outcomes, known as the Sleep Apnea Cardiovascular Endpoints (SAVE) (208). In this study, individuals with moderate to severe OSA and established cardiovascular disease were randomized to receive either CPAP therapy plus usual care or usual care alone and were followed for 3.7 years. Based on the results of the study, it was found that the AHI had been reduced from 29 to 3.7 events per hour per night, confirming that OSA had been adequately controlled (208).

The use of CPAP therapy plus usual care Compared with usual care alone, did not prevent cardiovascular events in individuals with moderate-to-severe OSA (208). In spite of the fact that the rate of cardiovascular events was slightly improved in those adhering to CPAP (i.e., ≥ 4 h per night), this benefit was not statistically significant (208). Based on the results of this study, CPAP cannot be recommended as a therapy for individuals with moderate to severe OSA with established cardiovascular disease if the sole objective is to reduce cardiovascular complications.

A multicentre, randomized control trial aimed to evaluate the effects of OSA and treatment with CPAP on the clinical evolution of non-sleepy individuals with acute coronary syndrome in 15 Spanish hospitals (209). It was found that OSA was not associated with an increased prevalence of cardiovascular events, and CPAP treatment did not significantly reduce this prevalence (209).

The failure of PAP therapy to demonstrate protective effects on cardiovascular outcomes and vascular deaths might be due to short follow-up periods and limited adherence to treatment (210). In addition, it is unclear whether PAP therapy will benefit "sleepy OSA" individuals since most trials included nonsleepy OSA individuals (27,211).

PAP therapy and metabolic syndrome: A retrospective study conducted in Hong Kong from 2006 to 2013 examined the relationship between OSA severity and incident T2D

as well as the effect of long-term CPAP treatment (212). Long-term use of CPAP appears to be associated with a reduced risk of T2D, after adjusting for various baseline metabolic risk factors and subsequent changes in body weight (212). In a meta-analysis that included three studies examining the impact of CPAP on insulin sensitivity showed that insulin sensitivity significantly improved after CPAP treatment ($p = 0.049$) among individuals with OSA and T2D (213).

PAP therapy and OSA-COPD overlap: In a retrospective cohort study conducted by Stanchina et al., the impact of CPAP use on mortality was assessed in 227 individuals with OSA-COPD overlap (214). According to a multivariate analysis, hours of CPAP use and age were independently predictive of mortality, implying that greater CPAP usage is associated with better survival benefits (214).

PAP therapy and cognitive impairment: In a systematic review and meta-analysis of four randomized clinical trials, CPAP was compared with a control group in older individuals with OSA (215). The use of CPAP was associated with an improvement of 2.62 points on the ESS, but only slight improvements on cognitive tests (digital span, digital symbol) (215). Furthermore, in a retrospective study, the association between CPAP therapy, adherence, and incident diagnoses of AD, MCI was examined in older individuals with OSA (216). It was found that CPAP treatment and adherence are independently associated with lower odds of incident AD diagnoses among older adults. Moreover, it has been suggested that treatment of OSA may reduce the risk of subsequent dementia (216).

PAP therapy and Cancer: The field is still at an early stage, with regard to evaluating whether CPAP therapy can reduce the risk of developing cancer in individuals with OSA. The first and multi-centre cohort study aimed to determine whether adherence to CPAP therapy is associated with a reduction in all-cancer incidence compared with nonadherent individuals with OSA (217). Inclusion criteria were those prescribed CPAP for OSA with no history of cancer prior to the diagnostic sleep study or during the first year of CPAP use (217).

Individuals who have documented CPAP use for at least four hours per night were considered adherents. The study evaluated 4499 OSA individuals without cancer at 1 year

after start of CPAP treatment and the median age was 63 years and median AHI was 37 events per hour, 60% of the individuals adhered to CPAP treatment (217). The nonadherent group consisted of those who discontinued or used CPAP for less than four hours per night. The non-adherent individuals were younger, had lower BMI and less severe OSA. During follow-up, 437 individuals (9.7%) were diagnosed with cancer, 10.7% and 9.1% in non-adherent and adherent individuals. As a result, after a median follow-up period of 5.4 years, adherence to CPAP therapy was not associated with a reduction in all-cancer incidence in individuals with OSA (217).

Impact of COVID 19 on PAP therapy adherence: In a prospective cohort study conducted in France, the impact of the COVID-19 national lockdown on CPAP compliance was examined using telemonitoring in 7485 individuals with OSA between 15 January 2019 and 15 April 2020 (218). The adherence rate to CPAP during the first month of lockdown (15 March to 15 April 2020) was compared with the adherence rate during the same time period in 2019, a 4.48% increase was observed during lockdown ($p < 0.001$). Furthermore, the proportion of very low adherers (less than 10 min of CPAP use per night) decreased by 18.5% ($p < 0.001$) between 2019 and 2020 (218).

Other recent study was conducted to evaluate the opinion of individuals with OSA about their disease during the COVID-19 pandemic, their treatment, and their follow-up (219). A telephone questionnaire was used to survey OSA patients treated with CPAP in Thessaloniki, Greece, and adherence was also evaluated objectively through telemonitoring. A total of 100 individuals with OSA aged 54.3 ± 12.5 years (72% males) were evaluated, 41% considered themselves as high-risk group for severe disease due to COVID-19 because they suffered from OSA, and 25% believed CPAP could be protective from COVID-19 (219). Further, COVID-19 infected individuals (31%) did not change their CPAP usage. Approximately 30% of respondents believed that their health care facilities were worse than they were before, and 16% reported poorer sleep quality (219).

A rise in CPAP adherence may be attributed to COVID-19. This may have encouraged the individuals to become more adherent to CPAP in order to protect themselves from the disease, and the fear of hospitalization might have motivated them to

adhere to CPAP more closely (218). The clinical impact of COVID-19 on CPAP adherence of individuals with OSA needs to be confirmed in large cohort studies.

PAP therapy adherence and patient education: There are various educational approaches aimed to improve CPAP adherence and, in some instances, other health outcomes utilized in several studies. The educational initiatives include physician-led video education regarding OSA, the importance of CPAP therapy, adherence, prognosis and outcomes related to CPAP use (220), whilst others comprised physician-led in-person, telemedicine or group-based education (221–223).

Some studies evaluated the impact of nurse-led education with video and physical brochure components (224), sleep-technologist-led video education (225), combined physician and nurse-led video (226) and combined nurse and psychologist-led education (227). The comparator or control groups generally comprised the provision of information as a reflection of usual care with less-intensive patient education. Adherence was measured using data derived from CPAP machines and, where reported, the impact upon sleep quality was ascertained using validated tools such as ESS (220,222,225).

Other studies also assessed the impact of CPAP adherence upon quality of life and psychological wellbeing, using appropriate instruments such as FOSQ (223,227), and Calgary Sleep Apnoea Quality of Life Index (227) and Pittsburgh Sleep Quality Index (PSQI) (225).

The effects of education upon CPAP adherence and other health outcomes are noted. Basoglu, et al. (220) showed that video education was associated with greater adherence to CPAP across all time points (one month, three months and six month), as compared to usual care. The difference in frequency of adherence between the education and comparator group was approximately 10-15%. The authors also found that exposure to video education led to a significant improvement in sleep quality as indicated by the ESS at six months, compared to baseline ($p < 0.0001$). In contrast, Guralnick, et al. (225) found that subjects who received education observed a slightly higher depression score, than compared to usual care but this was not significant ($p > 0.05$). Moreover, sleep quality was

also assessed using the PSQI and scores were more favourable for the education, than usual care group but again this effect was not significantly different ($p>0.05$).

The importance of novel initiatives with an educational component to support improvements in adherence among persons diagnosed with OSA has been previously recognised but the utility and emergence of research exploring eHealth with a dominant education component has been lacking (228).

However, a lack of an effect has been previously reported by Hui, et al. (226) who conducted a randomised controlled trial of 108 patients with OSA who were equally assigned in an augmented video education group and a basic support. The effects upon CPAP adherence and sleep quality and related quality of life were assessed and it was found that there were no significant between group differences in CPAP usage ($p=0.98$) but there was a significant effect upon sleep quality and quality of life ($p<0.05$) among the augmented education group, compared to control. However, this trial only followed individuals for four weeks and thus, any improvements in CPAP adherence may have been missed and the effect size concerning sleep quality and quality of life may have been under-estimated. Comprising education delivered through mobile health or telemedicine mediums represents a key opportunity to help improve the outcomes for individuals with OSA given that remote medicine can be tailored to be highly convenient, accessible and more cost-effective, than conventional approaches to care provision (229).

Overall, the most comprehensive data available regarding the impact of OSA treatment on the various health conditions/comorbidities are related to PAP therapy; there is lack of available data regarding other treatment options such as oral appliance and upper airway surgery.

1.14. Exploring Non-PAP Therapies for Obstructive Sleep Apnoea

Sleep positioning: an emphasis has been placed on the role that body position plays in OSA, as well as effective methods for avoiding sleeping positions that worsen the condition (230,231). It has been reported that individuals with OSA have more obstructive events in supine than in other positions, and both the frequency and duration of apnoeas

are influenced by body position (231,232). This observation has led to the definition of the so-called positional OSA. A positional OSA individual is defined as one whose respiratory disturbance index (RDI) or AHI is at least twice that observed in non-supine sleeping positions (231,233). The RDI is a measure used to measure sleep apnea and other respiratory disorders during sleep. A person's RDI is calculated by dividing the number of respiratory disturbances, including partial or complete obstructions of the airway, by the total number of sleep hours (231,233).

It has been found that positional OSA individuals are usually younger and less obese, suggesting they may experience a less severe phenotype of respiratory disturbance than non-positional OSA individuals (231). Individuals with non-positional OSA display a higher AHI level and a lower mean oxygen saturation level (SpO_2) than those with positional OSA (231,234). It has been reported, however, that there was no significant difference between positional OSA patients and those with non-positional OSA in terms of clinical characteristics such as BMI (231,235). The positional therapy measure of changing from a supine position during sleep can be a simple and effective method for reducing AHI, however it is unsatisfactory for those individuals with non-positional OSA, emphasizing the need for further relevant investigation for an accurate diagnosis (231,234).

It can be challenging for OSA individuals to maintain a non-supine sleeping position, especially for those who are accustomed to sleeping on their backs.(236–238) It is however possible for OSA individuals to achieve this goal by following a few practical tips. A simple solution is using pillows to prop the head and neck up in order to prevent them from falling backward. A body pillow or cushion can also be placed against the back to prevent rolling over during sleep. Additionally, raising the head of the bed by a few inches can reduce the likelihood of rolling onto the OSA individual back (237). It may take some experimentation for the OSA individual to find the best combination of pillows and bed adjustments, but over time, maintaining a non-supine position during sleep will become a habit leading to improved symptoms of OSA (237,238).

Oral appliances: Oral appliances are indicated for individuals suffering from mild to moderate OSA, and individuals who are unable to change their lifestyle. Oral appliances

can, however, also be used in severe cases of OSA when the individual cannot tolerate or use a CPAP. An oral appliance therapy is a form of non-invasive therapy in which intraorally applied devices are used to treat individuals with OSA and snoring and these devices are worn during sleep (239). As opposed to CPAP, oral appliance adherence is high, but response to oral appliance therapy varies greatly from individual to individual (240). The purpose of this therapy is to stabilize the mandible and the pharyngeal structures in order to prevent pharyngeal collapsibility and maintain the patency of the upper airway at night (239). Through the use of oral appliances, OSA-related symptoms such as daytime sleepiness and a high AHI can be alleviated (170).

In individuals with OSA, the oral appliance treatment is effective in improving sleepiness, although less effectively than CPAP (241). It has been suggested that when comparing oral appliance therapy with CPAP, CPAP is more effective in treating mild-to-moderate OSA (242,243). However, a comparison of these two therapies in 126 individuals with moderate OSA (mean AHI 25) showed that the two treatments resulted in similar results in terms of sleepiness, driving simulator performance, and disease-specific quality of life after 1 month (170). In the 36-item Short Form Health Survey (SF-36), oral appliance therapy significantly improved four general quality-of-life domains, but no difference was observed between oral appliance therapy and CPAP in the functional outcomes of Sleep Questionnaire (FOSQ)(170).

