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Recently diagnosed obstructive sleep apnea patients: Knowledge, mindset, and journey

Pauline Vanhoof

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Promotor(s)
Elke Van de Casteele, PhD

Copromotor
dr. Ellen collier

Coach
dr. Ellen collier

Drie Eikenstraat 655, 2650 Edegem / Dienst Mond-, Kaak- en Aangezichtschirurgie / Universitair Ziekenhuis Antwerpen

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Abbreviations

ADB	Abdominal movements
AHI	Apnea hypopnea index
APAP	Auto titrating positive airway pressure
BMI	Body mass index
BiPAP	Bilevel positive airway pressure
BRP	Barbed reposition pharyngoplasty
CBCT	Cone Beam Computer Tomography
CBT	Cognitive behavioural therapy
CO_2	Carbon dioxide
CPAP	Continuous positive airway pressure
DISE	Drug-induced sleep endoscopy
ECG	Electrocardiogram
EEG	Electro-encephalogram
EOG	Electro-oculogram
EMG	Electro-myogram
ENT	Ear, nose, throat
ESS	Epworth Sleepiness Scale
ICF	Informed consent form
IQR	Interquartile range
MAD	Mandibular advancement device
MDA	Mean disease alleviation
MMA	Maxillomandibular advancement
NA	Negative affectivity
OSA	Obstructive sleep apnea
OAHI	Obstructive apnea-hypopnea index
PALM	P_{crit} - Arousals threshold - Loop gain - Muscle responsiveness
PAP	Positive airway pressure
P_{crit}	Critical closing pressure
POSA	Positional obstructive sleep apnea
PSG	Polysomnography
PT	Positional therapy
REM	Rapid eye movement
SaO_2	Transcutaneous oxygen saturation
SI	Social inhibition
SPT	Sleep position trainer
THO	Thoracic movements
TMD	Transmandibular distraction
TPD	Transpalatal distraction
UAS	Upper airway stimulation
UPPP	Uvulopalatopharyngoplasty
UZA	Universitair ziekenhuis Antwerpen
VAS	Visual analogue scale

Abstract

Introduction. Obstructive sleep apnea (OSA) is one of the most common sleep-related breathing disorders affecting nearly one billion people worldwide. It is characterized by recurrent collapse of the upper airway during sleep, causing hypopneas and apneas. This results in various sleep-related and daytime symptoms and can lead to long-term cardiovascular and cerebrovascular consequences. Due to these health and social consequences, effective diagnosis and treatment is needed. This master thesis investigated the knowledge, mindset, and journey of recently diagnosed OSA patients, with the focus on three treatment options, including continuous positive airway pressure (CPAP), mandibular advancement device (MAD), maxillomandibular advancement (MMA).

Methods. To investigate knowledge and mindset of OSA patients, a questionnaire was used comprising various sections including demographics, OSA and treatment knowledge, treatment choices and factors influencing the treatment choice. Data from this questionnaire was combined with results from the overnight polysomnography (PSG) analysis. To investigate the treatment trajectory, the electronic patient records of a group of patients has been reviewed. The finale dataset, including demographics, PSG results, referring practitioners, treatment proposals and treatment choices was used to conduct analysis. Analysis used in this study were nominal logistic regressions and chi square analyses.

Results. Knowledge and mindset: Among the total cohort of 82 patients used for analysis, the level of OSA (42.7%) and treatment (average 45.1%) knowledge was observed to be moderate. OSA, CPAP and MAD knowledge tended to be higher in younger individuals. Regarding treatment choices, patients mainly chose CPAP treatment (69.5%), followed by MAD (65.9%) and MMA (20.7%) was the least preferred treatment. Patients would mainly initiate treatment to be better rested and find a good explanation from a doctor the most important during this process. Therapy related characteristics and side-effects tend to have an important role in the treatment choice, since these showed significant associations with the treatment choices made by the participants in this study.

Journey: When examining the treatment journey of a group of 72 patients, it became clear the age, BMI and OAHI of patients significantly influence the treatment proposals. Older patients, with higher BMI and OAHI values were more likely to receive a CPAP proposal, than any other treatment proposal. In addition, the reimbursement eligibility significantly determined whether a patient received a CPAP proposal, since eligible participants all received CPAP as standalone (90.2%) or combined proposal (9.8%), while no standalone CPAP proposals were provided to the none-eligible group. Only 3 participants (10.7%) received a combined proposal including CPAP. Whether a patient initiated treatment or not appeared to be influenced by the age and OAHI of the patient, since older participants with higher OAHI values were more likely to initiate treatment. Out of the 38 participants that initiated treatment, 37 (97.4%) of them followed the treatment proposal. Most of them (94.7%) chose CPAP therapy, while the other two (5.3%) opted for MAD treatment.

Conclusion. This study examined the knowledge, mindset, and treatment journey of individuals recently diagnosed with OSA. The findings clearly indicate that the average baseline OSA and treatment knowledge of recently diagnosed OSA patients is moderate. As a result, it is crucial to provide patients with a comprehensive explanation of all available treatment options following their diagnosis. Furthermore, the study highlights the significance of involving patients in the decision-making process regarding treatment, since it has been found that patients have different preferences when it comes to treatment options. Thus, when proposing a treatment to a patient, it is important to not only consider the polysomnography results, and to automatically choose the gold-standard treatment, but also to prioritize patient's preferences. By taking these into account, it might become possible to initiate the appropriate therapy for the patients more rapidly, leading to enhanced satisfaction and both improved compliance and adherence.

Nederlandse samenvatting

Obstructieve slaapapneu (OSA) is een van de meest voorkomende slaap-gerelateerde ademhalingsstoornissen en treft wereldwijd bijna één miljard mensen. Het wordt gekenmerkt door herhaalde ineenstorting van de bovenste luchtwegen tijdens de slaap, wat leidt tot hypopneu en apneu. Dit resulteert in verschillende slaap en dag gerelateerde symptomen en kan op lange termijn cardiovasculaire en cerebrovasculaire gevolgen hebben. Vanwege deze ernstige gevolgen is een effectieve diagnose en behandeling noodzakelijk. Deze masterproef onderzocht de kennis, mindset en het behandelingstraject van recent gediagnosticeerde OSA patiënten, met de focus op drie behandelopties, waaronder continuous positive airway pressure (CPAP), mandibulair repositie apparaat (MAD) en maxillo-mandibulaire advancement (MMA).

Om de kennis en mindset van OSA-patiënten te onderzoeken, werd een vragenlijst gebruikt die verschillende secties omvatte, waaronder demografische gegevens, kennis over OSA en de behandelingen, behandelingskeuze en factoren die de behandelingskeuze beïnvloeden. Gegevens uit deze vragenlijst werden gecombineerd met resultaten van het polysomnografisch onderzoek en gebruikt voor de analyse. Om het behandelingstraject in kaar te brengen, werden de elektronische patiëntendossiers van een groep patiënten bekeken. De uiteindelijke dataset, inclusief demografische gegevens, PSG-resultaten, verwijzende behandelaars, behandelingsopties en behandelingsopties, werd gebruikt om regressie- en Chi-kwadraatanalyses uit te voeren om mogelijke verbanden te beoordelen.

Kennis en mindset. Bij de totale cohort van 82 patiënten, werd een gematigd niveau van kennis over OSA (42,7%) en de behandeling (gemiddeld 45,1%) waargenomen. De kennis voor OSA, CPAP en MAD bleek hoger te zijn bij jongere individuen. Wat betreft behandelingsopties kozen patiënten voornamelijk voor CPAP-behandeling (69,5%), gevolgd door MAD (65,9%) en MMA (20,7%) was de minst gekozen behandeling. Patiënten wouden voornamelijk behandeling starten om beter uitgerust te zijn en beschouwden een goede uitleg van een arts als belangrijkste factor tijdens dit proces. Therapie-gerelateerde kenmerken en bijwerkingen speelden een belangrijke rol bij de keuze van een behandeling, aangezien deze significant geassocieerd waren met de behandelingsopties van de deelnemers in deze studie.

Traject. Oudere patiënten met hogere BMI- en OAHI-waarden kregen vaker een CPAP-voorstel dan enig ander behandelvoorstel. Bovendien bepaalde het recht op terugbetaling of een patiënt een CPAP-voorstel ontvangt. Alle deelnemers die in aanmerking kwamen voor terugbetaling kregen een voorstel dat ofwel uitsluitend bestond uit CPAP, of waarbij er meerdere opties werden gegeven, inclusief CPAP. Voor deelnemers zonder terugbetaling werd er geen enkel voorstel gegeven dat alleen uit CPAP bestond, en slecht 3 voorstellen waar CPAP een van de behandelopties was. Oudere deelnemers met hogere OAHI-waarden bleken vaker een behandeling te startten. Van de deelnemers die met een behandeling begonnen, volgden 97,4% het behandelvoorstel waarbij 94,7% koos CPAP-therapie, terwijl de 5,3% koos voor MAD-behandeling.

Deze studie onderzocht de kennis, mindset en het behandelingstraject van individuen die recentelijk gediagnosticeerd zijn met OSA. De bevindingen tonen duidelijk aan dat de gemiddelde basiskennis van OSA en behandeling matig is. Daarom is het van cruciaal belang om patiënten na hun diagnose een uitgebreide uitleg te geven over alle beschikbare behandelingsopties. Bovendien benadrukt de studie het belang van het betrekken van patiënten bij het maken van een behandelingskeuze, aangezien is gebleken dat patiënten verschillende voorkeuren hebben wat betreft behandelingsopties. Daarom is het belangrijk om niet alleen de resultaten van de polysomnografie in overweging te nemen, en automatisch te kiezen voor de standaardbehandeling, maar het is ook belangrijk om de voorkeuren van de patiënt te prioriteren. Door hier rekening mee te houden, zou men sneller de juiste therapie voor de patiënt kunnen opstarten, wat leidt tot een hogere tevredenheid en betere therapietrouw.

1 Introduction

1.1 Obstructive sleep apnea (OSA)

Obstructive sleep apnea (OSA) is one of the most common sleep-related breathing disorders characterized by recurrent collapse of the upper airway during sleep. This causes partial reductions, hypopnea, and complete pauses, apnea, in ventilation for at least 10 seconds (Lee en Sundar, 2021; Singh en Bonitati, 2021). The inadequate ventilation results in hypoxemia and hypercapnia. Upper airway permeability is restored by transient awakenings, also known as arousals. These cycles of apnea/hypopnea are repeated several times every hour, producing fragmented sleep (1999; Azagra-Calero et al., 2012).

Fragmented sleep can cause sleep-related and daytime symptoms. Sleep-related symptoms include snoring, apneas, and arousals often reported by the patient's partner. Daytime symptoms primarily include excessive sleepiness and fatigue, which result from the frequent arousals (Azagra-Calero et al., 2012; Rundo, 2019).

A recent study highlighted the global impact of OSA, affecting nearly one billion people worldwide. The prevalence varies between 3-14% in men and 4-9% in women. This emphasizes the need for effective diagnostic and therapeutic strategies to address this health concern (Benjafield et al., 2019; Young et al., 2004).

OSA is a multi-factorial disorder caused by both anatomical and non-anatomical factors. The main underlying cause of OSA is believed to involve a degree of anatomical compromise and/or increased upper airway collapsibility. Factors such as the craniofacial structure and body fat play significant roles in reducing the volume of the upper airway, thereby increasing the likelihood of pharyngeal collapse (Figure 1) (Carberry et al., 2018; Jordan et al., 2014). The upper airway collapsibility can be evaluated by the critical closing pressure (P_{crit}), which determines the anatomical contribution to OSA, since it is associated with anatomical features, such as pharyngeal length and tongue volume (Hirata et al., 2016).

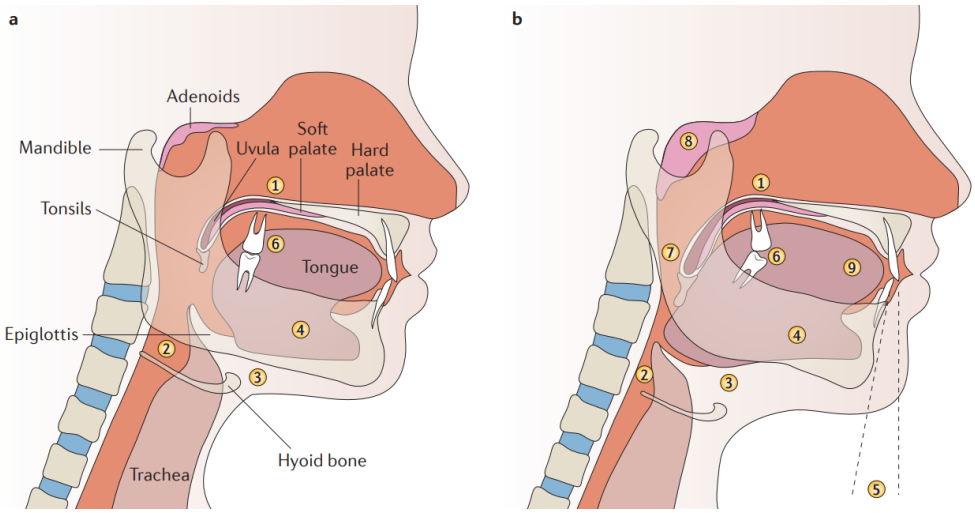


***Figure 1: Maxillofacial and soft tissue changes in patients with OSA**. a) Normal anatomy. b) Frequent anatomical changes associated with OSA: long soft palate and enlarged uvula (1); reduced retroglossal pharyngeal airway space (2); increased distance between the hyoid bone and the mandible (3); a shorter and more vertical mandible (4); a retro-position of the mandible, which is measured by the angle (retrognathia) (5); dental overbite or loss of normal dental occlusion (6); tonsillar hypertrophy (7); adenoid hypertrophy (8); and macroglossia (unusual large tongue) (9)(Levy et al., 2015)*

However, there are other, non-anatomical factors involved. Neuronal activity contributes significantly in maintaining upper airway patency during inspiration by causing contraction of dilatator muscles such as the genioglossus muscle. During sleep, when the muscle activity descreases, the airway becomes more susceptible to narrowing and collapse (Gottlieb en Punjabi, 2020; Levy et al., 2015).