There was a similar amount of blood pressure (BP) reduction noted in a meta-analysis of oral appliance treatments compared to CPAP trials (between 2- and 3-mm Hg)(244). As a result, the oral appliance therapy can be recommended as a first line therapy for individuals with mild, symptomatic OSA (245).

There are some contraindications to oral appliance therapy, such as individuals who suffer from central sleep apnea and other respiratory disorders other than OSA. In the case of individuals who have acute jaw joint pain or severe periodontitis, Oral appliance therapy should not be administered prior to the treatment of these symptoms. Furthermore, those with reduced opening capacity, i.e., <25mm, limited maximum protrusive distance (<6mm), active temporomandibular joint disorder and inability to cooperate, or the

skeleton is not fully developed, oral therapy treatment may be contra-indicated (246). Additionally, side effects, such as mucosal/mouth dryness, tooth discomfort, hypersalivation, and increased temporomandibular joint symptoms are common (247). It has been shown that after 6 months of oral appliance therapy, individuals with mild to severe OSA exhibit a low frequency of clinical signs of temporomandibular pain (248).

It should be noted that these side effects do not limit the use of oral appliances, with approximately 60% of individuals using their device in a long-term therapy (247). It is important to note that there are numerous designs and types of oral appliances available. These are generally divided into three broad categories: soft palate lifters, tongue retaining devices, and devices that work by mandibular advancement. It is no longer common to use soft palate lifters in clinical practice, and tongue retaining devices are rarely employed (249). Oral appliances are generally referred to as Mandibular advancement appliances (MADs), types are mandibular repositioning devices, mandibular advancement splints, and mandibular advancement appliances (250).

1.14.1. Pharmacological Treatment

The first line of treatment for OSA is PAP, as discussed earlier. Nevertheless, it has been suggested that drug therapy may be an alternative to PAP therapy in some individuals with mild to moderate OSA, particularly in individuals who are not tolerant to CPAP (251).

A systematic review was conducted in which randomised placebo-controlled trials of drugs targeted at treating OSA in adults were reviewed (251). The mechanism by which drugs may reduce OSA severity has been proposed in a number of studies. Among these are an increase in tone in the upper airway dilator muscles, an increase in ventilatory drive, a reduction in the proportion of rapid eye movement (REM) sleep, and mechanisms resulting in an increase in cholinergic tone during sleep, a reduction in airway resistance and an increase in upper airway surface tension (251). There were 25 drugs tested, 10 of which had some effect on OSA severity as measured by AHI, and four altered sleepiness symptoms, though the effects were generally modest (251).

The use of pharmacological agents to treat obstructive sleep apnoea has had a limited success rate (251). According to the systematic review, there is insufficient evidence to recommend the use of drug therapy in the treatment of OSA (251). It has been demonstrated that some agents have shown positive effects on short-term outcomes in small studies (251). Additionally, AHI has been shown to be reduced by 24% to 45% by certain agents in largely unselected populations with OSA (251). For example, it has been shown that intranasal corticosteroid therapy reduces AHI which is particularly pertinent to patients with reversible nasal obstructions (252).

It is imperative that further research be conducted in order to determine whether drug therapy is a viable treatment option for OSA. In spite of this, PAP therapy remains the first line of treatment for OSA, and healthcare providers should continue to emphasize its importance in the management of the condition.

1.14.2. Surgical Treatment

A Maxillomandibular Advancement (MMA) is a type of skeletal surgery, through MMA, the pharyngeal cavity is enlarged by extending the skeletal framework on which the soft-tissue pharyngeal structures and tongue attach, resulting in a reduction in the collapsibility of the pharyngeal cavity during negative pressure inspiration (253). The main indications for MMA are for individuals with moderate-to-severe OSA, and mild OSA individuals presenting with a dentofacial deformity (254) Further, MMA is considered to be an effective craniofacial surgery technique and an alternative procedure for non-adherers or those who are unable to tolerate lifelong PAP therapy (253,255).

The European Respiratory Society guideline on non-PAP therapies recommends MMA as one of the options for treating adult individuals with OSA (although individual acceptance may vary) (256) . The selection of MMA is more individualized and based on the individual phenotype, considering both clinical (i.e., age, comorbidities, neck circumference, BMI, and dentofacial deformity) and polysomnographic evaluation (253). Since MMA is an invasive procedure, it is likely to result in a longer recovery period and a

higher risk of postoperative complications. The duration of OSA individuals' hospitalization following MMA surgery ranges from two to eight days (254) .

Surgical cure rate of MMA ranges from 36% to 67.9%(254). It is reported that the major complications associated with MMA are reoperations to remove hardware; it is considered that the individual's age at surgery time increases the likelihood of requiring hardware removal. Additionally, individuals who had a history of smoking or who were active smokers were found to be at higher risk of complications. It has been indicated that facial paresthesia, local infection, and postoperative wound pain are common minor complications in MMA. It has also been suggested that age may increase the likelihood of facial paresthesia (254). A summary of the different treatment options discussed here can be found in table 3.

Table 3. Treatment options for obstructive sleep apnoea: narrative summary.

Treatment	Description	Advantages	Disadvantageous	Recommended for
PAP therapy (i.e. CPAP, APAP)	The use of a machine that delivers continuous positive airway pressure through a mask or nosepiece during sleep is referred to as positive airway pressure therapy	Effective at reducing AHI	May be uncomfortable or difficult to tolerate	Individuals with moderate to severe OSA
Lifestyle modifications (i.e. weight loss, physical activity)	Changes to lifestyle habits such as weight loss, physical activity, smoking cessation, and reduction of alcohol consumption	Effective at reducing AHI	Sustain long-term, can be challenging	Individuals with mild to moderate OSA or as adjunct therapy for severe OSA
Surgery	Various surgical procedures such as maxillomandibular advancement (MMA)	Can improve OSA and overall health outcomes	Risk of complications	Individuals with specific anatomical abnormalities or severe OSA who not tolerate to CPAP or other treatments
Positional therapy	Techniques or devices to encourage sleeping in positions that reduce apnoeas-hypopnoeasv	Can be effective for positional OSA	May be difficult to maintain throughout the night	Individuals with positional OSA
Pharmacological treatment	Medications - limited effectiveness	Can improve symptoms such as excessive daytime sleepiness and breathing function during sleep Can improve symptoms such as excessive daytime sleepiness and breathing	Side effects and may not treat underlying cause of OSA	Individuals who cannot tolerate other treatment options
Oral appliances	Non-invasive devices that reposition the jaw and tongue to keep the airway open during sleep	Can be effective for mild to moderate OSA	Less effective for severe OSA or individuals with certain jaw conditions	Individuals who cannot tolerate other treatment options or as adjunct therapy

1.15. International Consensus Document on Obstructive Sleep Apnoea

In the International Consensus Document (ICD) on OSA (257), guidelines are provided for healthcare professionals who manage adult individuals who suffer from this condition. There were 17 scientific societies represented, 56 specialists from different geographic regions, 4 international societies, a methodology expert, and a documentalist from the Iberoamerican Cochrane Center in the expert working group.

As part of the ICD, a clear therapeutic algorithm is provided for managing OSA, which outlines steps such as hygienic-dietary measures, identification and treatment of associated conditions and potentially reversible causes, as well as recommendations for CPAP therapy or alternative treatments in specific circumstances.

The document emphasizes the crucial role of primary care physicians in the management of OSA, addressing the need for training programs in primary care for improving the suspicion and diagnosis process. Additionally, it emphasizes the potential of primary care settings to fulfil the majority of treatment follow-up needs.

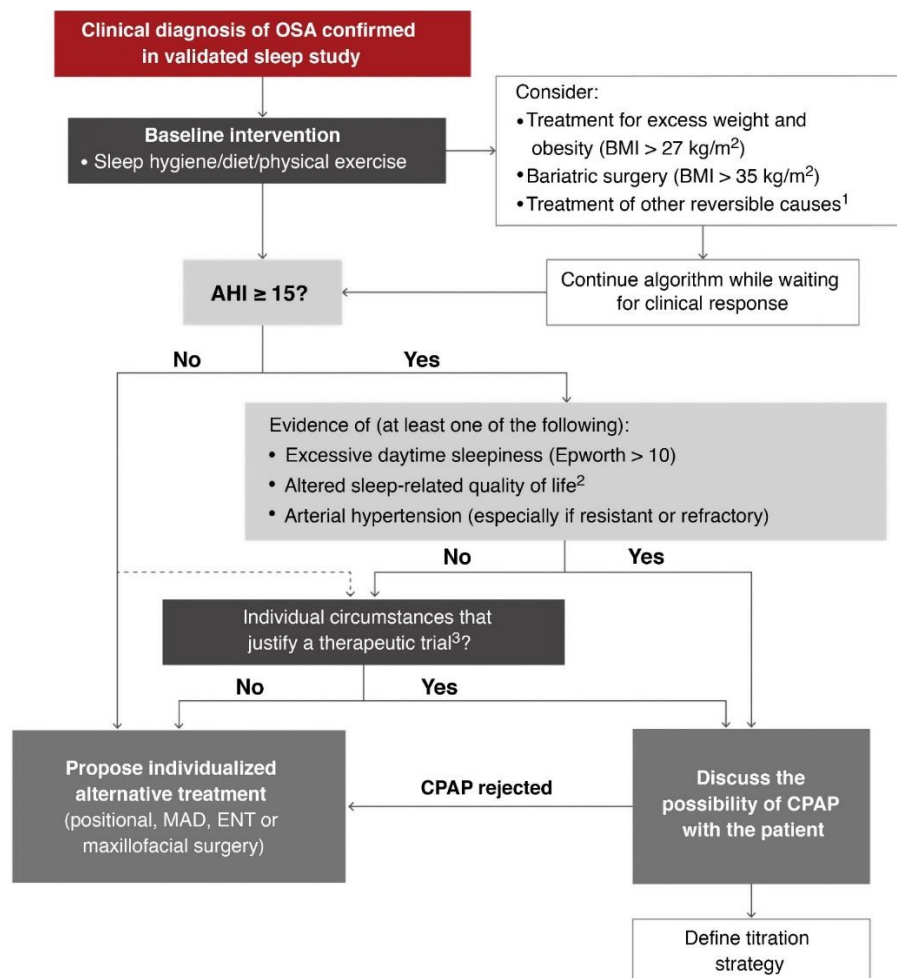
According to ICD, OSA is defined as the presence of $AHI \geq 15/h$, primarily obstructive, or an $AHI \geq 5/h$ accompanied by one or more factors, such as excessive daytime sleepiness, non-restorative sleep, excessive tiredness, and/or impaired sleep-related quality of life, unattributable to other causes.

In the ICD, it is stressed that classifications based solely on AHI do not adequately represent the severity of OSA and do not take into account heterogeneity. All medical, surgical, and physical treatment options for OSA should be considered rationally and complementary, either in isolation or in combination, and tailored to each patient after an in-depth evaluation. In multidisciplinary collaboration, an emphasis should be placed on the patient's participation in therapeutic decision-making.

In the OSA therapeutic algorithm, hygienic-dietary measures are recommended for all patients, evaluation is conducted to identify OSA-related conditions and potential reversible causes, and treatment of obesity and reversible factors is provided. Figure 4 shows the proposed therapeutic algorithm for OSA (257). The use of CPAP is recommended for patients with moderate-to-severe OSA, excessive daytime sleepiness,

impaired sleep-related quality of life, and/or hypertension. In the event that the therapeutic trial is unsuccessful, alternative treatments should be explored.

The involvement of primary care physicians in OSA underdiagnosis is crucial, as well as the implementation of training plans in primary care that enhance the suspicion of and diagnosis of OSA. A clinical suspicion should be based on at least two of the three primary symptoms: snoring, observed apnoeas, and excessive daytime sleepiness or unexplained intense fatigue. A majority of follow-up requirements can be met in primary care; however, there is insufficient evidence to support initiating CPAP treatment exclusively in a primary care setting. Fig. 8. Shows the proposed therapeutic algorithm for OSA (257).



1. Tonsillar hypertrophy, severe dental or facial alterations, acromegaly, hypothyroidism, and others.
2. Given lack of specific clinical questionnaires, consider intense snoring, choking episodes, insomnia, morning headache, nocturia, deteriorated occupational or academic performance, social impact, and/or tiredness
3. Use CPAP with short-term evaluation of therapeutic efficacy and withdrawal in case of no response

Figure 4. Proposed therapeutic algorithm for obstructive sleep apnoea. From (257).

1.16. Research Gap

As discussed previously, the management strategies for individuals with OSA fall into three broad categories: medical, surgical, and behavioral. Medical treatments include CPAP devices, oral appliances, and pharmacological solutions. Surgical interventions include procedures such as maxillomandibular advancement. An integrated behavioral approach includes positional therapy and lifestyle changes.

There are several gaps and areas for improvement in OSA management, despite the extensive treatment options available. Firstly, there is a lack of comprehensive, patient-centered care that addresses the multifaceted nature of OSA and its concomitant comorbidities. In addition, limited access to specialized healthcare services and long waiting times for sleep studies can complicate the diagnosis and treatment of sleep disorders. Additionally, suboptimal adherence to treatments, particularly CPAP therapy, has been observed, which may compromise the effectiveness of treatments.

Moreover, there is a substantial gap in addressing the educational needs of individuals with OSA, with a lack of targeted resources and interventions designed to bridge the knowledge gap and empower patients to manage their condition.

A profound need arises from these limitations to improve OSA management by integrating the expertise of healthcare professionals, including nurses. Nurses play an important role in closing these gaps by providing early screening, assessment, patient education, and support for treatment adherence.

Based on this contextual understanding, we will explore in greater depth the role of nurses in OSA management, the effectiveness of nurse-led interventions, the cost-effectiveness of primary care management of OSA, and patients' educational needs in the ensuing chapter of this thesis.

1.17. Thesis Hypothesis and Objectives

The objectives and hypotheses of this thesis are as follows:

Hypothesis 1: Nursing-led interventions in obstructive sleep apnoea management are both cost-effective and improve patient outcomes compared to a specialised sleep unit model.

Objective 1: To review the existing literature on nurses' roles in obstructive sleep apnoea management, in both sleep units and primary care settings, and with a focus on the cost-effectiveness and effectiveness of nurse-led interventions.

Hypothesis 2: By identifying the educational needs, beliefs, and experiences of individuals with obstructive sleep apnoea, we will gain valuable insight into developing tailored, patient-centered educational materials and interventions.

Objective 2: To explore the educational needs, beliefs, and experiences of individuals with obstructive sleep apnoea in Lleida, Spain.

Hypothesis 3: Based on the findings of the qualitative study, evidence-based recommendations will inform the development of targeted educational materials and interventions designed to improve obstructive sleep apnoea management, and overall health outcomes

Objective 3: To synthesize the findings of the qualitative study and provide evidence-based recommendations as well as implications to improve obstructive sleep apnoea management and patient outcomes through the development of educational materials and interventions.

METHODOLOGY



2. METHODOLOGY

This PhD thesis is a mixed-methods study that is based on a comprehensive literature review and a qualitative case study. A literature review has previously been published and provides the theoretical basis for the subsequent qualitative study (10) (Annex A). The following sections describe the methods used in each component of the study.

2.1. Literature Review

Firstly, the objective of this thesis was to review the existing literature on nurses' roles in OSA management, both in sleep units and primary care settings, as well as the effectiveness and cost-effectiveness of nurse-led interventions. Accordingly, a literature review was conducted. The methodology presented in this section was derived from a scoping review that sought to map current research on nurses' role in OSA management in primary care and sleep units. The review was titled "Nursing Professionals' Role in the Comprehensive Management of Obstructive Sleep Apnoea: A Literature Review" (10). The review followed the PRISMA 2020 guidelines for scoping reviews.

The review was based on scholarly publications and included qualitative, quantitative studies, and mixed method studies. The search for relevant literature was conducted using electronic databases such as PubMed/Medline, CINAHL, Scopus, the Cochrane Database of Systematic Reviews, and ScienceDirect. Specific keywords and terms related to the research topic were used in the search.

An inclusion criterion for the studies was established as peer-reviewed articles published in the English language between January 2015 and June 2021 which examined individuals with OSA of any age group and highlighted nursing contributions to the management of OSA in primary care settings or sleep units.

During the review, references were managed using EndNote 9.2, and then titles and abstracts of 345 articles were screened by two reviewers. Upon reviewing the full texts of the articles, it was determined that 10 articles met all the inclusion and exclusion criteria.

In February of 2023, before the journal's final decision, an updated search was conducted. Two additional articles were added, bringing the total number of included articles to 12. A quality assessment was conducted using the Critical Appraisal Skills Program (CASP) and the guiding quality questions provided by the program. This review was published in March 2023 (10).

2.2. Qualitative Study

2.2.1. Conceptual Framework

The second objective of this thesis was to explore the educational needs, beliefs, and experiences of individuals with OSA in Lleida, Spain. It was critical to select an appropriate theoretical framework for addressing the particular research question and population under study (258). Different theoretical frameworks offer various views on a research question, guiding variable selection and data analysis (258).

In this qualitative study, we will utilize the Health Belief Model (HBM) as the theoretical framework to explore the educational needs of individuals with OSA (259,260). Using the HBM, we hope to determine the key factors influencing OSA individuals' viewpoints and identify opportunities to develop tailored education programs that address their needs.

2.2.1.1. Health Belief Model (HBM)

The HBM is a widely recognized psychological model developed by social psychologists Godfrey Hochbaum, Stephen Kegels, and Irwin Rosenstock in the 1950s to explain and predict individual health behaviours (259). The model was originally developed to understand the reluctance of people to participate in preventive health programs (259). However, it has since evolved and has been applied to a wide range of health behaviours, including smoking cessation, weight loss, and vaccination (261). In addition to HIV (262), type 2 diabetes (263), tuberculosis prevention behaviour (264), nutritional behaviours (265), or developing preventive behaviours in young adults (266).

2.2.1.2. Components of HB

There are six main components that make up the HBM:

1. **Perceived susceptibility:** refers to a person's belief that it is likely that they will get a particular disease. Those who receive themselves as more susceptible to a health condition are more likely to take preventive measures (267).
2. **Perceived Severity:** refers to a person's belief about the severity of a health condition and its potential consequences. When people perceive a health condition to be severe, they are more motivated to engage in preventive behaviours (267).
3. **Perceived Benefits:** refers to a person's belief in the effectiveness of a particular action in reducing the risk or severity of a particular health condition. In general, the greater the perceived benefit of a particular action, the more likely it is that a person will engage in that action (267).
4. **Perceived Barriers:** refers to a person's belief in the obstacles or costs involved in undertaking a particular course of action. When perceived barriers outweigh perceived benefits, people are less likely to engage in preventive behaviours (267).
5. **Cues to Action:** refers to factors that cause a person to act, either internally or externally. There are internal cues, such as physical symptoms and emotional experiences, and external cues, such as advice from others, media campaigns, and environmental changes (267).
6. **Self-efficacy:** refers to a person's belief in their ability to perform a task successfully. Those with a high level of self-efficacy are more likely to adhere to a health behaviour over the long term (267,268).

2.2.1.3. Application and Limitations of HBM

This model has been extensively applied to health promotion and intervention programmes for chronic disease prevention, substance abuse prevention, and sexual health

promotion (269). HBM has also been employed to address OSA and treatment adherence in a number of studies, demonstrating relationships between health beliefs, self-efficacy, and treatment adherence (270–272).

The HBM has been criticized for its individualistic focus, which does not take into account social, cultural, or environmental influences on health behaviors (273). Nevertheless, the HBM remains a valuable tool for predicting and understanding health behaviors (274).

2.3. Study Design

The qualitative study utilized a semi-structured interview as the primary method of data collection as it is crucial to choose an appropriate method of data collection to obtain valid and reliable data (275). In the context of exploring the educational needs of individuals with OSA, semi-structured interviews provide several benefits over other methods.

The adaptability of semi-structured interviews is one of their most important advantages. In contrast to structured interviews, semi structured interviews allow the researcher to adjust the questions and expand on themes that emerge during the interviews (276). Furthermore, semi-structured interviews enable researchers to tailor their questions to each participant's unique experiences, resulting in context-specific insights (277). This is particularly beneficial in OSA research due to the diverse nature of individuals with OSA and the myriad factors affecting disease progression and management (23).

Furthermore, semi-structured interviews facilitate in-depth exploration of participants' experiences and reveal subtleties that may not be captured by structured questionnaires or survey instruments (278). The Standards for Reporting Qualitative Research (SRQR) guidelines were used to report the study methodology (279).

2.4. Sampling

This study employed a purposive sampling method (280,281). This approach involves the selection of participants based on certain characteristics, such as the diagnosis

of OSA. As part of purposive sampling, participants are required to possess characteristics or experiences relevant to the research question in order for the sample to accurately represent the population studied (280,281). In this instance, the inclusion and exclusion criteria were used to identify the individuals with specific characteristics relevant to the research study.

2.5. Participants

In this study, participants were recruited from the sleep unit at Hospital Universitario Arnau de Vilanova, Lleida / Spain. Health care providers at sleep units informed individuals who met the eligibility requirements about this qualitative study. Those who expressed interest in the study were provided with an information sheet (Appendix B) explaining the study's objectives, procedures, potential risks, and benefits. All participants provided written informed consent (Appendix C).

The inclusion criteria for participants in this study were that they had moderate OSA with an AHI of 15-30, as well as hypertension as determined by 24-hour ambulatory blood pressure monitoring (24h-ABPM). The study included both men and women of 18 years old or over and who had been diagnosed with OSA in a sleep unit. The participants should be fluent in Catalan and/or Spanish and currently live in Lleida, Spain.

Conversely, those with incapacity to handle technology, bariatric intervention or waiting list, psychiatric disorders, restless legs syndrome, pregnancy, another form of dyssomnia, or parasomnia were excluded from the study. Those who had previously or currently received CPAP, couldn't complete questionnaires, advanced heart failure (New York Heart Association class III or IV), associated advanced pathology (including any active neoplasm or tumor), pregnancy, or a BMI below 17 were also excluded from the study.

2.6. Data Collection

The collection of data is a crucial component of any research study, since it contributes greatly to answering the research questions (275). This study collected data

through in-person semi-structured interviews conducted in a neutral and comfortable environment at the Faculty of Nursing and Physiotherapy at the University of Lleida. This setting was intentionally selected in order to create a relaxed, non-threatening environment that encouraged participants to express themselves freely and reduced the likelihood of external influences (282).

All interviews were audio-recorded with the interviewee's informed written consent and transcribed verbatim to ensure accuracy and facilitate data analysis. The interviews took place between May and December 2022. The duration of the interviews varied between 25 and 85 min.

The final sample included 11 participants, with saturation achieved after data analysis indicated no new themes emerging (283). The interviewer (OM) is a doctoral candidate fluent in both Spanish and Catalan. All interviews were conducted in Spanish, although participants had the option of conducting them in the language of their choice, either Spanish or Catalan.

2.7. Interview Guide

A comprehensive literature review informed the development of an interview guide to facilitate the interviews. There were several key topics covered in the guide, including OSA symptoms, experiences with diagnosis and treatment, and participants' perceptions of OSA-related education. In addition to ensuring thorough coverage of relevant topics, the interview guide was used to encourage in-depth discussions and elicit detailed responses from participants. The use of an interview guide facilitates consistency across interviews, thereby improving the reliability of study findings (275). The questions in the interview guidelines include:

1. *Would you be able to describe your feelings regarding obstructive sleep apnoea?*
2. *What information have you received from your doctor or nurses regarding obstructive sleep apnoea (symptoms, medication/treatment option, diet, blood pressure control, sleep habits, follow-up, medical tests...)?*

3. *Could you please explain how well you felt that you could manage your care at home (Did you find the information useful, was it overwhelming, did you understand it?)?*
4. *Please describe what you did not receive in the instructions that you felt you could have benefited from knowing and that you need to know?*
5. *What are the advantages of using a technology to manage your condition over visiting a hospital?*
6. *What are the disadvantages of using a technology to manage your condition over visiting a hospital?*

2.8. Data Analysis

In this study, we employed a rigorous thematic analysis approach to identify, analyze, and describe the key themes and subthemes in the data. The transcripts were rigorously cross-checked against the original recordings, as outlined by Braun and Clarke (2006), for the purposes of examining, interpreting, and reporting significant patterns or themes emerging from the data collected (284). One of the researcher team OM meticulously transcribed the audio-recorded interviews verbatim, and the transcripts were rigorously verified for accuracy against their respective source recordings. A qualitative data analysis software called Atlas.ti was utilized to enhance the analysis process (285).