In addition to pharyngeal muscle responsiveness, other factors such as ventilatory control stability and arousal threshold are important. The stability of ventilatory control is assessed by evaluating the loop gain, which quantifies the relationship between the response and the disturbance in the ventilatory system. A high loop gain indicates a large ventilatory response to very small changes in the amount of CO_2. This results in hypocapnia and decreased respiratory drive, leading to recurrent episodes of upper airway collapse. Arousal threshold refers to the amount of intra-thoracic pressure change required to trigger cortical arousals from sleep. Approximately 30 to 50% of all OSA patients have a low arousal threshold, meaning they wake up too easily due to small fluctuations in intra-thoracic pressure (Carberry et al., 2018).

All of the above contribute to the presence and severity of OSA, however the specific contribution of each factor can vary among individual patients. To categorize patients based on their anatomical and non-anatomical characteristics, the PALM scale (**P**$_{crit}$, **A**rousal threshold, **L**oop gain, **M**uscle responsiveness) is used. This scale incorporates both anatomical characteristics, represented by the P_{crit}, and non-anatomical characteristics, represented by the arousal threshold, loop gain, and muscle responsiveness (Figure 2) (Eckert, 2018).

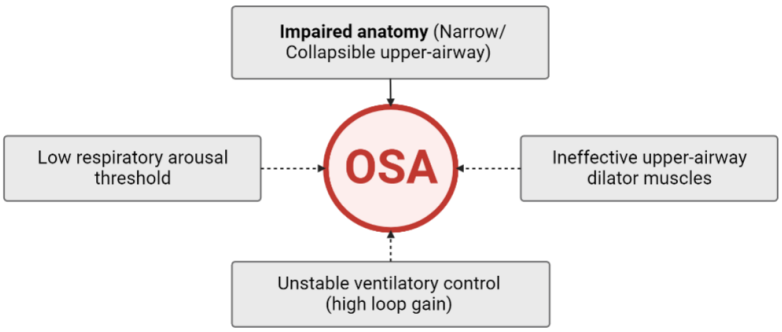


***Figure 2: Schematic representation of the four most important phenotypic characteristics causing OSA**. All patients have some impairment of the upper airway anatomy, but the amount varies widely between patients. Additionally, three other non-anatomical traits play a role in the pathogenesis of OSA (Carberry et al., 2018; Eckert, 2018).*

A combination of both anatomical and non-anatomical characteristics results in three proximate events: intermittent hypoxia, changes in intrathoracic pressure, and sleep fragmentation. These events can cause long-term cardiovascular and cerebrovascular consequences, such as systemic hypertension, myocardial infarction, and stroke. The repetitive episodes of hypoxia due to OSA contribute to the production of reactive oxygen species, which further contribute to the development of vascular disease, metabolic abnormalities, and inflammation (Foster et al., 2009; Gottlieb en Punjabi, 2020).

In addition OSA is associated with depressed neurocognitive function, an increased risk of motor vehicle accidents, and poor quality of life (Harding, 2000). Due to these multifactorial health and social consequences, OSA is seen as a major public health concern with a high social and economic burden (Faria et al., 2021).

1.2 Risk factors

The risk of developing OSA is influenced by a combination of modifiable and non-modifiable factors. Non-modifiable risk factors include sex, age, ethnicity, genetic predisposition, family history, and craniofacial anatomy. On the other hand, there are several changeable risk factors that individuals can address. These include obesity, medication use, endocrine disorders, smoking and nasal congestion or obstruction (Benjafield et al., 2019; Rundo, 2019).

With obesity as a major risk factor for OSA, it is not surprising that as obesity rates have increased, so has the prevalence of OSA. Obesity contributes to fat deposition (e.g., in the tongue and neck), which reduces the dimension of the upper airway, thereby increasing the likelihood of its collapse (Lee en Sundar, 2021). In a study conducted by Peppard et al., it was observed that a 10% weight gain results in a 32% increase of AHI (Peppard et al., 2000). This emphasizes strong association between obesity and development of OSA.

Male sex is a risk factor for OSA due to anatomical variations, higher abdominal and neck fat deposits, and the protective effect of female hormones, such as progesterone and estrogen (Lee en Sundar, 2021). The prevalence of OSA also increases with age, especially in women after the menopause, possibly due to redistribution of fat to the upper body, including the neck (Levy et al., 2015).

Certain facial phenotypes, the craniofacial and upper-airway structure and ethnicity also play a significant role in OSA occurrence. Studies by Lee et al. have demonstrated that ethnicity affects the impact of obesity and craniofacial differences on the severity of OSA. Asians tend to have more pronounced craniofacial limitations, whereas Caucasians tend to have higher body weight in relation to the OSA severity (Lee et al., 2010). Asians commonly have larger skeletal restrictions, including shorter maxillae and mandibles, as well as a more retropositioned mandible and shorter, deeper anterior cranial bases. As a result, their vulnerability to obesity is higher, aggravating any existing anatomical imbalance (Sutherland et al., 2012).

1.3 Diagnosis

The gold standard for diagnosing OSA is overnight polysomnography (PSG), performed in a sleep lab (Kapur et al., 2017). A typical baseline PSG, also called type I or Level 1 sleep study, involves the measurements of electroencephalogram (EEG), electrooculogram (EOG), chin and limb electromyogram (EMG), airflow signals, respiratory effort signals, oxygenation saturation, electrocardiogram (ECG), body position and a video and audio recording (Figure 3) (Rundo en Downey, 2019).

The EEG measures the electrical activity of the brain's surface and helps to identify stages of sleep and wakefulness. The EOG monitors eye movements by utilizing the corneoretinal potential, both during sleep and wakefulness. The EMG consists of submental and bilateral leg components and is used for sleep scoring and the diagnosis of period limb movements. To detect airflow, a thermistor that responds to temperature changes and a nasal cannula that responds to pressure changes are employed. Additionally, the respiratory effort is quantified using thoracic and abdominal inductance bands. The ECG records the cardiac rhythm using electrograph Lead II. Pulse oximetry is used to determine the oxygenation saturation.

Body position during sleep is an important factor to consider as snoring and sleepapnea often worsen in supine position. Changes in body position throughout the night are measured by a sensor, placed on the chest. In addition to the sensor, video recording can be utilized to visually assess the body position. This is combined with an audio recording that allows to determine the amount of snoring (Gottlieb en Punjabi, 2020; Jafari en Mohsenin, 2010; Rundo en Downey, 2019).

Results from a PSG provide information about OSA diagnosis and the need for treatment (Rundo, 2019). The presence and severity of OSA are quantified by the apnea-hypopnea index (AHI) (Formula 1). It represents the number of respiratory events per hour: no sleepapnea (AHI<5), mild sleepapnea (5≥AHI<15), moderate sleepapnea (15≥AHI<30), and severe sleepapnea (AHI≥30) (Gottlieb en Punjabi, 2020). Within the AHI, one can distinguish between obstructive and central apneas/hypopneas. The obstructive apnea-hypopnea index (OAHI) specifically quantifies the number of obstructive respiratory event per hour and can be determined by using Formula 2 (Lesser et al., 2012).

$$\text{Formula 1: AHI (events/hour)} = \frac{\text{Apneas} + \text{Hypopneas}}{\text{Total sleep time, hours}}$$

$$\text{Formula 2: OAHI (events/hour)} = \frac{\sum \text{Obstructive and mixed apneas} + \text{obstructive hypopneas}}{\text{Total sleep time, hours}}$$

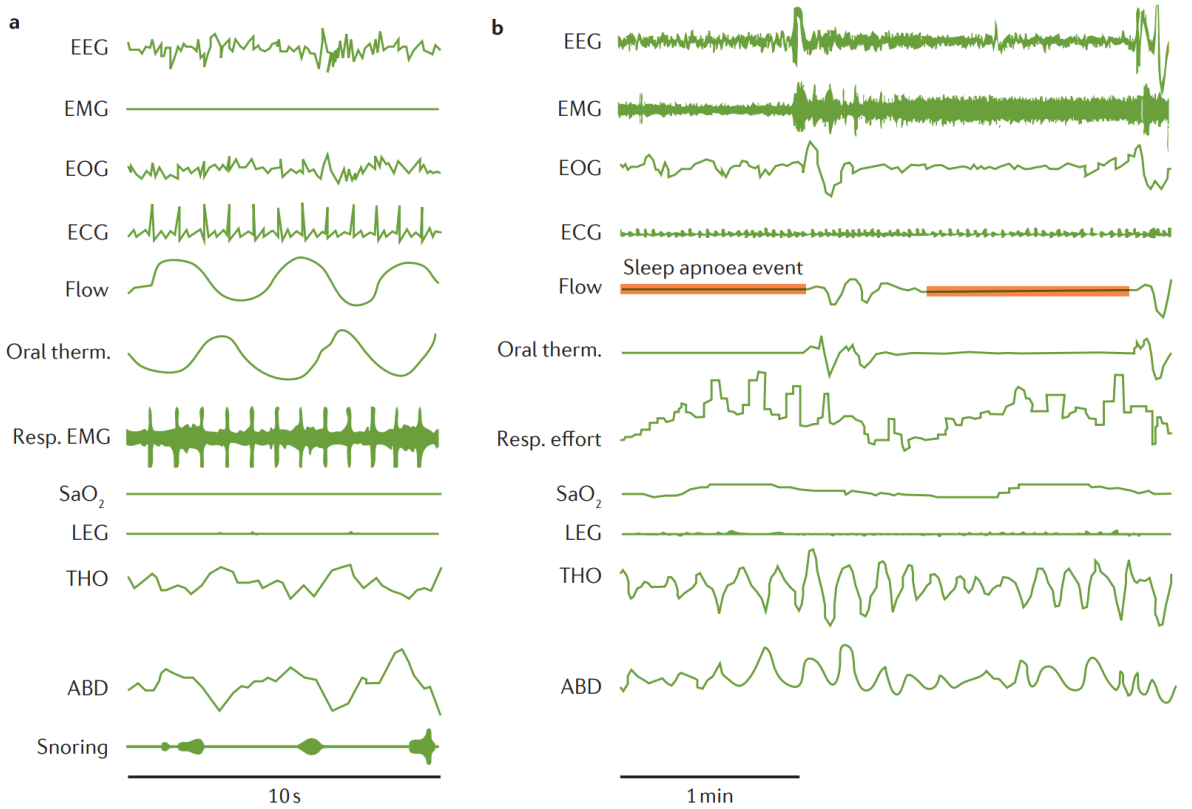


***Figure 3**: **Overnight polysomnography**. a) 10 second recordings with all signals used in an overnight polysomnography, in a normal individual. b) Polysomnography results of an OSA patient. It displays 2 episodes of obstructive apnea, indicated in orange boxes. Each apnea is associated with a cessation of airflow, increased respiratory effort, and decreased oxygen saturation, which is delayed due to the saturation time. Each apnea ends with an arousal which causes the pharyngeal muscles to contract, whereby the airway dilates. This is visible on the EEG, EMG and EOG. EEG: electroencephalogram; EMG: electromyogram; EOG: electrooculogram; ECG: electrocardiogram; Flow: nasal flow; Oral therm.: mouth breathing; Resp.: respiratory; SaO_2: transcutaneous oxygen saturation; Leg: detection of leg movement; THO: thoracic movement,; ABD: abdominal movements (Levy et al., 2015).*

During an overnight polysomnography conducted at the Antwerp University hospital, patients are required to complete several questionnaires, including a visual analogue scale (VAS) for snoring and the Epworth Sleepiness Scale (ESS) (Annex 1-2).

The VAS is a subjective method used to assess the amount and intensity of snoring. The patients are requested to provide a subjective assessment of the intensity of their snoring, relying on their personal experience and feedback from their partner or their surroundings. The VAS scale ranges from 0, indicating no snoring to 10 which means very intensive snoring (Lee et al., 2014). The ESS is used to assess the level of somnolence under various circumstances. It involves 8 questions, in which the patient needs to indicate the likelihood of falling asleep in different situations, on a scale from 0-3. ESS scores >10 indicate excessive daytime sleepiness (Walker et al., 2020).

1.4 Treatment

The main goal of treating OSA is to alleviate symptoms, improve quality of life, reduce the burden of co-morbidities, and to decrease mortality (Levy et al., 2015). Various treatment options are available for OSA, starting with behavioural interventions, which include weight loss, regular exercise, avoiding alcohol and sedatives, quitting smoking, establishing a regular sleep schedule, and help to alleviate OSA-related symptoms (Gottlieb en Punjabi, 2020; Kabir et al., 2013).

As previously discussed, the etiology of OSA can involve both anatomical and non-anatomical factors. The selection of an appropriate therapy for OSA depends on understanding the underlying cause of the condition. Treatment options can be categorized into those that primarily target anatomical factors such as the craniofacial structure or non-anatomical factors such as muscle function, arousal threshold, and loop gain. Anatomical therapies include CPAP, oral appliances, positional therapy, and surgery. Non-anatomical therapies include hypoglossal nerve stimulation, pharmacotherapies, pharyngeal muscle training, and oxygen therapy. (Carberry et al., 2018).

An example of the non-anatomical treatments is the hypoglossal nerve stimulation, a surgical treatment option that involves upper airway stimulation (UAS). In this procedure, the hypoglossal nerves, which control important dilator muscles like the genioglossus muscle, are electrically stimulated. An implantable device is placed in the upper right chest to deliver the simulation. By activating these nerves, the upper airway remains open and patent during sleep, effectively reducing the occurrence of OSA episodes (Zhou et al., 2022).

Anatomical treatment options all enlarge the airway but achieve this through various approaches. These type of treatments include continuous positive airway pressure (CPAP), oral appliance therapy, positional therapy, and surgery (Carberry et al., 2018). Positional therapy (PT) is used to treat positional obstructive sleep apnea (POSA), characterized by an AHI at least twice as high in supine position compared to non-suping sleeping position (Benoist et al., 2017; Yingjuan et al., 2020). This means that it is used to avoid the worst sleeping position causing POSA, most often the supine position. There are fairly simple methods such as the tennis ball technique in which a pocket, containing a tennis ball-sized object, is sewn onto the back of the patient's sleepwear. Due to discomfort caused by the presence of the ball, the patient will naturally switch to a non-supine position. In addition, alternatives such as the sleep position trainer (SPT) are available. The SPT is equipped with a chest strap and positioned on the chest. Whenever a supine position is detected, it initiates vibrations until the patient shifts into a non-supine position (Yingjuan et al., 2020).

Surgical interventions primarily involve the removal of excessive tissue at the level of the soft palate, velopharynx, oropharynx, tongue base, and epiglottis (Carberry et al., 2018). The most common surgical procedure was the uvulopalatopharyngoplasty (UPPP). An UPPP enhances the size retropalatal airway through the excision of the posterior portion of the soft palate and uvula, reshaping of the anterior and posterior tonsillar pillars, and, if not previously removed, complete removal of the tonsils (Sheen en Abdulateef, 2021). However, in 2015 a new surgical technique was proposed, the barbed reposition pharyngoplasty (BRP). This technique is more effective, addresses the lateral wall collapse, and focuses more on airway dynamics (Antonio et al., 2021; Lombo et al., 2022). Besides tissue removing surgeries, maxillomandibular advancement (MMA) surgery is used in which skeletal modifications are enlarge the airway.

In addition to these treatment options, there are also medical devices available for the treatment of OSA, which include continuous positive airway pressure (CPAP) and oral appliances such as mandibular advancement devices (MADs). This master's thesis will concentrate on these medical devices and one surgical treatment option, the MMA. These three therapeutic approaches, the CPAP, MAD, and MMA, will be thoroughly discussed in the next section.

1.4.1 Continuous positive airway pressure (CPAP)

Positive airway pressure (PAP) is a non-invasive, highly effective and, cost-efficient treatment for OSA. PAP therapy can be administered in three different modes: continuous positive airway pressure (CPAP) with a fixed pressure, bilevel positive airway pressure (BiPAP) with distinct pressures for inhalation and exhalation, and auto-titrating positive airway pressure (APAP) that adjusts pressure based on machine feedback (Lee en Sundar, 2021).

CPAP mode is most commonly used and widely prescribed treatment for OSA. It involves the use of a nasal or oronasal mask secured with elastic headgear, connected to a flow generator via tubing (Figure 4). CPAP therapy works through multiple mechanisms, including increasing the cross-sectional area of the pharynx, enhancing diaphragmatic activity, improving pulmonary compliance, and reducing airway resistance. As a result, it prevents or reduces the occurrence of hypopneas and apneas, leading to a decrease or complete resolution of sleep fragmentation and OSA symptoms (Giles et al., 2006; Gupta en Donn, 2016).

CPAP is a lifelong treatment that requires acceptance and compliance. However, maintaining long-term compliance with CPAP therapy can be challenging due to several factors such as pressure sores, air leakage, claustrophobia, nasal congestion, and other potential side effects. To enhance comfort and tolerance, CPAP can be administered with humidification (Ryan et al., 2009). The effectiveness of CPAP therapy is directly linked to patient compliance. Literature suggests using CPAP for at least 6 hours per night to obtain significant improvements in the apnea-hypopnea index and OSA-related symptoms (Lorenzi-Filho et al., 2017; Masa en Corral-Penafiel, 2014; Sin et al., 2002).

At the Antwerp University Hospital, a titration PSG study is conducted at the initiation of CPAP therapy to determine the optimal pressure settings for effective treatment. The ultimate goal is to eliminate or minimize respiratory events to a clinically satisfactory level, meaning a post-treatment AHI of < 10 events/hour (Sutherland et al., 2014). Following the initiation of CPAP therapy, patients are scheduled for regular follow-up visits with a pneumologist on an annual basis. These follow-up visits allow for ongoing monitoring of the patient's progress, adjustment of treatment if needed, and addressing any concerns or issues that may arise during the course of therapy. This ensures that the patient's CPAP treatment remains optimized and provides the necessary support for long-term management of OSA (Bosschieter et al., 2022; Rundo en Downey, 2019).

In Belgium, one is entitled to reimbursement for CPAP therapy when: (1) The OAHI of the diagnostic PSG, which is less than two years old, is ≥15; (2) there is a favourable effect during the titration study; and (3) there is a minimum use of ≥ 4 hours/night, which is monitored during the annual follow-up visit. If these conditions are met, patients pay a maximum of €0.25/day (RIZIV, 2020).

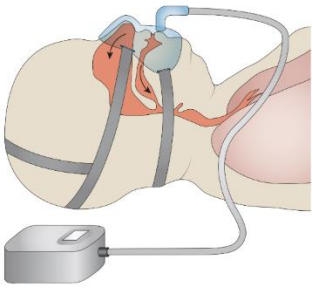


***Figure 4: Continuous positive airway pressure (CPAP)**: A CPAP device consists of 3 main parts: nasal or oronasal mask with straps to keep the mask in place, a tube that connects the mask to a flow generator, and the flow generator that blows air into the tube. CPAP devices are small, lightweight, and relatively quiet with a soft and rhythmic noise (Levy et al., 2015).*

1.4.2 Mandibular advancement device (MAD)

A mandibular advancement device (MAD) is a type of oral appliance. It is a lifelong, non-invasive therapy that requires compliance. A MAD is worn at night and advances the mandible and tongue forwards, lifting the palate, and thereby reducing upper airway collapsibility (Figure 5A), while the dilatator muscle activity, loop gain and arousal threshold remain unchanged (Marklund et al., 2012; Singh en Bonitati, 2021).

The attachment of a MAD to the teeth underscores the significance of oral health in the treatment process. For effective placement, a patient should have a minimum of 6-10 teeth in each arch, with particular attention given to the positioning of these teeth. Posterior located teeth offer better retention. In cases where natural teeth are no longer present, dental implants can serve as alternative anchors for the MAD (Verbraecken et al., 2022).

There is a wide range of designs available for MADs and they can be categorized as either prefabricated (e.g., bite and boil or thermoplastics) (Figure 5B) or custom-made. While custom-made MADs are more costly, they offer improved effectiveness and better tolerance. The process for obtaining a custom-made MAD involves dental impressions or scans. There are two main types of custom-made MADs: one-piece or monobloc (Figure 5C) and adjustable two-piece appliances with separate upper and lower plates that are interconnected dynamically (Figure 5D). The two-piece appliances, also known as titratable or adjustable MADs, allow for gradual adaptation to achieve optimal protrusion, resulting in fewer side effects (Basyuni et al., 2018; Uniken Venema et al., 2021).

A MAD is recommended for patients with mild to moderate OSA as it reduces the OSA severity to a lesser or similar extent than CPAP. However, MADs offer advantages such as higher compliance rates and fewer side effects. This makes MADs a more convenient option for controlling OSA (Dieltjens et al., 2012; Giles et al., 2006). The side effects associated with MADs are generally mild and temporary, occurring during the initial acclimatization period. Common side effects include hypersalivation, dry mouth, dental pain, gingival irritation, myofascial pain, and temporomandibular joint discomfort (Basyuni et al., 2018). In addition to these transient side effects, there are also potential persistent side effects such as teeth movement, skeletal changes, and occlusal alterations (Martinez-Gomis et al., 2010).

Drug-induced sleep endoscopy (DISE) can serve as a valuable tool for predicting the success of MAD treatment. DISE involves the administration of sedative drugs, such as propofol, to simulate sleep and identify sites of obstruction in patients with OSA. It is important to note that propofol does not induce rapid eye movement (REM) sleep, limiting the assessment of this stage during DISE. A recent study indicated that observed tongue base collapse during DISE can be considered a positive predictor for the effectiveness of MAD therapy. On the other hand, complete concentric collapse at the level of the soft palate and oropharyngeal collapse are viewed as negative predictors for the success of MAD treatment (Van den Bossche et al., 2021).

In addition to a DISE, there are several other positive predictive factors, including less severe OSA, female gender, younger age, lower BMI, lower neck circumference, and certain craniofacial features such as a shorter soft palate. However, it is important to note that these do not necessarily exclude individuals who do not fulfil these predictive factors form being successful treated with MAD (Sutherland et al., 2014).

At the University Hospital of Antwerp, patients who receive MAD therapy are required to have a follow-up sleep study three months after the device's placement to assess effectiveness. Subsequently, annual check-ups are scheduled to monitor the patient's progress and assess the condition of the MAD for any signs of damage. Reimbursement for MAD therapy is granted to patients who are diagnosed with an OAHI≥15 during a recent PSG examination, conducted within the past two years. Additionally, adherence to annual check-ups is necessary to maintain reimbursement eligibility. If a patient is entitled to reimbursement, they must pay a personal share of €0.50/day for a period of six months. After a period of five years, patients receiving reimbursement are entitled to obtain a new MAD (RIZIV, 2020).

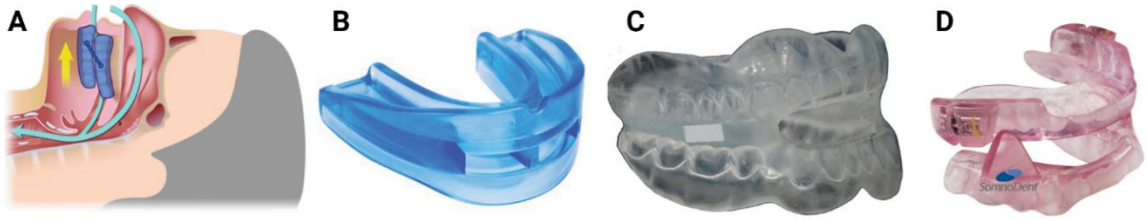


***Figure 5**: **Mandibular advancement device (MAD**) A) mechanism of action: enlarging the airway by advancing the mandible and tongue forwards, and by lifting the palate; B) Prefabricated MAD; C) Custom-made one-piece MAD; D) Custom made two-piece titratable MAD (Basyuni et al., 2018; Dieltjens et al., 2012)*

1.4.3 Maxillomandibular advancement (MMA)

Maxillomandibular advancement (MMA) is an invasive, curing, surgical treatment that involves repositioning of the upper and lower jaws forward to enlarge the upper airway and improve patency during sleep. This is being done by a combination of Le Fort I maxillary and bilateral sagittal split mandibular osteotomies (Figure 6). By advancing both the maxilla and mandible approximately 10mm, the anterior pharyngeal tissues connected to these structures, along with the hyoid bone, undergo forward movement. As a consequence, the entire pharynx is expanded, leading to a significant reduction in the collapsibility of the upper airway (Zaghi et al., 2016; Zhou et al., 2022).

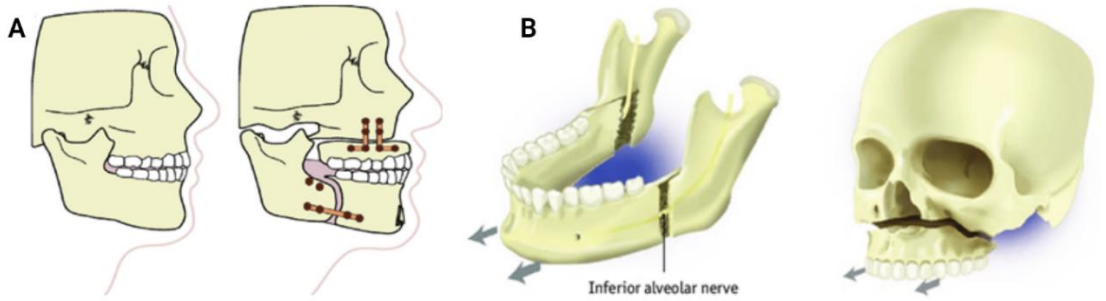


***Figure 6**: **Maxilomandibular advancement**; A) Before (left) and after (right) MAA (Holty, 2012); B) The surgery consist of a bilateral sagittal split mandibular osteotomy (left) combined with a Le fort I maxillary osteotomy (right) (Vanderveken, 2010)*

MMA is a highly effective treatment for OSA with large decrease in AHI and high rate of surgical success. After MMA, patients experience significant improvement in their quality of life, reduction of daytime sleepiness, alleviation of OSA-related symptoms, and improved control of their blood pressure. Several factors have been identified as predictive indicators for surgical success, including younger age, lower preoperative BMI/weight, more severe AHI, and greater extent of maxillary advancement. Furthermore, the response to MAD therapy can serve as an additional predictive factor, as patient who exhibit a positive response to MAD treatment are more likely to have successful results with MMA. Alongside these predictive factors, preoperative assessment of the pharyngeal anatomy and patient preferences play crucial roles in the surgical decision-making process (Boyd et al., 2015; Hoekema et al., 2006; Holty, 2012).

Certain pre-surgical measures might be necessary prior to undergoing MMA surgery. Such measures include dental (e.g., removal wisdom teeth) and/or orthodontic treatment (e.g., fixed appliance therapy) to prepare the teeth for surgery (Hoekema et al., 2006; Patel et al., 2004). If an imbalance in the width of the jaws is present, it is recommended to correct it in advance using a technique called distraction. In the maxilla, this procedure is known as transpalatal distraction (TPD), while in the mandible it is referred to as transmandibular distraction (TMD) (Nadjmi et al., 2015). The process involves gradually moving separated bone segments using a screw over a period of approximately 10 days, depending on the space that needs to be created. This allows for controlled expansion of the jaw and helps achieve proper alignment and balance. Because this treatment can be a long process, effective collaboration among various specialties becomes crucial (Gunbay et al., 2009; Mommaerts, 1999).