RA and MM independently coded the data, assigning codes to salient textual units. FP participated in a comprehensive discussion with RA and MM, facilitating a consensus-based approach to resolving any discrepancies. This collaborative process ensured the consistency and robustness of the coding process. The codes were then systematically amalgamated into cohesive overarching themes and subthemes, enabling us to explore the multifaceted nature of the participants' experiences and perspectives on OSA and its management. The abduction approach was used throughout the data analysis process, as we iteratively moved back and forth between the data and existing theories, in order to generate new insights and explanations. In accordance with the recommendations of Green et al. (2007) (286) and Eakin and Gladstone (2020) (287), we generated meaningful insights

and advanced our understanding of the research phenomenon by employing a rigorous and systematic approach to data analysis.

RESULTS



3. RESULTS

This section will meticulously summarize the significant findings obtained from an exhaustive synthesis of the existing literature, as well as a rigorous qualitative investigation. The results of this synthesis have enabled us to identify pivotal themes, knowledge gaps, and new insights prevalent across our research. Concurrently, the qualitative study has enabled us to delve into the intricate nuances and complexities of the subject matter. This has enhanced our understanding of the phenomena under scrutiny.

The synthesis of literature review and qualitative findings presented herein serves as a valuable resource for understanding the interwoven fabric of our research domain, while simultaneously contributing to the advancement of knowledge and theory in the field.

3.1. Literature Review

In our review (10), 12 articles were included, and three key themes emerged, namely the role of nurses in the diagnosis of obstructive sleep apnoea, the role of nurses in following up and supporting obstructive sleep apnoea patients, and the role of nurses in managing obstructive sleep apnoea in primary care and its cost-effectiveness. It has been demonstrated that nurses can play a very significant role in OSA management. The scope of their contributions encompasses an array of areas including screening, assessment, diagnosis, adherence to therapy, and follow-up care. In addition, they are responsible for providing patient education and collaborating with other health care professionals (10).

Additionally in the review it has been demonstrated that patient education is highly effective in promoting adherence to PAP therapy in both sleep units and primary care settings. Nurses monitor individuals for adverse effects associated with CPAP machines, such as facial irritation. This further reinforces their importance in managing OSA. It has been found that the primary care model of OSA management is more cost-effective than the sleep unit model (10).

3.2. Qualitative Study

This section presents the results of a meticulous thematic analysis of 11 semi-structured interviews with OSA individuals. The study included 9 male and 2 female participants aged between 43 and 61. Our findings revealed four primary themes, each encompassing a range of subthemes. Firstly, we identified the theme of "An introduction to obstructive sleep apnoea 101" that indicated a lack of knowledge about the condition. The second theme, "Weight management: how to do it?" emphasized the challenges individuals with OSA face in managing their weight and the need for evidence-based strategies. The third theme, "Sleep, It's All That Matters" shed light on the diverse experiences and impacts of OSA on individuals' lives. Finally, the fourth theme, "Physical Activity: Let's Talk About It" explored the role of physical activity in OSA management and the barriers individuals face in implementing it.

3.2.1. *An Introduction to Obstructive Sleep Apnoea 101*

In this theme, participants seek a comprehensive understanding of OSA, including the diagnosis, contributing factors, and the influence of OSA severity on treatment choices.

Participant 11 revealed their lack of awareness of the condition, stating:

"Because sometimes you wake up like that, but you don't give it much importance. But yes, it's been a few years. Since you don't know what it is, you don't really pay attention."

"Porque como te de vez en cuando te despiertas así y tampoco no le das importancia, pero si estoy ya hacía unos años, como tampoco no sabes lo que es ni nada, pues dices"

Similarly, Participant 5 expressed their desire for more information about OSA:

“I would like to know a little more about the disease, because understanding the disease is the first thing I would like to know. As far as I know, in my family, I am the only one with sleep apnea. I didn't even know about this disease.”

“me gustaría saber un poquito más de la enfermedad, porqued a la enfermedad es lo primero que ello me gustaría saber. Porque hasta donde yo sé de mi familia, soy la única quetengo apnea. Es que yo ni conocía esa enfermedad.”

Participant 5 commented on the use and attitudes towards technology:

“I don't know anything about this, and I'm just starting to use it now. So, I can't tell you yet if it's beneficial”

“Yo, como no sé nada de esto, apenas ahora lo voy a usar. Entonces no sé decir, no te sé decir todavía si me beneficia”

Meanwhile, participant 6 acknowledged the advantages of technological advancements, stating:

“What I see is that with the new technology, you can integrate it into your everyday life. With the traditional method, of course, you always have to go to the medical center, and you have to adhere to specific schedules. This, on the other hand, provides freedom, and I think it's good for both the patient and the doctor to have real-time data and so on.”

“Lo que veo es que la nueva tecnología te puedes conviviren tu día a día normal

El tradicional, pues claro, siempre tienes que acudir al centro médico, tienes que estar respecto aunos horarios. Esto pues, da una libertad y creo que es bueno tanto para el paciente como para elmédico detener atiempo realunos datos y demás”

3.2.1.1. Obstructive Sleep Apnoea: Why do I have it?

In this subtheme, the Participants expressed bewilderment and curiosity about the causes and underlying mechanisms of their OSA diagnosis. In their opinion, health professionals generally provide only brief explanations, which leaves them with a limited understanding of the condition. Participants in this subtheme underscore the importance of comprehensive education on OSA to assist patients in better understanding the cause, symptoms, risk factors, and pathophysiology of their condition.

Participant 2 admitted their lack of awareness of the severity of their condition, saying:

“I knew I snored, but I didn't know I was having apneas”.

Sabía que roncaba, pero no sabía que estaba teniendo las apneas.

In addition, the same participant emphasized the importance of understanding the factors affecting their OSA and exploring potential solutions:

“knowing everything that affects me, having a clear understanding of what affects me and then looking at possible solutions to solve or improve my case.....Does it get cured 100%, or how can it be cured?”

“saber en todo lo que me afecta, vale tener claro lo que me afecta a mí y luego mirar las posibles soluciones para solucionar o mejorar mi caso...Se cura 100% o cómo curarla?”

Participant 4 raised questions regarding the OSA etiology and risk factors:

“Maybe if the apnoea has to do with age....If it is a genetic cause...Or what the etiology”. Participant₄

“Quizá si el apnea tiene que ver con la edad.... Si es una causa genética....O la etiología que tiene.”

3.2.1.2. OSA Severity and Its Influence on Treatment Options

This subtheme revealed participant confusion regarding treatment options, particularly when healthcare professionals did not recommend CPAP therapy. The findings highlight the participants' desire to gain a comprehensive understanding of OSA and the need for clear communication and active participation in the decision-making process.

The participant 7 described their experience as follows:

“Nothing at all. The answer was that I didn't need to use a machine.”

“Nada de nada. La respuesta fue que no hacía falta que llevara máquina”

Similarly, Participant 8 mentioned, “They told me that the results showed I had apnoeas, but not enough to use a machine.”

“Entonces me dijeron de que los resultados que habían dado era que tenía apneas, pero no lo suficiente como para llevar una maquina”.

3.2.2. Weight Management: How to Do it?

This theme examines the difficulties experienced by OSA patients in managing their weight and the impact that weight management has on their condition. Although participants acknowledged the importance of maintaining a healthy weight, they expressed difficulties adhering to appropriate dietary practices.

Participant 3 admitted to their diet struggle, saying:

“I know I should lose weight. I could say that I know how to do it more or less. It mostly depends on my diet. And there, I have a bit of a problem because the diet I am currently following may not be the most appropriate, and I find it difficult to give up certain foods and replace them with others”

“Sobre todo depende de la alimentación. Y ahí sí que tengo un poco de problema porque igual la alimentación que estoy llevando hoy en día no es la más adecuada y me cuesta renunciar a según que alimento y sustituirlos por otros.”

Participant 7 expressed the desire for guidance on weight management and lifestyle changes to control their OSA:

“I would like them to provide methods so that it doesn't reach such extremes. Whether it's doing breathing exercises or eating lighter meals at night. That with a different diet, it could also improve. In other words, they should provide us with ways to control it”

“yo quisiera que me hicieran métodos para que no, no llegará a esos extremos. Se tenía que hacer ejercicios de respiración o por la noche en vez de comer no comemos fuerte, pero que con

otra alimentación también mejorara. O sea, que nos dieran medios para poder controlarla.”

Participant 10 shared a positive experience after adopting a healthier diet:

“and also started a diet, and the truth is that I lost weight, and I eat many good things, like vegetables that I didn't eat before, and I'm really happy about it. Because I feel less tired, of course. In the end, nutrition influences how you feel. If you don't eat fats and eat the food you should eat.”

“la verdad que bajo peso comes muchas cosas que son buenas, verduras que antes no comía tantas y la verdad que muy bien, muy contento. Porque me noto menos cansado, claro. Al final la alimentación influye. Si tú no comes grasas y comes la comida que deberías comer, pues también te sientes menos cansado”

3.2.2.1. Integrating Nutritionists into Comprehensive OSA Management

A number of participants expressed dissatisfaction with the vague weight loss guidance provided by healthcare professionals and emphasized the importance of including nutritionists in their OSA management plans.

Participant 3 described their experience with a healthcare professional, saying:

“The doctor simply told me that I should lose weight, but she did not specify anything else.”

“Simplemente me dijo la doctora que debería perder peso, pero no me concretó nada más.”

In addition, the same participant elaborated on their struggle with making dietary changes and the potential need for external assistance:

“I don't know if I have or will have enough willpower to stop eating some foods and replace them with others. That's where I might need a little external help to improve. I'm going to try, but I don't know if I can do it alone because I tend to eat certain types of food”

“Y yo no sé si voy a tener o tengo la suficiente voluntad para dejar de comer algunos alimentos y sustituirlos por otros. Ahí quizás sí que me vendría bien un poco de ayuda externa para mejorar. Vale, yo lo voy a intentar, pero no sé si solo lo conseguiré porque tengo tendencia a comer de determinados alimentos.”

Participant 5 expressed a desire for more concrete guidance from healthcare professionals:

“not just telling me to lose weight. I'd like them to tell me how to do it, how to lose weight.”

“no que me digan si tengo que bajar de peso. A mi me gustaría que me dijeran como tengo que hacerlo para bajar de peso”

Participant 7 sought nutritionist assistance, recounting:

“I even went to a nutritionist, paying for it privately”.

“Alimentación me he ido hasta a un nutricionista pagando yo por privado.”

3.2.2.2. Weight loss strategies: Distinguishing evidence-based approaches from fallacies

A number of weight loss strategies were discussed by participants, and misconceptions regarding effective methodologies were revealed. Their personal experiences with different dietary approaches to weight management were shared.

Among the strategies used by participants is a low-carb diet. According to participant 4:

“I have followed more or less a diet, which is not a particularly strange diet, but some supplements during the mid-morning and mid-afternoon that prevent me from not being so hungry. And then I've also lowered carbs. The very, very basic diet goes.”

“sí que he seguido más o menos una una dieta, que no es una dieta particularmente extraña, sino unos complementos durante la media mañana y media tarde que impiden que hacen no tener tanta hambre. Y después también he bajado carbohidratos. La dieta muy, muy básica va.”

Participants have also used intermittent fasting and removing certain foods from their diets. Participant 9 shared their intermittent fasting experience, saying:

“Now, I'm eating once a day. I'm doing intermittent fasting and only eat once a day.”

“Ahora, estoy comiendo una vez al día. Estoy haciendo ayuno intermitente y solo como una vez al dia”

Participant 11 described eliminating sugar and processed foods:

“So what I've done is eliminate sugar almost entirely; I can't say 100%, but I rarely consume it. I've eliminated carbonated drinks like Coca-Cola, lemonade, and all that. I've also eliminated processed pastries.”

“He eliminado las bebidas carbonatadas, lo que son cocacolas, limonadas, todo esto. He eliminado la bollería industrial.”

3.2.3. Sleep, it's all that Matters.

In the third theme, individuals' sleep experiences are examined. In addition, the impact of OSA symptoms on their sleep quality, interpersonal relationships, and the influence of external factors such as the COVID-19 pandemic.

Participant 1 shared:

“The symptoms are mainly those that my wife has told me about because I don't realize them. She has mentioned that besides snoring, which bothers her the most, she's worried because she has seen me stop breathing several times, and then I start breathing again. I don't notice it, but maybe some of my awakenings are due to apnea.”

“Pues los síntomas son básicamente los que me ha comentado mi mujer, porque yo no me doy cuenta, ella sí que me ha dicho que aparte del ronquido, qué es lo que más le molesta. Ella lo que le preocupa es que me ha visto, pues varias veces, pues que me quedo, que no respiro Y entonces después respiro. ¿Bueno, yo no me doy cuenta, no? Yo no he tenido, no sé si alguno de los despertares porque he leído algo de apnea”

Participant 5 explained their disrupted sleep experience:

“For example, I’m sleeping, and suddenly, I wake up gasping for air. A friend of mine, who I sometimes share a bed with, tells me that sometimes I stop breathing for a few seconds.”

“Yo por ejemplo estoy dormida y de pronto así, y bueno, y una amiga que luego ella, pues compartimos cama, y me dice ella que sí, que vos a veces te quedas como que unos segundos como que no respiras.”

Similarly, Participant 7 said:

“but they tell me that at night I snore and that I stop breathing. My wife says that sometimes I stop breathing and suddenly jump out of bed with my arms raised. I’ve done this several times”

“pero me dicen que por la noche ronco y que me quedo como si no respirara. Mi mujer dice que a veces me quedo sin respirar y de golpe salto de la cama con los brazos hacia arriba. Esto lo he hecho varias veces”

3.2.3.1. Sleep Position Recommendations: A Call for Individualized Approaches

A side-sleeping position was recommended in order to alleviate snoring, according to participants. The generic recommendation, however, did not adequately address their sleep-related concerns.

Participant 5 shared their experience with this advice:

“The only thing they’ve told me is to try to sleep on your side. OK no face up on the side, more than anything, I guess it’s because he broke it, because I also I’ve noticed, I sleep on my side and I think I don’t snore as much as if I’m on my back”

lo único que me han dicho es que que procure dormir de lado. Vale, no boca arriba de lado, más que todo, me imagino que es por lo rompió, porque yo también me he notado, yo duermo de lado y creo que no ronco tanto, como si estoy boca arriba”

3.2.3.2. Understanding the Extensive Effects of Snoring on Sleep Quality and Interpersonal Relationships

In this subtheme, participants discussed the impact of snoring on sleep quality and interpersonal relationships.

As participant 8 described, sleeping in separate rooms helps to get better sleep, but it also creates challenges when monitoring each other's sleep patterns and identifying potential apneas:

“because I snore quite a bit and my wife also have a somewhat light sleep, we decided to sleep in separate rooms, and she can't monitor me because we are in separate rooms, so she can't tell me if I have apneas or not”

“mi mujer también tiene un sueño un poco superficial, superficial, pues entonces decidimos de dormir en habitaciones separadas y el control, claro, no me lo lleva a ella, porque con

siestamos en habitaciones separadas, pues no, no podemos, no me puede decir si tengo apneas, no”

3.2.3.3. Impact of OSA on Daytime Functioning and Sleep Hygiene

This subtheme examined the effects of OSA on participants' daytime functioning, including excessive daytime sleepiness, difficulty concentrating, and poor work performance.

Participant 2 described their experience:

“I have a feeling of tiredness. The feeling of a lack of energy”.

”Tengo sensación de cansancio. Tener la sensación de. De falta de energía. Vale”.

Participant 5 shared:

“The problem is that if I sleep four or five hours, I don't sleep through it because every time I go to the bathroom. So, no, rest well. So that's where I feel a little bit the next day that I'm like I'm tired like.”

“El problema es que si duermo cuatro o 5 horitas no los duermo de tirón porque cada vez estoy yendo al baño. Entonces, no, descanso bien. Entonces ahí es donde me siento un poco al otro día que como que estoy cansada como.”

Participant 8 explained their sleep disruptions:

“Usually, after about 1:30 or 2 hours of sleep, I tend to wake up, often with a nightmare or a feeling of sleeping poorly. Then I fall back asleep and wake up again maybe every half hour or every 20 minutes, something like that.”

“Normalmente, cuando llevo 1:30 h o dos de estas dormido me acostumbro a despertar normalmente con una, una pesadilla o más sensación de estar durmiendo mal. Vale, después me

vuelvo otra vez a dormir y me vuelvo a despertar a lo mejora la media hora o cada 20 minutos, una cosa así alguna”

Participant 10 recounted a dangerous situation:

“I took the highway, and I crashed into a truck. I didn't get hurt, thanks God.”

“me coge la autopista y cuando me quise dar cuenta me postré contra un camión. Me quede dormido.No me pasó nada, gracias a Dios”

3.2.4. Physical Activity: Let's Talk About It

The fourth theme examines the role that physical activity plays in the management of OSA.

3.2.4.1. Navigating the Exercise Landscape: A Call for Professional Guidance

Participants expressed a desire for professional guidance on exercise, as they were unsure about the appropriateness, intensity, and frequency of their physical activities.

Participant 2 shared:

"I suppose you can't start doing the exercise you want the way you want, someone has to guide you on what to do to start."

"Supongo que tampoco puedes empezar a hacer el ejercicio que quieres de la manera que quieras, sino alguien que te guíe de lo que has de hacer para ir haciendo. Vale."

Participant 3 explained their uncertainty:

"Of course, I can do physical activity, but I don't really know if I'm doing the right kind for my age and everything else, or if I'm doing too little or too much, or if I'm doing it regularly enough. If I'm not doing it regularly enough, I don't know. Maybe a professional could guide me a bit more."

"Porque claro, yo puedo hacer actividad física, pero no sé tampoco muy bien si hago la adecuada a mi edad y a todos, y hago pocas y hago demasiadas y la hago con la suficiente regularidad. Si no lo hago con la suficiente regularidad, no lo sé. Quizás un profesional que me orientará un poquito más."

Participant 4 wanted more specific information:

"but I would like to know what is the minimum frequency and time per day and what is the maximum desirable for."

“El mínimo y el máximo de ejercicio físico que son recomendables para recomendaciones muy genéricas, pero me gustaría saber cuál es el mínimo de frecuencia y de tiempo al día y cuál es el máximo deseable para.”

3.2.5. Physical Activity and OSA Symptom Severity

This subtheme explores the relationship between physical activity levels and OSA symptom severity, with participants acknowledging that regular exercise may contribute to a reduction in OSA symptoms.

Some participants were uncertain about the impact of physical activity on their OSA symptoms, as exemplified by Participant 8:

“Well, I can't be sure if it's good or not. I couldn't answer that question because I don't know if it affects”

“Pues no puedo estar seguro si va bien o no, no, no podría. No podría contestarte a esta pregunta porque no sé si influye en este tema”

However, despite this uncertainty, a number of participants believed that regular exercise could help alleviate some symptoms of OSA.

3.2.6. Barriers to Exercise

In this subtheme, a variety of barriers were identified by patients as preventing them from participating in physical activity, including a lack of motivation, time constraints, and physical limitations and comorbidities.

The majority of participants reported that comorbidities, such as arthritis, asthma, and previous surgeries, held them back from engaging in physical activity due to their comorbid conditions.

Participant 5 shared their challenges:

“Because I have several good things, I have arthritis, I have asthma, I have and right now in May I had surgery on my knee, they have given me a prosthesis.”

“porque yo tengo bueno varias cosas, tengo artritis, tengo asma, tengo y ahorita en mayo me operaron de la rodilla, me han puesto una prótesis.”

It was mentioned that time constraints, such as family and work commitments, were some of the barriers to participating in physical activity.

Participant 3 said:

“Time has probably been a significant factor. I've had three children fairly close together, so they've occupied me for about 20 years. Now, they're older, so it's not as much of an issue, but between work and family, it was all-consuming.”

“Seguramente el tiempo ha sido importante. He tenido tres hijos bastantes seguidos, con lo cual me han ocupado. Ahora no, porque ya son mayores. Me han ocupado digamos que durante bastante 20 años. Aparte de trabajar todo era toda la”

Physical limitations, such as comorbidities or workplace constraints, can hinder individuals' ability to engage in physical activity.

Participant 4 mentioned, “I would say that the main reason to not engaging in physical activity at some point is the work environment.”

“diría que la limitación principal para no realizar en algún momento actividad física es el ámbito laboral”

Table 4. An overview of the four main themes, subthemes, and corresponding codes derived from the transcripts.

Table 5. An overview of the four main themes, subthemes, and corresponding codes derived from the transcripts.

Theme	Subtheme	Codes
1. An introduction to obstructive sleep apnoea <i>IO1</i>	1.1 Obstructive sleep apnoea: why do I have it?	- Confusion about OSA etiology - Superficial information from healthcare professionals
	1.2 OSA Severity and Its Influence on Treatment Options	- Treatment options -Why not CPAP
	2.1 Integrating Nutritionists into Comprehensive OSA Management	- Dissatisfaction with unclear weight loss guidelines - Incorporating nutritionists
2. Weight management: how to do it?	2.2 Weight Loss Strategies: Distinguishing Evidence-Based Approaches from Fallacies	- Dissatisfaction with unclear weight loss guidelines - Incorporating nutritionists
	3.1 Sleep Position Recommendations: The Call for Individualized Approaches	- Sleep on your side - Inadequate sleep-related advice
	3.2 Understanding the extensive effects of snoring on sleep quality and interpersonal relationships.	- Effects of snoring on sleep quality - Impact of snoring on interpersonal relationships - Importance of addressing snoring consequences
2. Weight management: how to do it?	3.3 Impact of OSA on Daytime Functioning and Sleep Hygiene Practices	- Daytime sleepiness - Difficulty concentrating - Impaired work performance
	4.1 Navigating the Exercise Landscape: A Call for Professional Guidance	- Need for specialized exercise recommendations - Uncertainty about exercise appropriateness, intensity,
	4.2 Physical Activity and OSA Symptom Severity	- Relationship between physical activity and OSA symptoms - Acknowledgment of exercise benefits - Advocating for physical activity in OSA management
4. Physical Activity: Let's Talk About It	4.3 Barriers to Exercise	Comorbidities Time Work Home responsibilities

DISCUSSION



4. DISCUSSION

This discussion section explores the implications and significance of the research findings in the context of the broader scholarly landscape. In order to clarify the contributions that this study makes to our understanding of the OSA topic, we will examine the results and draw connections with prior studies. Furthermore, we will critically evaluate the study's limitations, and provide insights into potential avenues for future research that could build upon and refine the current knowledge base.

4.1. Literature Review

Our literature review emphasizes the vital role nurses play in the journey of individuals with OSA. The literature review indicates that nurses play a crucial role in the diagnosis, assessment, management, and follow-up of individuals with OSA. The various roles performed by nurses are presented in Figure 5. Nurses are responsible for providing superior standards of care. They impart their expertise in promoting patients' health and wellbeing, educating patients, and integrating evidence-based practices into all settings of care (10).