A few weeks before surgery, a set-up consult is required which determines the final planning of the surgery. This consult involves conducting an assessment of the facial and jaw structures, encompassing clinical examination, radiological examination (such as cone beam computer tomography (CBCT), cephalometry, and 3D models), photographic examination (including clinical and 3D photos), and model examination. This enables precise 3D planning of the procedure and facilitates the fabrication of a splint that will guide the accurate positioning of the jaws during surgery. Furthermore, this approach enables the prediction of facial changes that occur as a result of the procedure. (Liu et al., 2019; Yu et al., 2020).

MMA, being an invasive surgical intervention, can lead to temporary discomforts including pain, swelling, tingling sensation, jaw stiffness, and facial paraesthesia. The facial paraesthesia is a result of temporary neurosensory deficiency of the inferior alveolar nerve, which typically resolves within 6-12 months following the surgery. The risk for this temporary paraesthesia is higher in elderly patients and patients with larger advancements of the mandible (Van Sickels et al., 2002). As previously mentioned, facial aesthetic changes will occur as a result of MMA. Nevertheless, most patients perceive the cosmetic outcomes positively (Holty, 2012; Zaghi et al., 2016).

At the University Hospital of Antwerp, the MMA procedure requires a one-night hospital stay. Following the surgery, there will be a period during which the patient is advised to consume soft nutrition. Complete recovery is typically achieved within 2-10 weeks. One of the advantages of MMA is its effectiveness without the need for lifelong usage or annual follow-up, unlike CPAP and MAD therapy (Boyd et al., 2015; Zaghi et al., 2016).

2 Objectives

This master thesis will be divided into two distinct parts. The first part focusses on the knowledge and mindset of the participants in which knowledge and treatment preferences of newly diagnosed OSA patients are examined. These participants have not yet received information about their condition or available treatment options, and thus are therapy naïve. The second part explores the treatment trajectory of a group of OSA patients. More specific, it examines the treatment proposals received by patients, whether they initiate treatment or not, and the treatment option they ultimately choose (Figure 7).

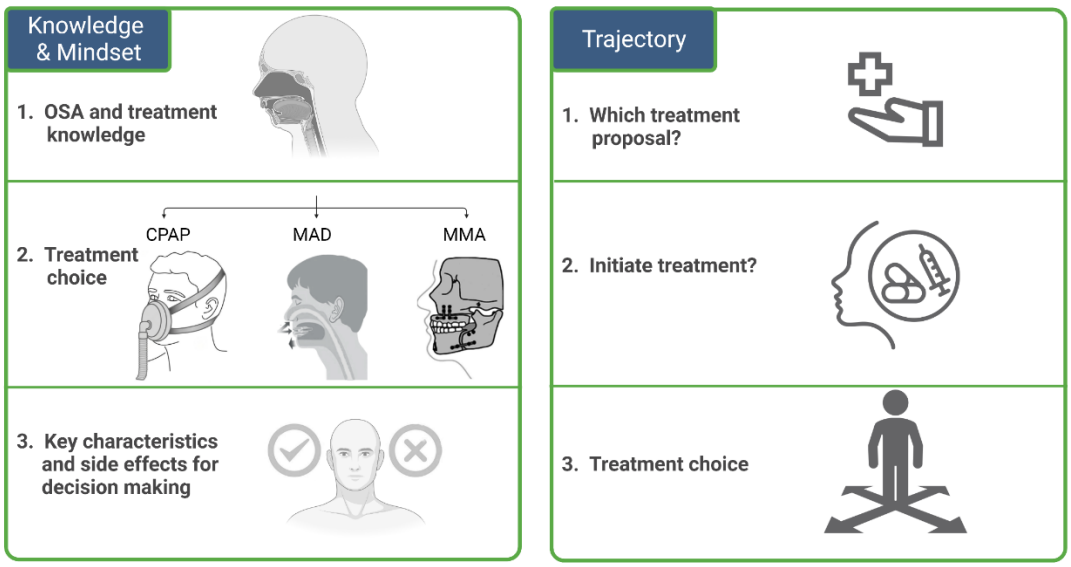


***Figure 7: Study objectives**. This study is divided into two distinct parts. The first part examines the knowledge and mindset of recently diagnosed OSA patients, the second part reviews their treatment trajectory.*

3 Knowledge and mindset

3.1 Objectives

- Do newly diagnosed OSA patients have any knowledge about their condition and possible treatments?
- Which treatment do therapy-naïve patients prefer based on general information?
- Which characteristics and side effects play a significant role in determining a treatment choice?

3.2 Materials and methods

3.2.1 Study design and patient enrolment

The aim of this study has been achieved through a descriptive, observational, cross-sectional study conducted on patients who had undergone a diagnostic PSG as part of their initial OSA diagnosis. It should be noted that these participants had not yet had a follow-up appointment and thus did not receive any information about the condition or potential treatment options. Individuals who fulfilled the inclusion/exclusion criteria were contacted and invited to participate. Patients were asked to complete an online questionnaire, which included the informed consent form at the start of the questionnaire. The data obtained from this questionnaire was combined with the information gathered during the diagnostic overnight polysomnography for analysis (Figure 8).

Inclusion criteria
- Age 18–59 years old
- Non-syndromic patients
- Dutch speaking patients

Exclusion criteria
- Patients who already received treatment for their OSA
- Psychiatric disorders such as depression, anxiety disorders, personality disorders…

Figure 8: Study design

All study participants underwent a diagnostic overnight PSG at the Antwerp University Hospital Sleep Centre, following the standard protocol of care. Each patient was monitored for a minimum time period of 8 hours. Sleep stages and respiratory events were evaluated using the definitions provided by the American Academy of Sleep Medicine (Berry et al., 2017). This allowed to calculate the AHI and OAHI, which helped identify the presence of sleep apnea among the participants.

Approval for this study was obtained from the UZA ethics committee on 20/03/2023 (Project ID 5242 - Edge 2927 - BUN B3002023000047). All participants provided their consent by completing the online informed consent form (ICF), attached at the beginning of the questionnaire. Completion of the ICF was mandatory prior to proceeding with the questionnaire. The study is conducted in accordance with the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent revisions.

3.2.2 Data collection

The questionnaire used in this study was made in Qualtrics^{XM} and written in Dutch. It included various aspects, such as demographic information and the Perceived Stress Scale (PSS-10). The Perceived Stress Scale is a self-report measure comprising 10 items that asses the degree to which individuals perceive everyday situations during the previous month as unpredictable, uncontrollable, and stressful (Soria-Reyes et al., 2022).

Furthermore, the questionnaire included questions aimed to assess participants' knowledge and awareness of OSA and the selected treatment options: CPAP, MAD, and MMA. Initially, participants were required to indicate whether they were familiar with OSA and, if so, the source(s) from which they obtained information. Subsequently, they received a concise explanation about OSA. Following this, participants were asked to identify their awareness of the treatment options and express if they would choose for each of these treatments. Additionally, participants were requested to provide reasons for considering treatment and specify the crucial factors in this decision-making process. After receiving a brief overview of each treatment, participants were asked to reassess their treatment choices.

The final section of the questionnaire included two questions regarding therapy-related characteristics and side-effects. The first question required participants to identify the most influential characteristic affecting their treatment choice. The second question presented a list of potential side effects, and participants were asked to evaluate the perceived severity of each side effect (Annex 4).

Prior to participant enrolment, the questionnaire underwent a testing phase involving 10 individuals. The purpose of this testing phase was to assess the clarity of the questions and identify any potential uncertainties, ambiguities, or general comments. Based on the feedback, necessary adaptations were made to the questionnaire. Additionally, the testing phase helped to determine the estimated time, required to complete the electronic questionnaire.

The information collected through the questionnaire was organized into an Excel file. Additionally, the Excel file was enhanced by incorporating supplementary data derived from the overnight PSG, including the AHI, OAHI, the VAS snoring scale, and ESS sleepiness score.

3.2.3 Statistical analysis

The data collected in the Excel file was imported into JMP® (Pro version 16.0.0, SAS Institute Inc., Cary, NC, 1989-2019), where all statistical analyses were conducted. To assess the normality of the data, the Shapiro-Wilk test and visual examination of histograms were employed. Descriptive statistics were applied to summarize the patient population, with continuous variables presented as mean$\pm$standard deviation, median, and range, and categorical variables reported as frequencies and percentages. To provide insights into any potential associations or influences between predictor variables and a categorical outcome variable, nominal logistic regressions and chi square test were conducted.

3.3 Results

3.3.1 Patient enrolment

Initially, patients who had undergone a diagnostic overnight PSG and received a diagnosis of OSA were screened remotely. If these patients met the inclusion/exclusion criteria, they were contacted via telephone and invited to participate in the study, and this before their scheduled follow-up appointment with a doctor, meaning they were therapy naïve. Once a patient agreed to participate, a questionnaire link was sent to them via email. However, it became evident that this enrolment approach had certain limitations. It was challenging to reach participants during office hours, and even when a patient agreed to participate, the questionnaire completion rate was relatively low. Among the 18 patients contacted, 5 patients (27.8%) could not be reached, and an additional 5 patients (27.8%) declined to participate. The remaining 8 patients (44.5%) agreed to participate, but only 3 patients (16.7%) successfully completed the questionnaire (Figure 9A).

In response to the limitations encountered during the initial enrolment approach, a modified strategy was implemented in which patients were directly enrolled at the Antwerp University Hospital Sleep Centre. Every patient who underwent a diagnostic overnight PSG as part of their initial OSA diagnosis was screened for eligibility. Eligible patients were approached during their visit at the sleep centre and invited to participate in the study. If a patient agreed to participate, they received the questionnaire and instructions on how to complete it, either via email or by scanning a QR code.

During the enrolment period at the sleep centre, 149 patients were approached. Out of this group, 138 patients (92.6%) agreed to participate, while 11 patients (7.4%) opted not to participate. Primary reasons for non-participation included concerns about the online nature of the questionnaire, anonymity concerns, and personal factors such as excessive workload or fatigue. Out of the 138 patients who agreed to participate, 27 patients (18.1%) received the questionnaire but did not complete it. Therefore, a total of 111 patients (74.5%) successfully received and completed the questionnaire (Figure 9B). Thus, the final cohort consisted of 114 participants, with 3 individuals enrolled through telephone calls and 111 participants recruited directly at the sleep centre.

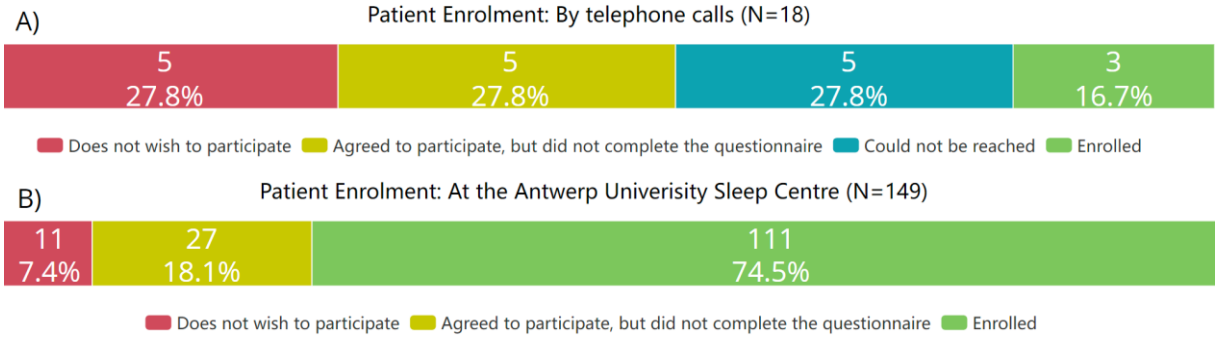


***Figure 9**: **Enrolment** A) Patient enrolment through telephone calls. B) Patient enrolment at the Antwerp University sleep centre.*

Because participants were included into the study before their sleep study results were available, it was uncertain at this point whether they had OSA. Among the total cohort of 114 participants, 30 individuals (26.3%) did not receive a diagnosis of OSA, and thus had an AHI<5/hour. Furthermore, the PSG results of two individuals (1.8%) were not yet available during the data analysis phase, leading to their exclusion from further analysis. This resulted in a total of 82 participants (71.9%) that were used for further analysis (Figure 10).

***Figure 10: Patient selection for data analysis**. Patients were excluded from further analysis if they had an AHI<5 or when they did not yet receive their PSG results.*

3.3.2 Patient demographics

The first section of the questionnaire contained standard questions aiming at gathering demographic information about the participants. Among the 82 participants, 63 (76.8%) were male individuals. The average age of the study population was 47±9 years old, and the mean BMI was 30±6 kg/m^2. To classify participants based on their BMI, a categorical variable for BMI was created, consisting of four levels: normal BMI (BMI<25 kg/m^2), overweight (25≤BMI<30 kg/m^2), obesity class I (30≤BMI<35 kg/m^2), and obesity class II/III (BMI≥35 kg/m^2) (Jordan et al., 2014).

To gain a more comprehensive understanding of the participants lifestyle and professional environment, several questions focused on gathering information about the participants' living- and working situation. The findings indicated that the majority of participants live with a partner, with friends, or family members. Only 12 participants (14.6%) reported living alone. Out of all participants, 57 (69.5%) have at least one child, with most of them being either younger than one year old or older than 18 years old.

The educational level of the majority of participants (50.0%) was secondary education. Among the other, 18 individuals (22.0%) reported having a professional bachelor's degree, 4 participants (4.9%) held an academic bachelor's degree, and 19 participants (23.1%) had obtained a master's degree or a higher level of education. There was not a single participant without a secondary education degree.

When looking at the professional environment, 65 participants (79.3%) were working fulltime and 14 (17.1%) parttime. The remaining 3 participants (3.6%) were unemployed, had permanent invalidity and were housewife. When examining the subgroup of working individuals, it became clear that the majority them were employed as employees (62.0%), followed by self-employed individuals (19.0%) and laborers (17.7%). Only 1 participant (1.3%) has a liberal profession.