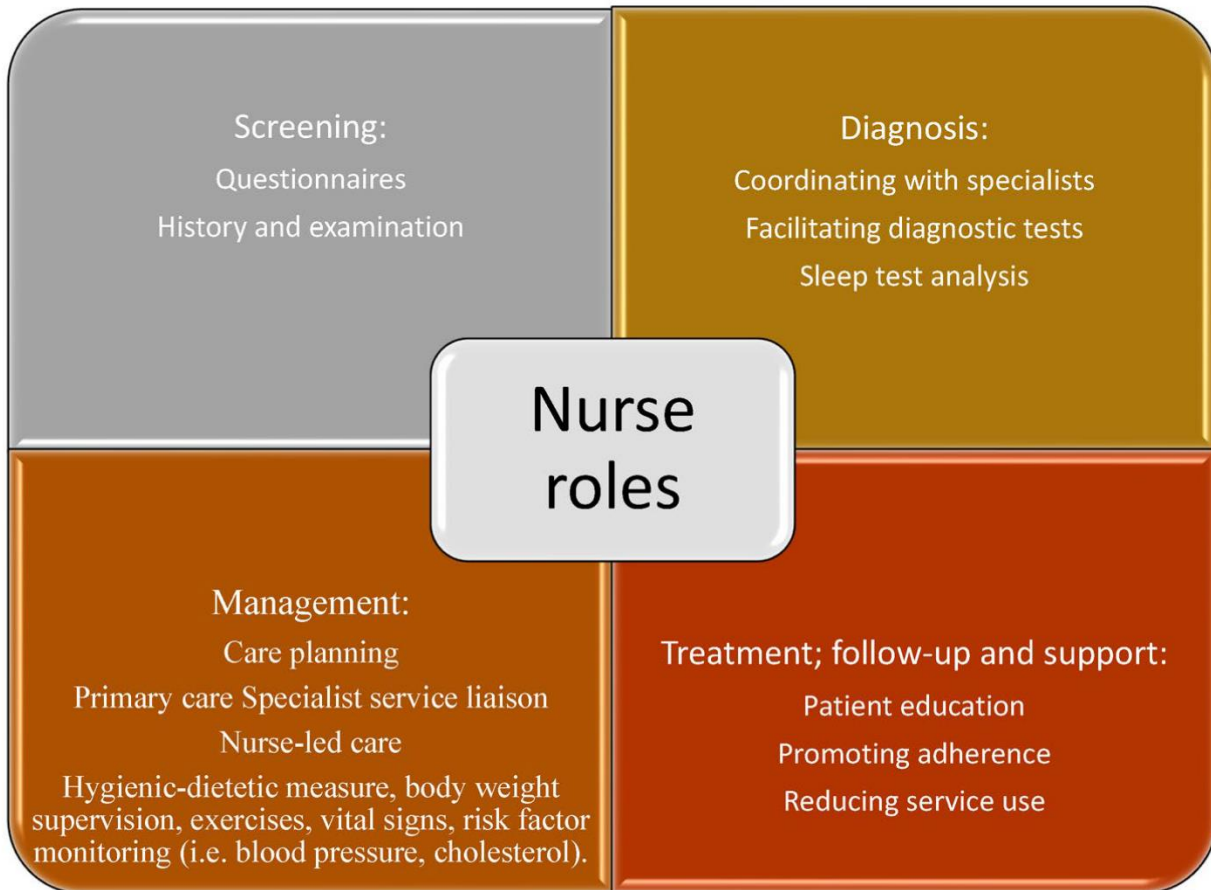


Figure 5. Conceptualisation of nurse roles in care of patients with OSA. From (10).

4.2. Qualitative Study

Below is the discussion of the qualitative study themes in aims to provide an in-depth examination of the themes that emerged from the study results, with a focus on the Health Belief Model.

4.2.1. Theme 1: An Introduction to OSA 101

Integrating empirical findings and theoretical constructs, our study examines participants' awareness and trepidation regarding OSA. As a result, this supports prior assertions suggesting that a lack of knowledge and misperceptions concerning OSA may lead to unwarranted expectations and excessive healthcare demands (288,289). The

findings are consistent with previous research that has highlighted the importance of patient education in the treatment of chronic diseases (290,291).

This study indicates that meeting individuals' educational needs, particularly those related to the origins, causes, and consequences of the condition is critical and can improve treatment patient satisfaction, and health outcomes. The findings of our study are consistent with those of Jamil (2022) and Watach et al. (2021), which also emphasize the importance of personalized and comprehensive patient education in the management of OSA (292,293).

Individuals with OSA frequently misunderstand treatment due to their own perception of need and case severity concerns, especially when healthcare professionals do not recommend CPAP therapy for moderate OSA. The findings of our study are consistent with those raised by Sawyer et al. (2011) (228) regarding the importance of patient involvement in treatment decision-making. It is important that individuals with OSA participate in treatment sourcing and intermediation, which supports the body of literature supporting shared decision-making in healthcare (294).

There are alternative treatments or behavioural interventions that may provide alleviation without the use of PAP-related therapies for some individuals, such as positional therapy (230) pharmacological treatments (251), and lifestyle interventions (295). The findings of this study support the concept that these treatment options should be considered and discussed with the individuals to facilitate informed decision-making, which has been demonstrated to enhance patient satisfaction, positive behavioural outcomes and treatment compliance (296,297).

This phenomenon can be analyzed through the lens of the Health Belief Model (259,260,267), we discern the criticality of perceived susceptibility and severity in health behaviour, reflected in our participants' demand for comprehensive patient education encompassing the pathogenesis, etiology, and repercussions of OSA. These insights will enable healthcare professionals to better address the education needs and create a more collaborative approach to treatment planning.

4.2.2. Theme 2. Weight Management

As a result of the data and theoretical insights, participants' perceptions of the value of behavioral interventions are highlighted, illuminating the benefits perceived within the Health Belief Model. Despite this, our study highlights participants' dissatisfaction with the lack of comprehensive guidance provided by healthcare professionals, which is a crucial perceived barrier to their health.

According to the participants, behavioural interventions can play an important role in improving their health and wellbeing. It has been shown that weight loss interventions have a positive effect on BMI, one of the main determinants of OSA risk (172). However, the study participants were dissatisfied with the lack of guidance they received from healthcare providers in order to achieve their weight loss goals. It is therefore imperative that the healthcare system enhances its capacity to offer comprehensive weight loss guidance and support, particularly through the integration of nutritionists and physical therapists.

The current study indicates that participants who consulted with nutritionists achieved better weight loss outcomes and experienced less OSA symptoms. This is in line with previous research that has demonstrated the importance of individualized diet counselling, and weight management strategies for achieving long-term weight loss success (298,299). There is, however, a need for further research to determine the most effective dietary strategies for OSA individuals.

Further, the current study's findings highlight the challenges OSA patients face in navigating the wide variety of diet recommendations and weight loss programs available.

The importance of this is heightened in the digital age, in which false information is widely disseminated and individuals may adopt ineffective or harmful weight loss practices. This assertion necessitates an enhancement of the healthcare system's capacity to deliver detailed weight loss guidance and support. Such an endeavor, we argue, should involve the integration of nutritional experts and physiotherapists, thereby fostering an interdisciplinary approach to patient care, vital for managing complex conditions like OSA.

4.2.3. Theme 3. Sleep, it's all that Matters

The empirical findings, corroborated by theoretical underpinnings, shine a light on the deleterious impacts of snoring on both the quality of sleep and interpersonal relationships of individuals with OSA. This resonates with prior literature that highlights the pervasive implications of snoring on sleep quality and relationship dynamics (300,301). Furthermore, we enhance this understanding by illuminating how snoring disrupts sleep environments, precipitating help-seeking behaviour—a crucial 'cue to action' within the Health Belief Model.

Our study adds to the existing literature by providing a comprehensive understanding of how snoring can disrupt sleep environments. Furthermore, it affects the quality of sleep of individuals and their partners as well as causing strain in relationships. Moreover, the negative consequences of snoring often act as a catalyst for help-seeking behaviour among OSA individuals, since they recognize the need for intervention in order to address the adverse effects of their snoring. The implications of this insight highlight the importance of incorporating the interpersonal dynamics and consequences of snoring into educational interventions and resources for OSA individuals and their partners.

Moreover, we identified the consequences of OSA on individuals' daytime functioning. The participants reported excessive daytime sleepiness, difficult concentration, and impaired performance at work. One participant had a car accident because of excessive daytime sleepiness. This finding is consistent with previous research that has demonstrated the negative impact of OSA on cognitive function and quality of life (77,115). This study contributes to the literature by highlighting the importance of developing educational interventions for individuals with OSA that address these daytime effects.

4.2.4. Theme 4. Physical Activity: Let's Talk About it.

Our data illustrates the challenges participants face in engaging with physical activity due to various comorbidities and physical limitations, thus underlining the significance of perceived barriers in the Health Belief Model. We advocate for expert

guidance to address these barriers, facilitate a better understanding of the interplay between physical activity and OSA symptom severity, and provide strategies to surmount these obstacles.

According to the findings of our study, comorbidities, and physical limitations, including arthritis, asthma, and prior surgeries, hindered participants' participation in physical activity. This finding is consistent with existing studies that have demonstrated the intricate interplay between OSA and various comorbid conditions (194,302,303). The results of this study emphasize the importance of providing expert guidance, addressing comorbidities, understanding the relationship between physical activity and OSA symptom severity, and overcoming physical activity barriers.

Healthcare professionals can support OSA individuals in managing their overall health and achieving optimal treatment outcomes by addressing comorbidities and their impact on physical activity.

Based on our findings, OSA individuals need tailored educational interventions focused on physical activity. It was noted that participants expressed a desire for expert guidance regarding exercise, as they were uncertain about the suitability, intensity, and frequency of their physical activities. As a result of the integration of these insights into educational programs, healthcare providers and educators can better address the unique challenges faced by OSA individuals and aid them in achieving improved health and symptom management.

The study emphasizes the importance of exercise in managing OSA. In accordance with Aiello et al. (2016) (304), the participants in our study recognized the potential benefits of regular physical activity in alleviating OSA symptoms. Furthermore, they emphasized the need for additional expert guidance.

Our study unveiled several obstacles to exercise faced by OSA patients, such as lack of motivation, time constraints, and physical limitations. In order to overcome these barriers, healthcare professionals may consider strategies such as customized exercise programs, group classes, motivational tools and resources, as well as education on the benefits of physical activity. As a result of addressing the exercise barriers that were

identified in this study, healthcare professionals can better assist OSA patients in achieving their physical activity objectives, ultimately improving their health and quality of life.

Our study proposes tailored educational interventions that underscore the value of physical activity and offer evidence-based advice to OSA individuals. By integrating empirical and theoretical perspectives, healthcare providers can address the unique challenges faced by OSA individuals, contributing to improved health outcomes and symptom management.

4.3. Theoretical discussion

Based on the Health Belief Model (259,260,267), and in alignment with Green et al. (2007) and Eakin and Gladstone (2020), our study adopts an abductive analytical approach, weaving together empirical data and theoretical perspectives to construct a comprehensive narrative around OSA. This method allows us to illuminate the lived experiences of individuals with OSA within the rich framework of the Health Belief Model.

Perceived susceptibility and severity emerge as crucial facets driving OSA individuals to seek comprehensive understanding of their condition. A recognition of the benefits of weight management, improved sleep quality, and physical activity reinforces their commitment to maintaining a healthy lifestyle. However, perceived barriers such as inadequate weight loss guidance and limitations affecting physical activity impede their progress toward a healthy lifestyle. Notably, the disruption in sleep environments and interpersonal relationships resulting from snoring provide potent cues to action, triggering help-seeking behaviour.

Our findings thus underscore the potential of a multidimensional, abductive analytical approach to deliver nuanced insights into the lived experiences of individuals with OSA.

Ultimately, the results of the qualitative study can be interpreted in terms of the Health Belief Model, which emphasizes the importance of addressing individuals' perceptions of susceptibility, severity, benefits, barriers, cues to action, and self-efficacy. Healthcare professionals are able to better support OSA individuals in managing their

condition and improving their health outcomes through the development of tailored educational materials and interventions that take into account these factors.

4.4. Recommendations and Implications

The third objective of this PhD thesis was to formulate recommendations to guide the creation of educational materials for the individuals with OSA as well as the implications.

4.4.1. Recommendations

It is essential that educational materials provide comprehensive and personalized information about OSA, including its causes, symptoms, consequences, and treatment options. It will enable patients to make informed decisions regarding their care and manage their condition more efficiently.

There are several misconceptions about OSA. These include the belief that it only affects overweight individuals, meal starving technique or that it is not a serious medical condition. As a result of dispelling these myths, patients and their families will be able to gain a deeper understanding of the disorder and the importance of seeking appropriate treatment.

Information about alternative treatments and behavioral interventions for OSA, such as positional therapy, pharmacological treatment, and lifestyle interventions, should be included in educational resources. In collaboration with healthcare professionals, individuals will be able to explore various options and make informed decisions about their care.

It is essential that the materials provide guidance on effective weight management strategies that are tailored to the specific needs of OSA individuals. There may be information on nutrition, portion control, and exercise included. In addition, working with nutritionists and other healthcare professionals may contribute to long-term weight loss success.

It is important that educational resources provide information about developing adaptive exercise programs that take into account the comorbid conditions and physical limitations of patients. In some instances, this may involve presenting examples of low-impact exercises, aquatic therapy, or other modified activities that are appropriate for patients with specific health conditions.