In addition, participants were asked to indicate, on VAS scale of 0-10, how much physical load and concentration their job requires. On average, the participants' jobs required more concentration (8±1) than physical load (4±3). Furthermore, it was interesting to examine whether the participants worked in a shift system. Out of the total group, only 18 participants (22.8%) indicated that they work in shifts, with 8 of them (10.1%) specifically mentioning night shifts.

Finally, the net income of the participants was questioned. Most participants (48.8%) had a salary of €2500-5000, followed by 29 participants (35.3%) with €1000-2500/month, and 7 participants (8.5%) with more than €5000/month. 6 participants (7.3%) did not wish to provide information about their monthly income. Again, it can be noted that no participant reported having a monthly net income of less than €1,000/month.

In addition to collecting demographic information, participants were asked to complete the PSS-10 questionnaire. Out of the total sample, 39 participants (47.6%) were categorized in the low stress group with PSS-10≤13 while 41 participants (50.0%) fell into the moderate stress group with 14≥PSS10≥26. Only 2 participants (2.4%) reported experiencing a high level of stress with PSS10≥ 27. All this information is summarized and presented in Table 1.

***Table 1: Patient demographics and PSS-10 result of the study population**. Categorical data are presented as number and percentage. Percentages are calculated based on all 82 respondents. Continuous data are presented as mean±SD, median, and range.*

Variable	Categorical variables		Continuous variables		
	N	%	Mean±SD	Median	Range
Sex					
- Male	63	76.8%			
- Female	19	23.2%			
Age (years old)			47±9	49	[26 – 59]
BMI (kg/m²)			30±6	29	[20 – 48]
- Normal (BMI <25 kg/m²)	11	13.4%			
- Overweight (25≤BMI<30 kg/m²)	35	42.7%			
- Obesity class I (30≤BMI<35 kg/m²)	22	26.8%			
- Obesity Class II/III (BMI >35 kg/m²)	14	17.1%			
Living situation					
- Married or cohabiting	65	79.3%			
- Cohabiting friends/family	5	6.1%			
- Living alone	12	14.6%			
Number of children					
- 0	25	30.5%			
- 1	19	23.2%			
- 2	30	36.6%			
- 3 or more	8	9.7%			
Age children (N=74)					
- <1 year old	2	35.1%			
- 1-2.5 years old	4	2.7%			
- 2.5-6 years old	7	5.4%			
- 6-12 years old	13	9.5%			
- 12-18 years old	22	17.6%			
- >18 years old	26	29.7%			
Educational attainment					
- No education	0	0.0%			
- Secondary education	41	50.0%			
- Professional bachelor	18	22.0%			
- Academic bachelor	4	4.9%			
- Master or higher	19	23.1%			
Work situation					
- Unemployed	1	1.2%			
- Permanent invalidity	1	1.2%			
- Housewife/houseman	1	1.2%			
- Parttime	14	17.1%			
- Fulltime	65	79.3%			
Profession					
- Employee	49	62.0%			
- Self-employed	15	19.0%			
- Laborer	14	17.7%			
- Liberal profession	1	1.3%			
Physical load			4±3	3	[0 – 10]
Concentration			8±1	8	[3 – 10]
Shifts					
- No	61	77.2%			
- Yes without night	10	12.7%			
- Yes with night	8	10.1%			
Net income (per month)					
- <€1000	29	35.3%			
- €1000-2500	40	48.8%			
- €2500-5000	7	8.5%			
- >€5000	6	7.3%			
- I prefer not to say					
PSS-10					
- Low perceived stress	39	47.6%			
- Moderate perceived stress	41	50.0%			
- High perceived stress	2	2.4%			

3.3.3 Polysomnographic results

In addition to the study-specific questionnaire, participants were required to fill in the basic questionnaires of the sleep centre, including the VAS snoring scale, and the ESS sleepiness scale. For this cohort, the VAS snoring score was on average of 7±2. 75.0% of the participants had a VAS score ≥6, which is seen as socially disturbing (Rohrmeier et al., 2015). The ESS score was on average 10±5. 42.7% of the participants showed some form of increased daytime sleepiness, with 8.5% having severe excessive daytime sleepiness (Perotta et al., 2021).

Following the night at the sleep centre, a report is generated including the AHI and OAHI. The average AHI was 26.4±19.0, ranging from 5.1 to 98.7, with an interquartile range (IQR) of 12.3-36.9. The average OAHI was 24.9±17.9, ranging from 4.9 to 98.7, with an IQR of 12.1-32.6. Additionally, a categorical variable was created for the AHI to classify participants into groups based on the severity of their sleep apnea: no sleepapnea (AHI<5), mild sleepapnea (5≤AHI<15), moderate sleepapnea (15≤AHI<30), and severe sleepapnea (AHI≥30) (Gottlieb en Punjabi, 2020). Since this study only included participants with sleepapnea, the category of "no sleep apnea" is not applicable (Table 2).

Table 2: Polysomnographic results of the study population *Categorical data are presented as number and percentage. Percentages are calculated based on all 82 respondents, unless specified otherwise. Continuous data are presented as mean±SD, median, and range.*

Variable	Categorical variables		Continuous variables		
	N	%	Mean±SD	Median	Range
VAS snoring (N=76)			7±2	8	[0 – 10]
- Not socially disturbing (VAS<6)	19	25.0%			
- Socially disturbing (VAS≥6)	57	75.0%			
ESS; Daytime sleepiness			10±5	9	[1 – 24]
- Normal (ESS<10)	47	57.3%			
- Excessive (10≤ESS≤15)	28	34.1%			
- Severe excessive (ESS>15)	7	8.5%			
AHI			26.4±19.0	20.0	[5.1 – 98.7]
- Mild sleepapnea (5≤AHI<15)	24	29.3%			
- Moderate sleepapnea (15≤AHI<30)	29	35.4%			
- Severe sleepapnea (AHI≥30)	29	35.4%			
OAHI			24.9±17.9	18.85	[4.9 – 98.7]

VAS = Visual Analogue Scale for snoring; ESS = Epworth Sleepiness Scale; AHI = Apnea Hypopnea Index; OAHI = Obstructive Apnea Hypopnea index

3.3.4 Knowledge regarding OSA and the treatment options

In the next section of the study specific questionnaire, participants were asked whether they had any knowledge of OSA and if they were familiar with the different chosen treatment options, CPAP, MAD, and MMA. The results show that a slight minority of 35 participants (42.7%) have heard something about OSA (Figure 11A). The primary source of information were friends, acquaintances, and relatives (39.3%). The second most common source was their doctor (24.6%), followed by media and internet (each 16.4%), while others mentioned hearing about OSA through their work (3.3%) (Figure 11B).

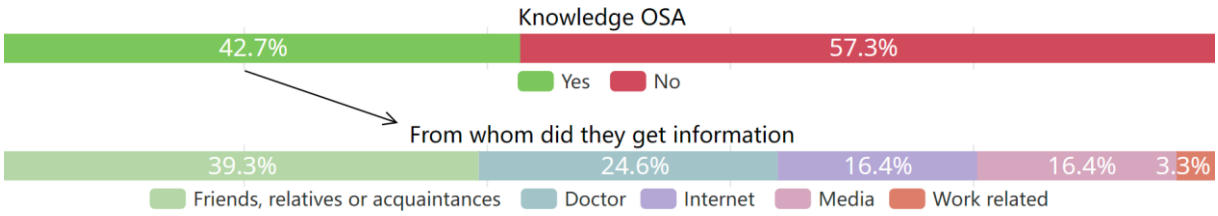


Figure 11: *A) Baseline Knowledge of OSA. B) Sources of OSA information*

The participants' knowledge about the treatment options for OSA varied a lot. Among the total study population, CPAP was the most known treatment, with 63 participants (76.8%) indicating that they had heard about CPAP. In comparison, 32 participants (39.0%) had heard of MAD, and only 16 participants (19.5%) mentioned hearing about MMA (Figure 12).

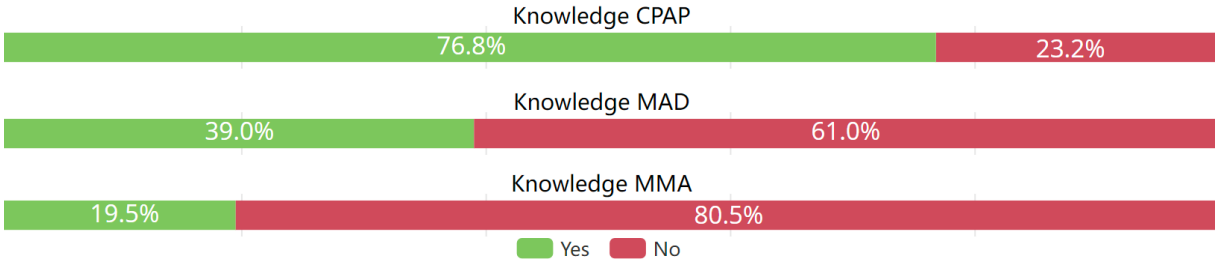


Figure 12: *Baseline knowledge of the treatment options: CPAP, MAD, and MMA*

An interesting observation is that the prevalence of CPAP knowledge is higher compared to OSA knowledge. This indicates that a number of participants knew a treatment method without necessarily understanding the condition it addresses. Upon closer examination, among the 47 participants without OSA knowledge, 33 (70.2%) participants had treatment knowledge, meaning that they knew at least one treatment option (Figure 13A). Among the participants who did have treatment knowledge without have OSA knowledge, it is remarkable that all of them (100.0%) knew CPAP, 13 of them (39.4%) knew MAD and 3 participants (9.1%) knew MMA (Figure 13B).

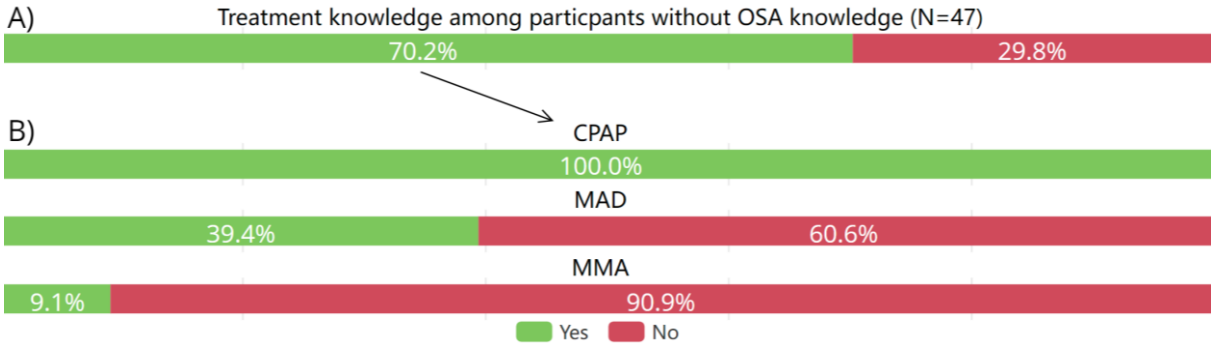


Figure 13: *A) Treatment knowledge of participants without OSA knowledge; B) These figures represent the separate treatment knowledge of participants without OSA knowledge.*

As treatment knowledge was questioned individually, an additional analysis was conducted to assess combined treatment knowledge. Results showed that that only 12 participants (14.6%) knew all treatment options, while 17 (20.7%) participants did not know any treatment. In addition, 29 participants (35.4%) only knew CPAP, and 2 participants (2.4%) only knew MMA. Furthermore, 2 participants (2.4%) knew both CPAP and MMA but had not heard of MAD. Lastly, 20 participants (24.4%) knew both CPAP and MAD but did not know MMA (Figure 14). This also means that there were no participants that only knew MAD treatment, and that there were no participants that knew MAD and MMA but did not know CPAP.

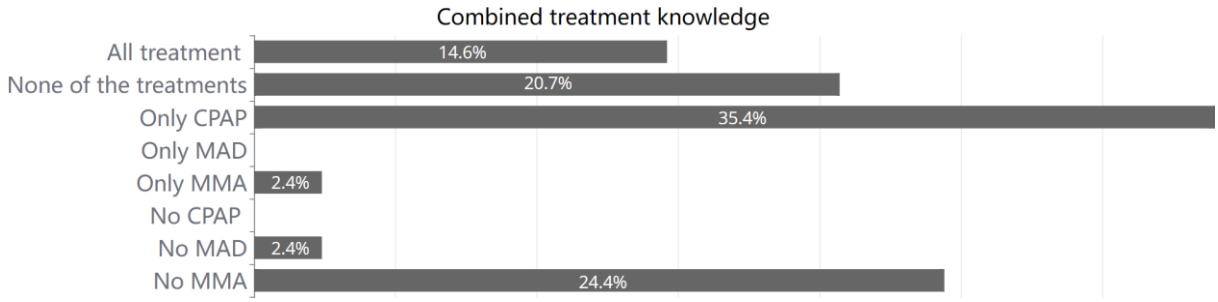


Figure 14*: Combined treatment knowledge of the participants. The numbers in the figure represent the percentages, based on the total study population of 82 participants.*

To see whether OSA knowledge was associated with treatment knowledge, chi square analyses have been conducted. The results show that OSA knowledge was not significantly associated with CPAP knowledge (p=0.0999) (Figure 15A). However, there were statistically significant associations with both MAD and MMA knowledge with p-values of 0.0145 and 0.0005 respectively (Figure 15B-C).

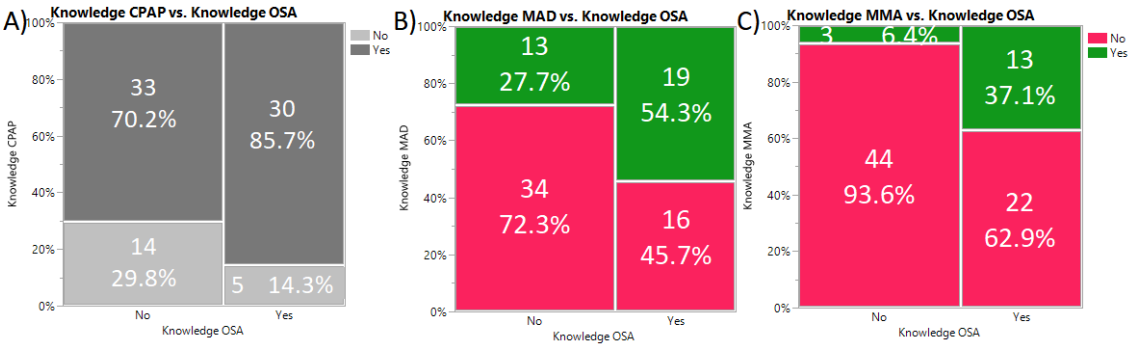


Figure 15*: *Correlation analysis results of OSA and treatment knowledge. *A) There is no significant association between OSA and CPAP knowledge. However, there is a statistically significant association between OSA knowledge and both B) MAD (p=0.0145) and C) MMA (p=0.0005) knowledge.*

In addition chi square analyses have been done to visualize whether the knowledge of the different treatments are associated to each other. It was found that CPAP and MAD knowledge were statistical significantly associated with each other with a p-value of <0.0001 (Figure 16A). Similarly, MAD and MMA knowledge were statistical significantly associated with each other with a p-value of 0.0010 (Figure 16B). However, there was no statistically significant association between CPAP and MMA knowledge with p-value of 0.2595 (Figure 16C).

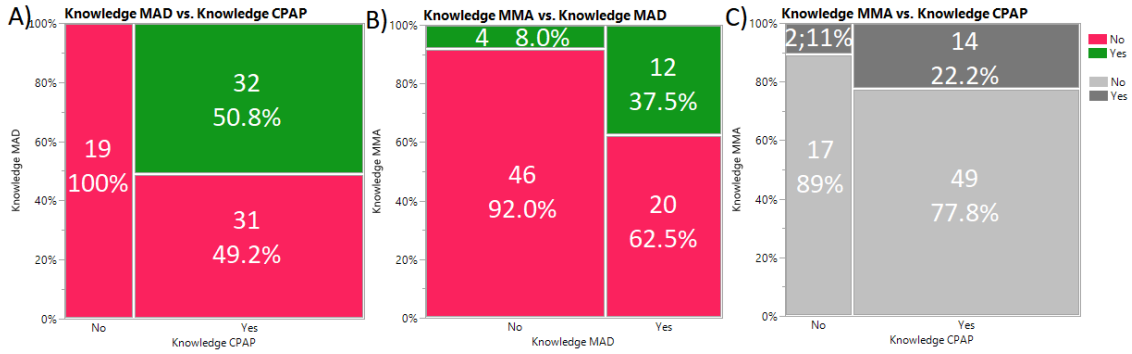


Figure 16*: *Correlation analysis results of treatment knowledge. *There is a statistically significant association between A) CPAP and MAD knowledge with p-value of <0.0001 and B) MAD and MMA knowledge with p-value of 0.0010. However, there is no significant association between CPAP and MMA knowledge (p=0.2595).*

To evaluate the potential impact of various patient demographics including age and sex, as well as their living and working conditions, and PSG results including the OAHI, VAS snoring, and ESS, on participants' OSA and treatment knowledge, nominal logistic regression analyses were conducted. The results indicated that the age of the participants had a significant impact on OSA (p=0.0281), CPAP (p=0.0377) and MAD knowledge (p=0.0024) (Figure 17A-C). Younger participants tend to have higher knowledge regarding OSA, CPAP and MAD compared to older participants. There was no significant association between age and MMA knowledge (p=0.5445), however there was an association between MMA knowledge and OAHI values, reflecting the severity of OSA (p=0.0235) (Figure 17D). Participants with lower OAHI values tended to exhibit higher MMA knowledge than those with higher OAHI values. But, considering the average values for both groups, specifically 21.9 for the group without knowledge and 17.0 for the group with knowledge, it is remarkable that there is no difference in OSA severity, since they both fall within the moderate OSA category.

In addition to these findings, there were no other factors found to have a significant influence on participants' knowledge of OSA or treatment options. This suggests that factors such as the living situation, education attainment, work circumstances, VAS snoring and ESS did not appear to noticeably impact the levels of knowledge observed.

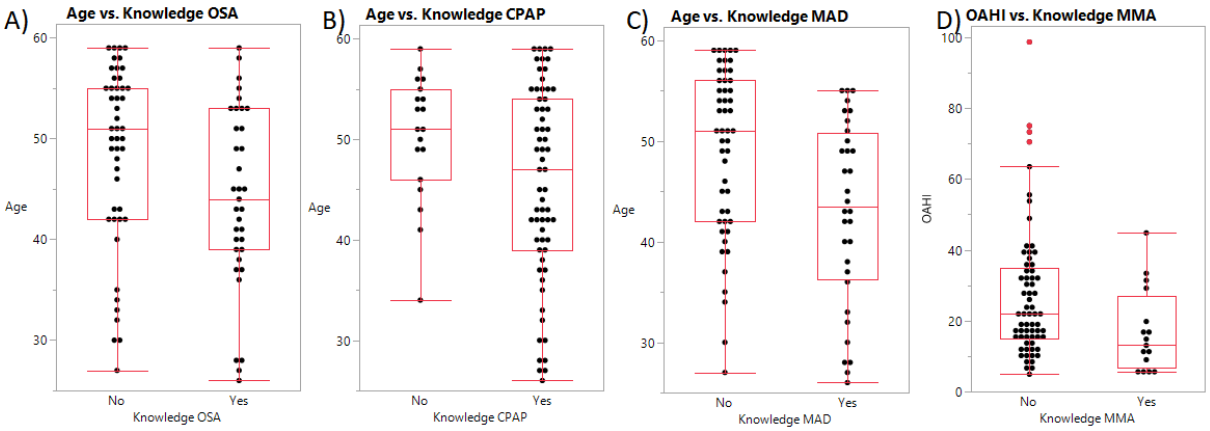


Figure 17: *Representation of the associations between the age and OAHI of the participants and their OSA and treatment knowledge. Younger participants tend to have more A) OSA (p=0.0281), B) CPAP (p=0.0337), and C) MAD (p=0.0024) knowledge compared to older participants. D) Regarding MMA, participants with lower OAHI values tend to have more MMA knowledge compared to those with higher OAHI values (p=0.0235).*

3.3.5 Treatment Choices

Regarding treatment choice, participants were asked to indicate their motivations for initiating treatment and to identify key factors that would influence their decision. Each participant was allowed to select maximum two answers for each question. Most of the participants (53.7%) expressed the desire to initiate treatment in order to be better rested in the morning. The second most common reason was the desire to stop snoring (36.6%), followed by the motivation to protect their heart and blood vessels (30.5%). The least important reason appeared to be avoiding falling asleep in front of the TV (1.2%) (Figure 18A).

Regarding key factors that would be important for treatment choice, most participants (82.9%) expressed that a good explanation from a doctor is highly important. The next factors considered to be important were the opinion of their partner (28.0%), and the overall experience of their environment (20.7%). The number of follow-ups required by the chosen treatment did not appear to be important for these participants (3.7%). In addition to the predefined choices, participants were given the opportunity to provide other factors that would influence their decision. These other factors included sleeping comfort/discomfort, dependency on therapy, and effectiveness of the treatment (Figure 18B).

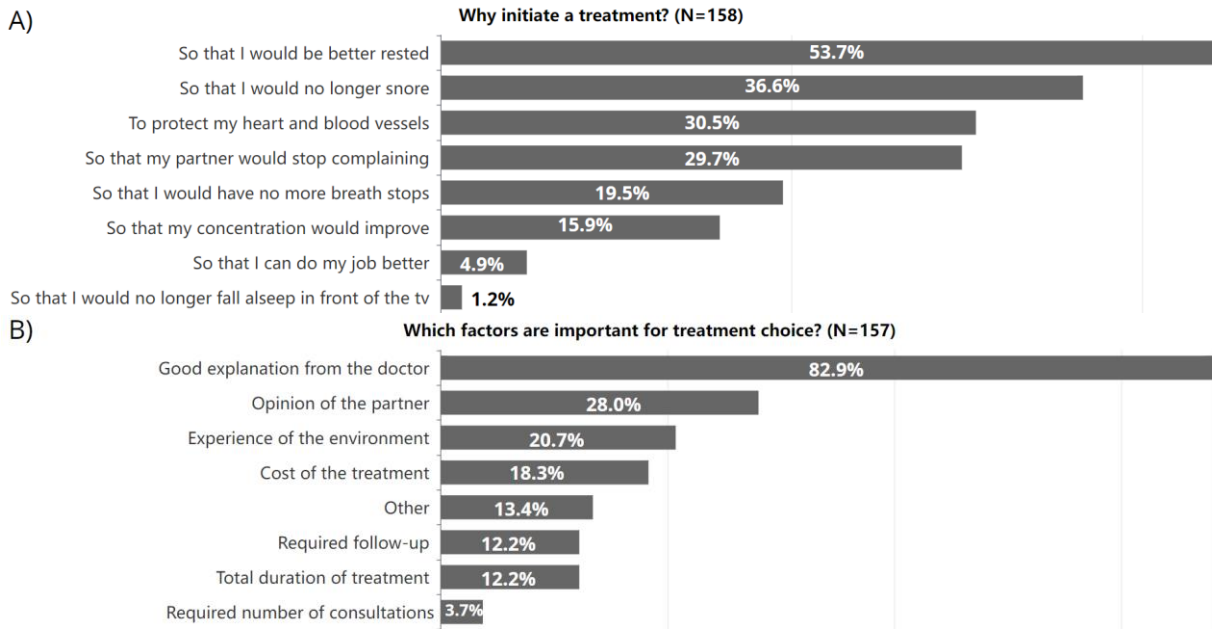


Figure 18: A) *Most important reasons for treatment initiation; B) Most important factors for treatment choice; The number in the figure represent the percentages that were calculated based on the total amount of participants, N=82*

Prior to receiving a brief explanation about the treatments, participants were asked to indicate whether they would choose each of the treatment options or not. The choices for CPAP and MAD treatment were very similar, with 37 participants (45.1%) indicating that they would opt for these treatments. In contrast, only 8 participants (9.8%) indicated that they would choose for MMA as treatment option. Smaller portions of the study group indicated to not choose for CPAP (17.1%) and MAD (15.9%), while a large group chose not to want MMA (42.7%). The remaining participants indicated that they did not know whether they would choose for these treatment options or not (Figure 19A).

After the participants read a brief explanation of each treatment, they were asked to reconsider their treatment choices. It is important to note that participants were no longer given the option to choose "I don't know". The majority of participants indicated that they would choose for CPAP (69.5%). MAD was the second most preferred option (65.9%), and MMA remained the least preferred treatment choice among the participants (20.7%) (Figure 19B).

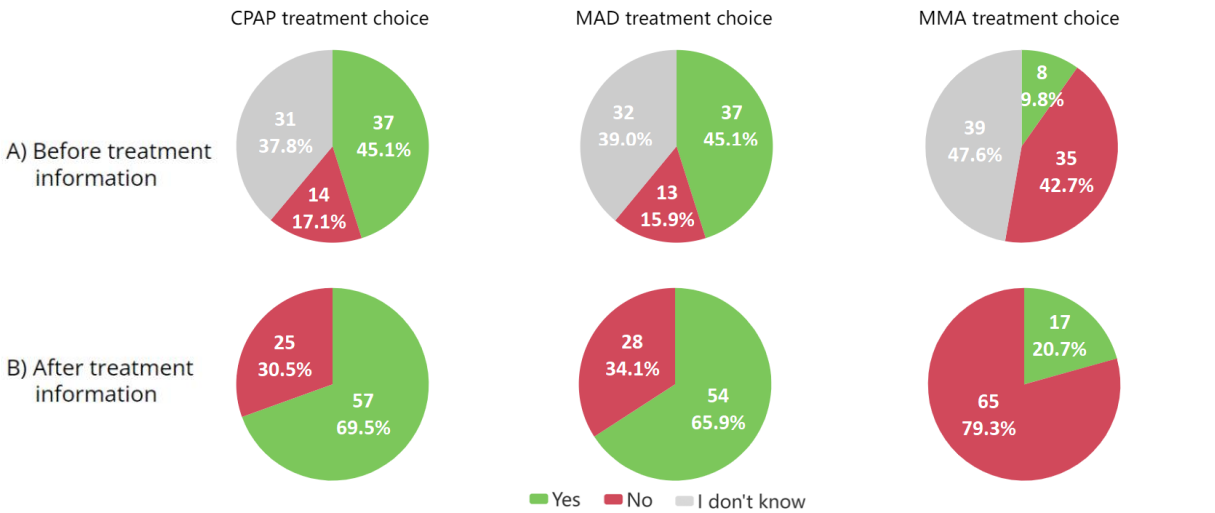


Figure 19: Treatment choices. *A) These graphs reflect the treatment choices of the participants before receiving any information about the treatments. B) These graphs reflect the treatment choices of the participants after receiving information about the treatments.*

As participants were able to choose multiple treatments, a summary of the participants' combined choices is given below. Out of the 82 participants, 7 participants (8.5%) would opt for all treatments, while 6 participants (7.3%) would not choose any of the treatments. 31 of the participants chose only one treatment, more specifically, there were 18 participants (22.0%) who only chose CPAP, 10 participants (12.2%) who only chose MAD and only 3 participants (3.7%) that specifically chose for MMA. The remaining 38 participants chose 2 treatment options, and thereby excluded one of the treatments. There were 6 participants (7.3%) who excluded CPAP, only 1 participant (1.2%) excluded MAD and 31 participants (37.8%) excluded MMA (Figure 20).