OSA individuals and their partners should be made aware of the interpersonal consequences of snoring in educational materials. Snoring may be mitigated through communication strategies, sleep environment modifications, and coping mechanisms.

It is important that resources are developed that explore OSA's daytime consequences, such as excessive sleepiness, difficulty concentrating, and impaired performance at work. Furthermore, they should be able to provide practical coping strategies and techniques in order to improve their day-to-day functioning and overall quality of life.

To meet diverse learning preferences and increase accessibility, educational resources should be developed in digital and multimedia formats in addition to traditional print materials. A variety of interactive websites, mobile applications, videos, and podcasts might be included in this category.

Based on these findings, educational materials can be developed which will better meet the needs of OSA individuals and their families, ultimately leading to better patient outcomes.

4.4.2. Implications

4.4.2.1. Implications on the Policy Level

The insights derived from semi-structured interviews with OSA individuals highlight several policy-level implications that can be addressed in order to improve OSA management and to enhance the quality of health care provided to individuals. Policies should be developed that provide comprehensive, evidence-based education on OSA for individuals and healthcare professionals that address salient subjects such as its etiology,

consequences, and treatment options. Consequently, healthcare professionals will be better able to manage OSA, resulting in better outcomes for individuals.

The promotion of shared decision-making and facilitation of collaboration between healthcare providers and individuals is important for improving treatment adherence and patient satisfaction. Additionally, policymakers should advocate for the inclusion of multidisciplinary care teams in OSA management, including nutritionists, physical therapists, and specialists from different fields. As a result, a holistic, integrated care approach can more effectively address OSA patients' intricate needs.

It is also important that policies allocate resources for nutrition and exercise counseling for OSA individuals, so that qualified professionals can provide them with personalized advice and support. Furthermore, healthcare professionals should be provided with guidelines for identifying and treating potential comorbidities that may affect the ability of OSA individuals to participate in physical activity. In addition to comprehensive health assessments and adaptive exercise programs, guidelines should emphasize monitoring individuals with comorbid conditions on a continuing basis.

Healthcare professionals will be able to provide superior care if research is supported on effective treatment strategies for OSA, including alternative treatments and behavioral interventions. Moreover, policymakers should support public awareness campaigns to educate the public on the signs, symptoms, and consequences of OSA, leading to earlier diagnosis, timely intervention, and better outcomes.

In addressing these policy-level implications, potential weaknesses and areas for improvement should be considered. It may be necessary to ensure diverse perspectives, evaluate cost-effectiveness of interventions, address potential implementation barriers, monitor and evaluate policy outcomes, foster collaboration and information sharing, and address socioeconomic disparities in access to OSA services. Considering these factors can help policymakers create an environment conducive to improved understanding, management, and treatment of OSA, ultimately resulting in improved patient outcomes and enhanced quality of care.

4.4.2.2. Implications for Research

Based on the findings of the semi-structured interviews with OSA individuals, the following implications can be drawn for future research on the management of OSA:

The findings of our study highlight the importance of comprehensive and personalized patient education in the management of OSA. Future research should focus on identifying the most effective means of providing patient education, including the use of digital platforms, multimedia resources, and group sessions. Furthermore, research should be focused on maximizing patient participation in treatment decisions, particularly when it comes to alternative treatments and behavioral interventions.

The findings of this study demonstrate the importance of individualized weight loss guidance for individuals suffering from OSA. Future research is needed to determine the most effective dietary strategies for OSA individuals, while taking into account individual differences and preferences. In addition to providing tailored support to individuals with OSA, nutritionists can also play a significant role in the integration of multidisciplinary teams into weight loss programs.

Based on our findings, we believe that tailored exercise programs are needed to accommodate the comorbidities and physical limitations of OSA individuals. There is a need for further research to examine how such programs can be developed and implemented, as well as their effectiveness in improving OSA symptoms and overall health. Furthermore, research should focus on creating innovative strategies to overcome exercise barriers experienced by OSA individuals, such as motivational tools, group sessions, and targeted educational materials.

This study provides insight into the interpersonal consequences of snoring among OSA individuals and their partners. Further research should be conducted to examine the dynamics of these relationships, investigating the impact of snoring on the quality of sleep, the well-being of the partner, and the satisfaction with the relationship. In addition, research should be conducted on the effectiveness of interventions and resources aimed at mitigating the negative effects of snoring on OSA individuals and their partners.

It is possible to gain valuable insight into the trajectory of OSA individuals over time through longitudinal research designs. This includes changes in symptom severity, adherence to treatment, and general health. Studies examining these aspects longitudinally can identify patterns and predictors of successful OSA management, which can be used to optimize treatment plans.

It is recognized in our study that external factors, such as the COVID-19 pandemic, may have an impact on sleep patterns and the diagnosis of OSA. Further research should examine how external factors affect OSA patients, including access to healthcare, diagnosis, and adherence to treatment.

4.4.2.3. Implications for Healthcare Professionals: Nurses, Nutritionists, and Physical Therapists

The nurse plays a crucial role in providing patient education regarding the causes, consequences, and management of OSA. Based on our findings, it is evident that personalized, comprehensive patient education plays a significant role in addressing the knowledge gaps and misconceptions associated with OSA. In order to improve treatment adherence, patient satisfaction, and health outcomes, nurses should prioritize clear communication and encourage patient participation in treatment decision-making. This should include considering alternative treatments or behavioral interventions.

Nutritionists can provide valuable support to OSA individuals in achieving their weight loss goals and managing their condition. The results of our study emphasize the importance of individualized dietary counseling and physical activity interventions for the long-term success of weight loss programs. The role of nutritionists is to provide tailored dietary guidance to OSA individuals, considering their unique circumstances, and helping them navigate the plethora of diet recommendations and weight management programs available. It is possible to enhance the effectiveness of these interventions by collaborating with other healthcare professionals.

A physical therapist can make a significant contribution to the management of OSA by designing and implementing exercise programs that are customized to accommodate the comorbidities and physical limitations of patients. Our findings emphasize the

importance of addressing barriers to exercise, such as a lack of motivation, a lack of time, and physical limitations. Individuals with OSA should be assisted by physical therapists in developing strategies for overcoming these barriers through tailored exercise programs, group sessions, motivational tools and resources, and education on the benefits of physical activity. It is important for physical therapists to address these challenges in order to be able to effectively support OSA individuals in achieving their physical activity goals and improving their overall health and well-being.

Nurses, nutritionists, and physical therapists can enhance the care and support they provide to OSA patients by incorporating insights from this study into their practice. This will ultimately result in improved patient outcomes and quality of life.

4.5. Limitations

This section of the PhD thesis describes the limitations and shortcomings of the literature review, the qualitative study, and the overall research project. A comprehensive analysis of the limitations is presented in this thesis in order to provide a comprehensive understanding of the limitations of the sources and methods used during the research, as well as the limitations inherent in the study itself. As a result of acknowledging these limitations, it is possible to identify areas for future research and improvement, which will contribute to the advancement of knowledge in the field.

4.5.1. Overall PhD Project Limitations

1. Impact of COVID-19 on the thesis-3 years PhD programme:

Time Constraints: The COVID-19 pandemic resulted in a significant loss of time, as several months were spent with little progress on the thesis. As a result, alongside the first year spent preparing the study proposal and working slowly on the systematic review, time constraints imposed by the three-year, non-renewable contract with Lleida University were exacerbated.

2. Systematic Review Delays:

Duplication of Research: The systematic review of the effectiveness of eHealth interventions for OSA individuals was expected to be completed by January 2023. However, the publication of similar systematic review by other authors, with approximately similar objectives, necessitated a reassessment of the systematic review. Therefore, the supervisors decided to postpone the review and consider potential modifications to the objectives.

3. Study Protocol Exclusion:

Moore4Medical Project: This PhD thesis included a study protocol for the European project called Moore4Medical. Unfortunately, the supervisors determined that incorporating the study protocol would be inappropriate for the thesis as the main focus of the project is patient education through e-health tool, resulting in its exclusion.

4. Educational Materials Preparation:

Integration with European Project: The PhD student developed educational materials based on the thesis findings for individuals with OSA. The educational materials were intended to be video recorded and incorporated into an eHealth platform within the aforementioned European funded project. Additionally, the student prepared paper-format education brochures for individuals with OSA based on the qualitative study's findings. As the European study protocol is not included in this thesis the presentation of the developed education materials is not feasible.

As a result of the COVID-19 pandemic, non-renewable contract constraints, and the need to adjust the research plan, the development of this PhD thesis was limited in many ways. As a result of these challenges, the thesis' progress and direction were significantly impacted.

4.5.2. Literature Review Limitations

The scope of the literature review was limited by the time frame of the articles reviewed, as only articles published between 2015 and 2023 were included (10). Due to this

constraint, there may have been a limited pool of articles that may have hindered the identification of a more comprehensive understanding of the role of nurses in the management of OSA.

4.5.3. Qualitative Study

The semi-structured interview study with OSA individuals provided valuable insights into the experiences, needs, and challenges. However, a few limitations should be considered when interpreting the results:

Diversity: The participants may not adequately represent the diversity of OSA individuals in terms of age, gender, ethnicity, and OSA severity (Moderate only).

Cross-Sectional Design: The cross-sectional design of this study restricts the ability to observe changes in experiences, needs, and challenges over time and to infer causality.

Focus on Adult OSA individuals: This study focuses on adult OSA individuals, and the findings may not apply to paediatric OSA or to other subgroups within the OSA population.

This study, despite its limitations, provides valuable insights into the experiences of OSA individuals. These insights can be used to inform the development of educational materials, clinical practices, and future research in this area.

There are several subgroups within this category, including paediatric OSA individuals, geriatric OSA individuals, pregnant OSA individuals, individuals with comorbid mental health conditions, obese OSA individuals, and individuals from multicultural backgrounds. This subpopulation of OSA individuals can be included in the scope of research in order to facilitate a more comprehensive understanding of OSA. This will facilitate the development of effective, tailored interventions and healthcare approaches suited to diverse individuals' populations.

The social determinants of health, which include socioeconomic status, access to healthcare, social support systems, and living conditions, can have a significant influence on an individual's experience with OSA and health outcomes.

We focused our study on lifestyle interventions and themes associated with the Health Belief Model based on the objectives. We recognize, however, that social determinants of health also play an important role in the management of OSA which is not elaborated on in detail in this study.

It would be beneficial for future studies to consider these social determinants in detail to gain a more comprehensive understanding of OSA management and the impact it has on individuals' well-being. To develop more targeted and effective interventions that address not only lifestyle aspects but also the broader societal context in which individuals with OSA live and seek care, researchers and healthcare professionals must explore how social factors interact with OSA and its management.

4.5.4. Trustworthiness

During qualitative research, trustworthiness is defined as the extent to which the research findings are credible, transferable, dependable, and reliable (305).

Several strategies were used to ensure trustworthiness, including member checking, and reflexive journaling (306). By utilizing a collaborative approach between RA, MM and FP, triangulation was enhanced, thereby enhancing the study's credibility and rigor.

Through reflexive journaling, the researchers were able to reflect on their positionality, biases, and potential influence on the research process. The interviewer (OM) is a doctoral candidate fluent in both Spanish and Catalan who was trained to minimize bias and maintain consistency throughout the interview process. In order to enhance the study's rigor, all researchers-including the interviewer-actively acknowledged and addressed potential biases, assumptions, and preconceptions during the research process.

4.6. Conclusion

The findings of the literature review indicate that nurses can significantly contribute to the management of OSA through a variety of crucial tasks, including screening, assessment, diagnosis, follow-up, education of patients, and coordination with other healthcare providers. These nurse-led interventions have been shown to be highly effective

in promoting patient adherence to PAP therapy in both sleep units and primary care settings. The review also found that the primary care model is more cost-effective in the management of OSA patients than the sleep unit model. The results of the review highlight the significant role that nurses play in the management of OSA, as well as the importance of considering the nurse's contribution in the design and implementation of patient-centered care plans.

Ultimately, the semi-structured interviews conducted with OSA individuals have provided valuable insight into the varied experiences, challenges, and educational needs of individuals with this complex condition. As a result, crucial gaps have been identified in individuals' understanding of OSA, including its etiology, symptoms, and treatment options. The study also shed light on how the condition affects individuals' daily functioning, interpersonal relationships, and overall quality of life.

The interview data have been thoroughly analyzed, and several key areas have been identified that need to be addressed in the development of educational materials and interventions for individuals with OSA. The themes provide comprehensive information, addresses misconceptions, investigates alternative treatment options and behavioral interventions, such as weight management, promotes adaptive exercise programs, addresses interpersonal dynamics and snoring management. It is important to acknowledge that the results of our study represent a single snapshot of OSA Individuals' experiences and educational needs. Future research should explore the perspectives of diverse OSA populations in order to build upon these findings.

Overall, this study contributed to a better understanding of OSA individuals' experiences and educational needs. This paves the way for more effective and targeted educational materials and interventions.

4.7. Ethical Considerations

This study received approval from the Hospital Universitario Arnau de Vilanova's Institutional Review Board with approval number (CEIC-2511). Informed consent was obtained from all participants before conducting interviews, with assurances that

participation was voluntary, and participants could withdraw at any time without repercussions. All data were anonymized and securely stored to ensure participants' confidentiality and privacy.

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ANNEXES



APPENDIX A: Nursing Professionals' Role in the Comprehensive Management of Obstructive Sleep Apnoea: A Literature Review

Annex 1. Nursing Professionals' Role in the Comprehensive Management of Obstructive Sleep Apnoea: A Literature Review (10)



Review

Nursing Professionals' Role in the Comprehensive Management of Obstructive Sleep Apnoea: A Literature Review

Rabie Adel El Arab^{1,2}, Manuel Sánchez-de-la-Torre^{1,3,4,*}, Fran Valenzuela-Pascual^{1,2,5,*}, Esther Rubinat-Arnaldo^{1,2,5}, Joan Blanco-Blanco^{1,2,5}, Francesc Rubi-Carnacea^{1,2,5}, Oriol Martínez-Navarro^{1,2}, Olga Mediano^{4,6,7} and Montserrat Gea-Sánchez^{1,2,5}

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Abstract: Background: obstructive sleep apnoea is a common and burdensome condition, characterised by obstruction of the airway during sleep at the level of the pharynx, which may occur with symptoms or without any symptoms. The most common place for obstructive sleep apnoea management is in specialised sleep units. Aim: to identify what is known about nurses' role in comprehensive management of obstructive sleep apnoea, and to determine the effectiveness of nurse-led interventions as well as the cost effectiveness of management of obstructive sleep apnoea in primary care settings. Methods: a scoping review was carried out by searching PubMed/ Medline, CINAHL, Scopus, Cochrane Database of Systematic Reviews and ScienceDirect. The study findings were synthesised using a thematic analysis approach. Results: In this review, 12 articles were included, and three key themes emerged, namely the role of nurses in the diagnosis of obstructive sleep apnoea, role of nurses in the follow up and support of obstructive sleep apnoea patients, and role of nurses in the management of obstructive sleep apnoea in primary care and the cost-effectiveness. Conclusion: Nurses can play a critical role in obstructive sleep apnoea. There are many ways in which nurses can contribute, including screening, assessment, diagnosis, promotion of therapy adherence, and following up with patients, including monitoring for any side effects associated with the CPAP machine, such as irritation of the face. Additionally, nurses can provide patient education and coordinate with other health care providers. Nursing interventions such as patient education have been demonstrated to be highly effective in promoting adherence to PAP therapy in both sleep units and primary care settings. Based on the findings of this review, the primary care model is more cost-effective than the sleep unit model in the management of obstructive sleep apnoea patients. The role of nurses in managing Obstructive Sleep Apnoea in both paediatric and adult populations shares similarities, but also includes differences that should be carefully considered and explored. In this review, one article only explored the role of nurses in paediatric OSA care. Thus, there is a need to identify the potential role of nursing in the comprehensive management of paediatric obstructive sleep apnoea, as well as to explore alternative cost-effective approaches that include primary care settings.

Keywords: obstructive sleep apnoea; adult; paediatric; chronic diseases; clinical care; clinical management; personalised medicine; precision medicine; nursing care; sleep nurse



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APPENDIX B: Information Sheet

HOJA DE INFORMACIÓN

Esta hoja informativa se dirige a los pacientes derivados a la unidad del sueño del Hospital Universitario Arnau de Vilanova de Lleida – Santa Maria. Se les invita a participar en el siguiente estudio piloto llevado a cabo por el equipo de investigación del Instituto de Investigación Biomédica de Lleida (IRB) conjuntamente con la Facultad de Enfermería y Fisioterapia de la Universidad de Lleida

Título del estudio: Efectividad de una intervención *eHealth* sobre la tensión arterial, la calidad del sueño y la actividad física en pacientes con apnea obstructiva del sueño en Lleida.

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Investigadores: Oriol Martínez Navarro, Dr. Manuel Sánchez de la Torre, Dr. Ferran Barbé Illa, Dr. Joan Blanco Blanco, Dra. Esther Rubinat Arnaldo, Dr. Francesc Rubí Carnacea, Dr. Gerard Torres, Dr. Jordi de Batlle, Dra. María Masbernat Almenara, Blanca Manuel, Rabie Adel El Arab, Francisco José Verdejo, Dra. Jessica González.

Centro: Universidad de Lleida. Facultad de Enfermería y Fisioterapia

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Introducción

Nuestro grupo de investigación de la Facultad de Enfermería y Fisioterapia de la Universidad de Lleida junto al IRB-Lleida pretende explorar los desafíos que presentan el uso de sensores y dispositivos de tecnología de la salud para pacientes con apnea del sueño, profesionales de la salud y cuidadores informales, para acabar desarrollando una herramienta educativa biopsicosocial que formará parte de una plataforma web. De esta forma, se podrá evaluar la eficacia de una intervención educativa, a través de la misma, en pacientes adultos diagnosticados de apnea obstructiva del sueño.

A continuación, va a recibir información y va a ser invitado a participar el estudio piloto. Antes de dar su consentimiento lea con atención esta hoja informativa. No tiene que responder hoy, puede consultar con el equipo de investigación u otros profesionales ajenos antes de tomar una decisión. Si tiene dudas, formule todas las preguntas que sean necesarias.

Participación Voluntaria

Su participación en esta investigación es totalmente voluntaria. Usted puede elegir si quiere o no participar. Su decisión no tendrá repercusiones en su actividad laboral. De aceptar participar, podrá abandonar el estudio en cualquier momento con total libertad y sin perjuicio alguno.

Descripción General del Estudio

Se trata de un estudio piloto en el que pretendemos evaluar la efectividad del algoritmo usado en el dispositivo electrónico de muñeca en relación con la recogida de datos de diferentes parámetros físicos. Por este motivo se le pedirá que use la pulsera electrónica durante un mes, tanto tiempo como sea posible, para recoger el máximo de información posible.

En la misma sesión, se realizaría una entrevista semiestructurada para la realización de un estudio cualitativo. En esta investigación, se pretende conocer con la máxima profundidad posible, su experiencia en relación a la apnea obstructiva del sueño.

Beneficios y Riesgos Derivados de su Participación en el Estudio

No se espera que le aporte ningún efecto positivo, ya que se trata de un estudio para la recogida de información para mejorar la herramienta y poder ofrecerle un mejor servicio de rehabilitación en un futuro.

Debido a que su participación en el estudio no implica ninguna intervención física, no existe ningún riesgo derivado del estudio para el profesional sanitario o participante.

Confidencialidad

La gestión, la comunicación y la cesión de los datos de carácter personal de todos los participantes se ajustará a lo dispuesto en la Ley Orgánica de protección de datos de carácter personal 3/2018 en los artículos 4, 5, y 6. De acuerdo con lo que se establece en dicha legislación, usted puede ejercer los derechos de acceso, modificación, oposición y cancelación de datos, para lo cual deberá dirigirse a la persona de contacto.

La información recogida durante la investigación será totalmente confidencial. Esta será recogida por los mismos dispositivos eHealth y a través de ellos enviada directamente a un ordenador al cuál solo tendrán acceso el investigador principal y los miembros del equipo que gestionan el dispositivo electrónico. Los datos estarán identificados mediante un código, de forma que nadie pueda asociar la información a su persona.

Le pediremos también si es posible grabar el audio durante la entrevista semi estructurada. Esto se debe a el posterior análisis de la información, con el objetivo de mejorar el tratamiento que podamos ofrecerle en un futuro. Esta grabación se guardará y no se utilizará para ningún otro fin.

El acceso a su información personal quedará restringido al personal del estudio, autoridades sanitarias, al Comité Ético de Investigación Clínica y personal autorizado por el investigador, cuando lo precisen para comprobar los datos y el procedimiento del

estudio, pero siempre manteniendo la confidencialidad de estos de acuerdo a la legislación vigente. Excepcionalmente, en caso de requerimiento legal será relevada su identidad.

Compensación Económica

Su participación en el estudio no le supondrá ningún gasto. Por otro lado, tampoco recibirá ninguna compensación económica ya que su participación no le supone ningún riesgo para su salud.

Derecho a Negarse o Retirarse

Usted no tiene obligación de participar en la presente investigación si no desea hacerlo. En el caso de aceptar, podrá dejar de participar en cualquier momento. Si decide retirar el consentimiento para participar en este estudio, ningún dato nuevo será añadido a la base de datos y puede exigir la destrucción de todos los datos identificables previamente registrados. Serán respetados todos sus derechos.

Con Quien Contactar

En caso de dudas durante y posteriormente a su participación en el estudio puede contactar con la persona responsable de la investigación.

Francesc Valenzuela Pascual, Doctor en salud.	Col.2703
fran.valenzuela@udl.cat	692864540
Delegado de Protección de Datos	
Fundació TicSalut i Social	
Dpd@ticsalutsocial.cat	935532642

Otra Información Relevante

Cualquier información que surja durante la investigación y pueda afectar a su participación, le será comunicada por el investigador lo antes posible.

El investigador podrá excluir del estudio si lo considera oportuno a los participantes que no sigan el procedimiento del estudio establecido, o dejen de cumplir los criterios de elegibilidad. En el caso de ser excluido, usted recibirá una explicación adecuada del motivo que ha ocasionado su retirada del estudio.

Al firmar la hora de consentimiento adjunta, se compromete a cumplir con el procedimiento del estudio que se le ha expuesto anteriormente.

APPENDIX C: Consent Form

CONSENTIMIENTO

Título del estudio: Efectividad de una intervención *eHealth* sobre la tensión arterial, la calidad del sueño y la actividad física en pacientes con apnea obstructiva del sueño en Lleida.

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Su consentimiento significa que nos autoriza a realizar esta sesión.

Usted puede retirar este consentimiento cuando lo desee. Firmarlo no le obliga a participar en el estudio. De su rechazo no se derivará ninguna consecuencia adversa respecto a la calidad del resto de la atención médica recibida. Antes de firmar, es importante que haya leído atentamente la información contenida en la hoja informativa del estudio, que ha recibido junto con este consentimiento.

Si tiene alguna duda o necesita más información no dude en decírnoslo, le atenderemos con mucho gusto.

Consentimiento informado

DATOS DEL/ DE LA PACIENTE

Apellidos y nombre del / de la paciente:

D.N.I.: _____

Teléfono: _____

Dirección: _____

**PROFESIONAL QUE INTERVIENE EN EL PROCESO DE INFORMACIÓN Y / O
CONSENTIMIENTO:**

Apellidos y nombre: _____ Firma: _____

Fecha: _____

Consentimiento

Yo, D / Dña. _____ manifiesto que estoy conforme con el estudio que se me ha propuesto. He leído y comprendido la información contenida en la hoja informativa que se me ha proporcionado. He podido preguntar y aclarar todas mis dudas. Por eso he tomado consciente y libremente la decisión de participar. También sé que puedo retirar mi consentimiento cuando lo estime oportuno.

Autorizo a los investigadores a grabar el audio de la sesión, que se utilizará para un estudio cualitativo en relación a la experiencia de los pacientes con apnea obstructiva del sueño. Sí No

En _____ el ____ de _____ de 2022

El/La PACIENTE

Firmado

Revocación del consentimiento

Yo, _____, de forma consciente y libre he decidido retirar mi consentimiento a participar en este estudio.

En _____ el ____ de _____ de 2022

El/La PACIENTE

Firmado