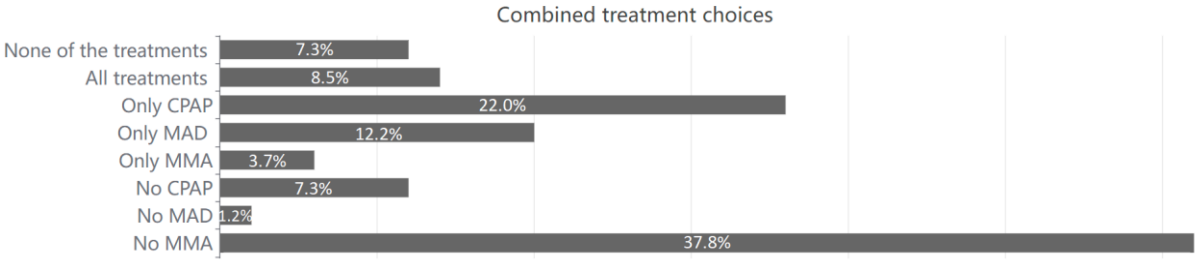


Figure 20: Combined treatment choices: *This represents the combined treatment choices of the participants, since they were able to select more than one treatment.*

To visually represent the changed treatment choice of the participants, a new variable, "Change", was created. For CPAP, only participants that initially chose “I don’t know” changed their opinion. Out of the 31 participants in this category, 20 individuals selected "yes" for CPAP, while the remaining 11 participants chose "no" instead. For MAD, out of the 32 participants who had initially selected "I don't know," a total of 15 participants ultimately chose “yes”, and the remaining 17 participants did not. In addition there were 4 participants who changed their minds regarding their treatment preference. Among these 4 participants, 2 individuals initially chose "yes" but changed to "no", while the other 2 participants initially chose "no" but later changed their preference to "yes”. In the case of MMA, 8 out of the 39 participants who initially selected "I don't know”, ultimately decided to choose MMA as a treatment option, while the remaining 31 participants did not. Similarly to MAD, 3 participants changed their minds regarding their preference for MMA. One participant switched from an initial "yes" to "no”, while the other two changed from an initial "no" to "yes" (Figure 21).

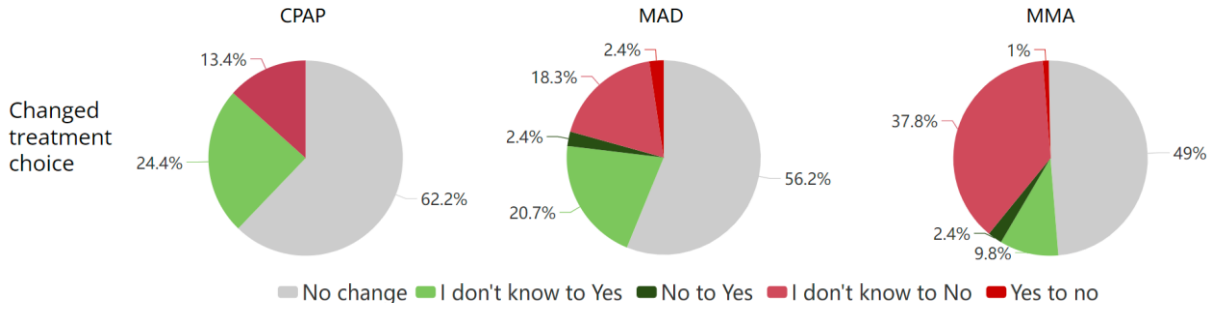


Figure 21: Changed treatment choices: *This graph represents the changed treatment choices of the participants after they received some brief explanation of each treatment.*

In addition to providing their treatment choices separately, participants were asked to rank them, with their preferred treatment assigned the first place. The results showed that CPAP was most frequently ranked as number 1 choice by participants (43.9%), followed by MAD (40.2%), and MMA received the lowest number of first place rankings (15.9%). When considering the second place, MAD therapy was chosen most often (46.3%), followed by CPAP (35.4%), and MMA remained in last place with 15.9%. In terms of the least preferred treatment, MMA received the highest percentage (68.3%), followed by CPAP (20.7%), and MAD (13.4%) (Figure 22).

Thus, the ranking confirms the results of the separate treatment choices, creating a consistent preference pattern among the participants, with CPAP being the most favoured treatment, followed by MAD, and MMA ranked last.

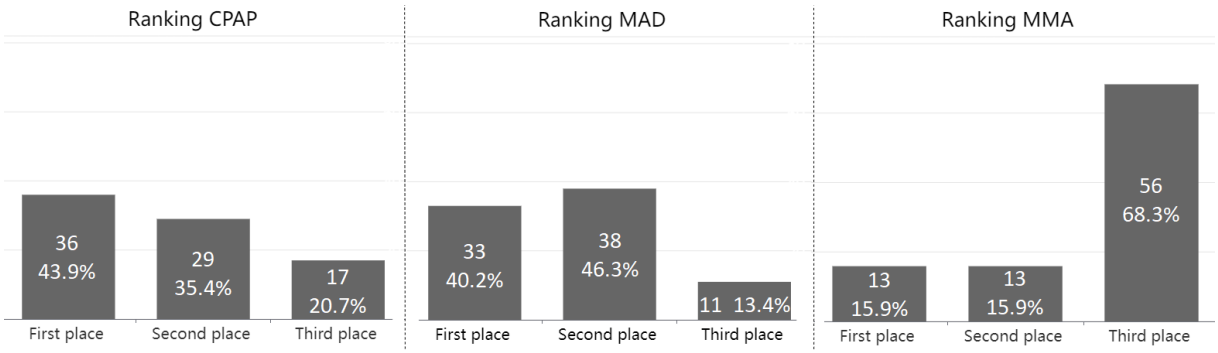


Figure 22: Treatment ranking. *These graphs represent the ranking for each treatment.*

To evaluate the potential impact of various patient demographics including age and sex, as well as their living and working conditions, and PSG results including the OAHI, VAS snoring, and ESS, on participants' treatment choices, nominal logistic regression analyses were conducted. However, none of the variables exhibited any influence on the participants' treatment choices, except for the ESS score, which showed an association with the MMA treatment choice. It was observed that patients opting for MMA tended to have higher ESS scores (p=0.143) (Figure 23).

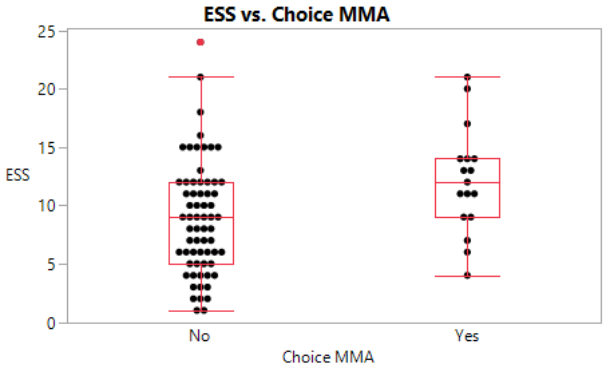


Figure 23: *Representation of the associations between the OAHI value and the MMA treatment choice. Participants with higher OAHI values are more likely to choose MMA treatment compared to participants with lower OAHI values.*

3.3.6 Treatment-related characteristics and side-effects that affect treatment choices

In the last section of the questionnaire, participants were first presented a list of twelve important treatment-related characteristics, without showing which characteristic is linked to which treatment. They were asked to rank these characteristics from most to least important. A final ranking has been created based on the number of times each characteristic was ranked as number 1, meaning most important. The characteristic ranked as most important, was guarantee on success of the treatment, if a device is used correctly. This was followed by the fact that the treatment does not require surgery and has a quick start-up. A complete overview of the ranking is provided in Table 3.

Table 3: Ranking of most to least important treatment characteristics

Ranking	Characteristic	Related treatment	Number of times #1	
1	Guarantee on success if the device is used correctly	CPAP	20	24.4%
2	No surgery required	MMA	18	22.0%
3	Rapid treatment start-up	CPAP	13	15.8%
4	No noise (30 dB) from a device during the night	CPAP	11	13.4%
5	No lifelong commitment to an appliance (+power)	CPAP	4	4.9%
6	No lifelong commitment to a mouthpiece	MAD	4	4.9%
7	I desire no impact on my appearance	MMA	4	4.9%
8	No recovery period required	MMA	3	3.7%
9	Cost of a therapy	CPAP/MAD/MMA	2	2.4%
10	No anaesthesia required	MMA	2	2.4%
11	I want a positive change on my appearance	MMA	1	1.2%
12	No annual follow-up required	CPAP/MAD	0	0.0%

In the last question, participants were given a list of nine side-effects, again associated with one or more of the treatments. Without mentioning which side-effects was linked to which treatment, participants were asked to indicate the level of concern they had regarding each side effect, using a scale ranging from "not radical" to "very radical". A final ranking was made based on the number of times each characteristic was ranked as “very radical.” The side effect perceived as most radical was temporary nerve damage that can occur after MMA treatment. This was followed by teeth displacements, and on the third place, complaints related to the masseter muscles and jaw joint, which both can occur as a result of MAD treatment. According to the participants, the least radical side effects were mainly associated with CPAP and MAD treatment, and included nasal complaints, dry mouth, and increased salivation. A complete overview of the ranking is provided in Table 4.

Table 4: Ranking of most to least radical treatment related side-effects

Ranking	Side effect	Related treatment	Number of times as very radical	
1	Temporary nerve damage	MMA	34	41.5%
2	Teeth displacement	MAD	28	34.1%
3	Complaints of masseter muscles and the jaw joint	MAD	18	22.0%
4	Temporary discomfort after surgery	MMA	12	14.6%
5	Nasal complaints	CPAP	9	11.0%
6	Pressure of a face mask	CPAP	7	8.5%
7	Increased salivation	MAD	4	4.9%
8	Masking spots upon waking	CPAP	4	4.9%
9	Dry mouth	CPAP/MAD	3	3.7%

Nominal logistic regression analyses were conducted to examine if the treatment choices are associated with the characteristics ranking and the perceived severity of the side-effects. For CPAP therapy, four characteristics were found to have a statistically significant influence on treatment choice. Participants who chose CPAP therapy considered a rapid treatment start-up ($p=0.0055$) and the success of treatment, if a device is used correctly ($p=0.0053$) to be statistical significantly more important compared to those who did not choose CPAP (Figure 24A-B). Furthermore, they value significantly less importance to the requirement of a lifetime commitment to a mouthpiece ($p=0.0042$) or an appliance that requires power ($p=0.0010$), compared to individuals who did not choose CPAP (Figure 24C-D). A statistically significant model could be built based on two of these characteristics: no lifetime commitment to an appliance that requires power and guarantee of treatment success. The model had a p-value of 0.0002 and a misclassification rate of 23.2%. This means that the model will make incorrect predictions about CPAP choice in approximately 23.2% of cases, based on these two characteristics.

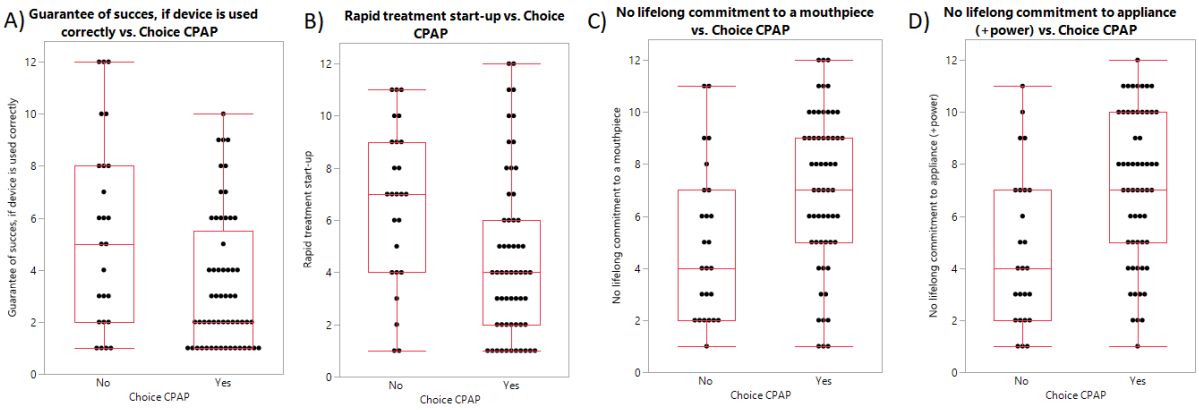


Figure 24: Visual representation of the associations between CPAP treatment choice and treatment related characteristics*. This figure represents the characteristics that have a statistically significant impact on the CPAP treatment choice. Characteristics that were significantly more important to the participants that chose CPAP were: A) Guarantee of success, if the device is used correctly (p=0.0053), and B) rapid treatment start-up (p=0.0055). Characteristics that were significantly less important to the participants that chose CPAP were: C) No lifelong commitment to a mouthpiece (p=0.0042) and D) No lifelong commitment to an appliance that requires power supply (p=0.0010).*

None of the characteristics showed a statistically significant influence on the MAD treatment choice. However, in the case of MMA treatment, several characteristics were found to be statistically significant. Participants who chose MMA treatment attached significantly more importance to no lifetime commitment to a mouthpiece (p=0.0002) or an appliance that requires power (p<0.0001), and no noise at night coming from that appliance (p<0.0001), compared to those who did not choose MMA (Figure 25A-C). On the other hand, certain characteristics were considered significantly less important by those who chose MMA, including the requirement for surgery (p<0.0001), a quick treatment start-up (p=0.0125), and a recovery period (p=0.0011) (Figure 25D-F). Once again, a statistically significant model could be made using two characteristics: no lifetime commitment to a mouthpiece and no noise from a device during the night. The model shows an overall p-value of <0.0001 and a misclassification rate of 8.5%. This indicates that the model will provide a correct prediction about the MMA treatment choice in 91.5% of cases, based on those two characteristics.

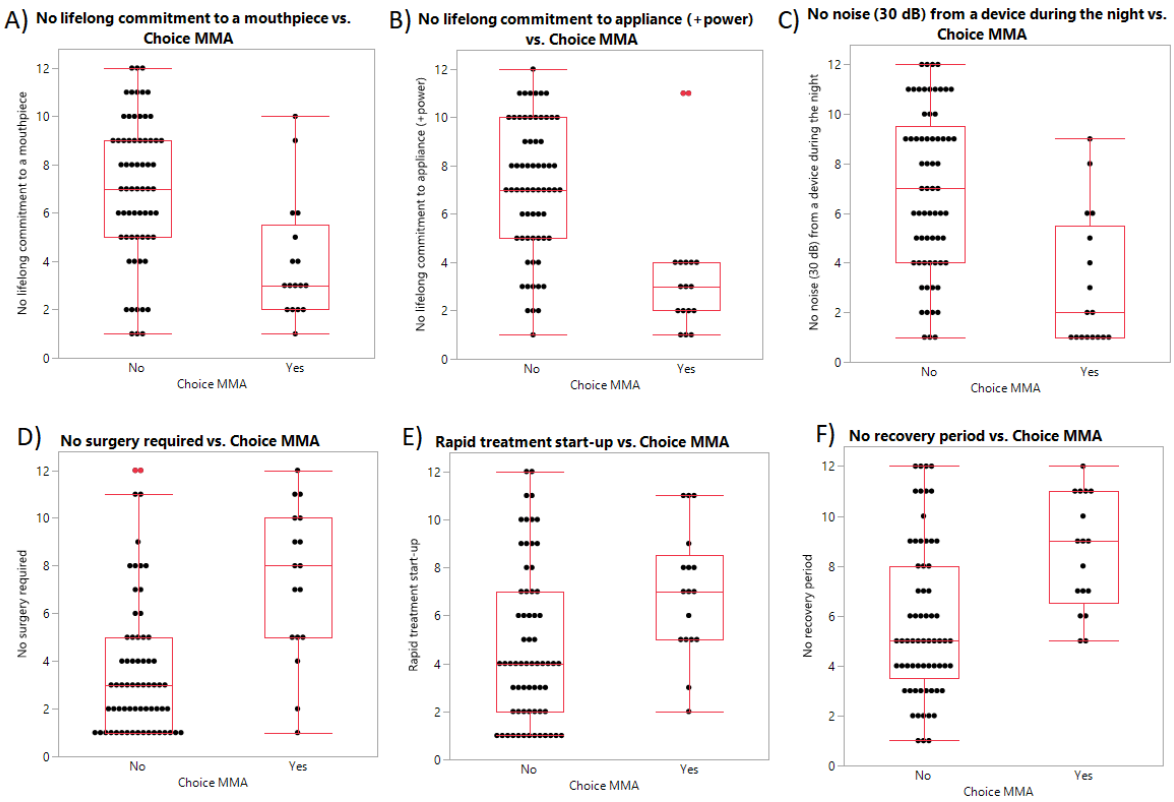


Figure 25: Visual representation of the associations between MMA treatment choice and treatment related characteristics
This figure represents the characteristics that have a statistically significant impact on the MMA treatment choice. Characteristics that were statistical significantly more important to the participants that chose MMA were: A) No lifelong commitment to a mouthpiece (p=0.0002), B) No lifelong commitment to an appliance that requires power supply (p<0.0001), and C) No noise (30dB) from a device during the night (p<0.0001). Characteristics that were statistical significantly less important to the participants that chose MMA were: D) No surgery required (p<0.0001), E) Rapid treatment start-up (p=0.0125), and E) No recovery period (0.0011).

Additionally, the perceived importance of the side effects were associated with treatment choice. This has been done by chi square analyses, since the results of the nominal logistic regression were unstable due to the presence of too many categories, and thus unreliable for interpretation. As a result, only the individual level was taken into account, and no general models could be made.

For CPAP, only one side effect, the pressure of a face mask, was statistical significantly associated with treatment choice (p=0.0123). Participants who chose CPAP therapy perceived the pressure of a face mask as less radical compared to those who did not choose CPAP (Figure 26A). For MAD treatment, there were two side-effects statistically significant, including increased salivation (p=0.444) and complaints of the masseter muscles and jaw joint (p=0.0203). Participants who chose MAD therapy perceived both side effects as less radical compared to those who did not choose MAD (Figure 26B-C).

Finally, for MMA, there were multiple side-effects that had a statistically significant impact on the MMA treatment choice. Participants who chose MMA therapy perceived several side effects as less radical compared to those who did not choose MMA. Some of these are related to MAD treatment, including increased salivation (p=0.0466), teeth displacement (p=0.0213), and complaints of the masseter muscles and jaw joint (p=0.0013) (Figure 26D-F), while other are directly related to MMA treatment, including temporary discomfort after surgery (p=0.0009) and temporary nerve damage (p<0.0001) (Figure 26D-H).

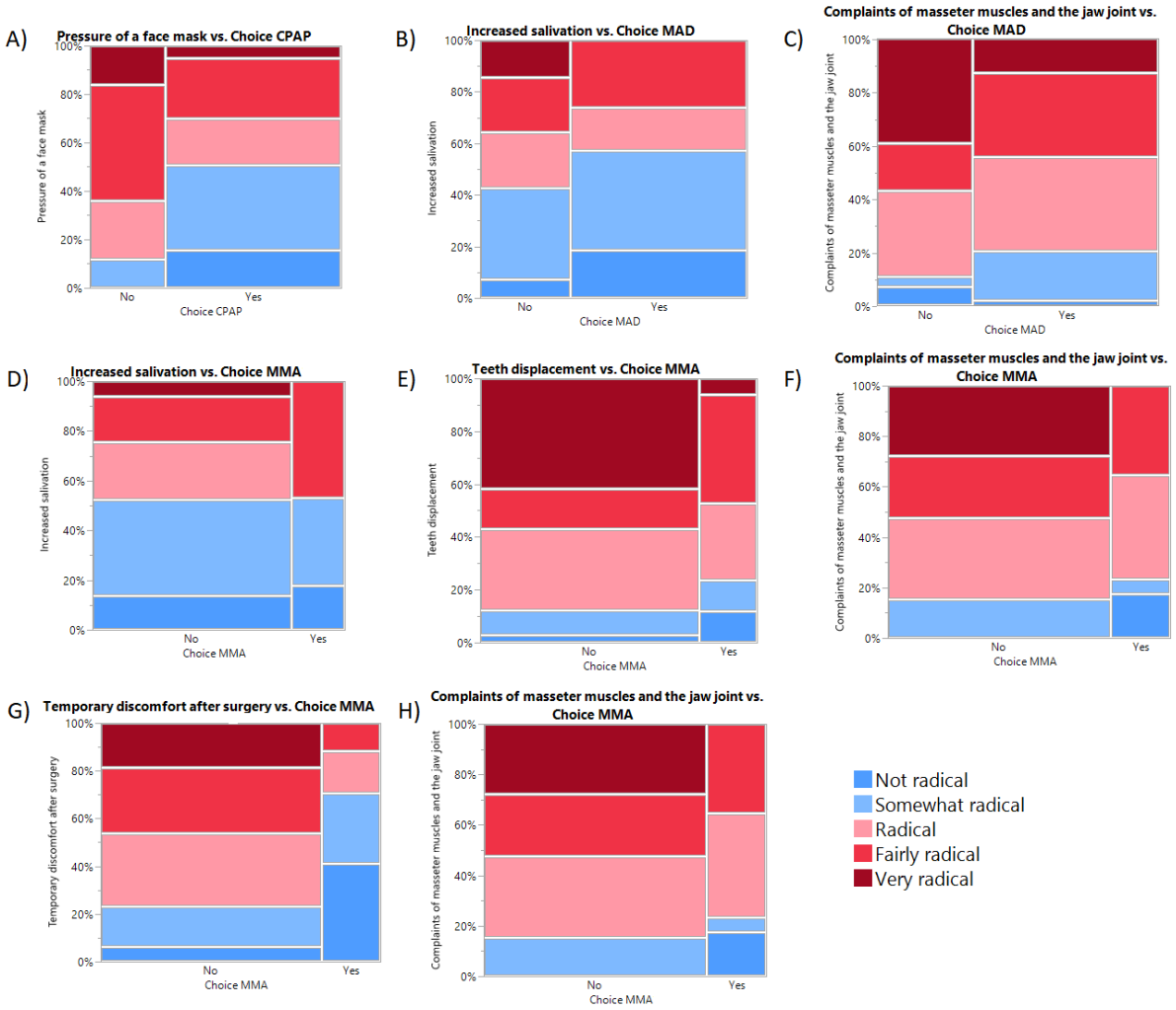


Figure 26: *This figure represents the side-effects that have a statistically significant impact on the treatment choices. Those who opted for the treatment perceived these side effects as less severe in comparison to those who did not choose the treatment. For CPAP: A) Pressure of a face mask (p=0.0037); For MAD: B) Increased salivation (p=0.0281) and C) Complaints of the masseter muscles and jaw joint (p=0.176). For MMA: D) Increased salivation (p=0.0122), E) Teeth displacements (p=0.0141), F) Complaints of the masseter muscles and jaw joint (p=0.006), G) Temporary discomfort after surgery (p=0.0009), and H) Temporary nerve damage (p=0.0001).*

3.4 Discussion

3.4.1 Knowledge

The present study reveals variation in knowledge of OSA and OSA treatments among recently diagnosed OSA patients. Out of the study population, 42.7% of the participants reported having baseline knowledge of OSA, primarily obtained from friends, relatives, or acquaintances. These results differ from a previous study conducted by Sia et al., who reported only 20% of their participants having OSA knowledge, with newspapers serving as the primary information source (Sia et al., 2017). However, it is important to note that Sia et al. used the general population as study group, instead of the OSA patient population that was used in this study. Furthermore, the increasing prevalence of OSA (Lyons et al., 2020), combined with rising media attention for sleep problems, including OSA (Johan Verbraecken, 2020; Johan Verbraecken, 2022; Saerens, 2020) since the conduct of the study by Sia et al. in 2017, may also contribute to these differences.

When comparing our study population to the general population, notable differences arise. Firstly, the mean BMI of our study population is higher than the reported average value of 25.5 among the Belgian population (Sciensano, 2018). This can be explained by the fact that our study population comprises individuals diagnosed with OSA, where obesity is more prevalent as known risk factor, leading to higher overall BMI values (Choi, 2021). Additionally, there is a higher level of educational attainment among the participants, with everyone at least having a secondary education degree. Moreover, the average personal net income of our study population is higher compared to the general population, with no participants reporting an income below €1,000/month (Vlaanderen, 2023a, b). Thus, a specific segment of the population, with low educational level and low income, is not represented by these analyses. Due to the limited diversity and variability within these groups, the analyses were unable to produce conclusive or significant results for these variables. Thus, despite not intentionally selecting certain groups during the enrolment process, some form of selection bias did occur. This might be explained by considering that individuals with higher education and income tend to actively seek health information more often (Anker et al., 2011), which in its turn may result in them visiting the sleep centre more rapidly to get a diagnosis for their health concern.

Regarding treatment knowledge, CPAP was the most known treatment option among participants, followed by MAD, and MMA was least known. This result might be explained by the fact that CPAP is seen as the gold standard and first-line treatment for OSA (Epstein et al., 2009; Nogueira et al., 2018). Consequently, CPAP usage is most prevalent, potentially resulting in better knowledge among the population.

Besides evaluating knowledge for each item separately, the study investigated the relation between the knowledge of OSA, CPAP, MAD, and MMA. Participants who had OSA knowledge were significantly more likely to also know MAD and MMA, compared to those without OSA knowledge. However, this relationship was not observed for CPAP. This difference can be explained by more people having knowledge about CPAP (76.8%) compared to OSA (42.7%), meaning that some participants knew a treatment method without knowing the condition it addresses. Additionally, there was a significant correlation between knowledge of CPAP and MAD, as every participant who had MAD knowledge also had CPAP knowledge. Similarly, individuals with MAD knowledge were more likely to have MMA knowledge. However, there was no statistically significant relationship found between CPAP and MMA knowledge, suggesting that these two are unrelated.

Regression analysis of OSA and treatment knowledge revealed that younger patient had more OSA, CPAP, and MAD knowledge. Younger individuals tend to display more active health seeking behaviour and are more inclined to utilize the internet as a resource for acquiring health-related information (Anker et al., 2011; Beck et al., 2014). Consequently, considering both factors could explain higher knowledge in younger people. On the other hand, MMA knowledge was associated with lower OAHI values, however the mean values of both groups show that there is no difference is OSA severity between both groups.

No other factors were found to have a significant influence on participants' knowledge of OSA or treatment options. This suggests that factors such as living situation, education, and work circumstances did not appear to noticeably impact the levels of knowledge observed. However, this can be explained by the poor distribution of these variables as mentioned earlier. Furthermore, both the VAS snoring and ESS do not significantly influence the knowledge, meaning that the level of burden experienced by the patients is not linked to their knowledge.

3.4.2 Mindset

Regarding the mindset of the participants, this study highlights the importance of clear explanations from healthcare professionals in the treatment decision-making process, since participants indicated that a good explanation from a doctor was the most crucial factor when initiating treatment. The fact that the majority of participants in this study initially chose the "I don't know" for their treatment choice, indicates a lack of sufficient baseline knowledge to make an informed decision. Therefore, providing comprehensive explanations becomes crucial to enable patients to make well-informed treatment choices. This observation is consistent with a study conducted by Beisecker, wherein patients clearly expressed the significance they place on acquiring comprehensive information from their healthcare physician (Beisecker en Beisecker, 1990).

Following the brief explanation of the treatments, the majority of individuals expressed a preference for CPAP as their primary choice, followed by MAD, and MMA as least preferred treatment among the participants. This aligns with expectations, since MMA is an invasive treatment that requires a recovery period, and it may not be suitable for all patients, which makes it not a first-line treatment (Yu et al., 2020). In contrast, CPAP is seen as the gold standard first-line treatment since it is effective, non-invasive, and can be offered to all patients. However, CPAP requires acceptance, tolerance, long term follow-up, and compliance to be effective (Epstein et al., 2009). MAD was also frequently favored as treatment option. It is also a non-invasive treatment, but it is more convenient than CPAP, since it is portable, requires no power supply, and makes no noise (Handi, 2016). But, like MMA, not everyone is eligible for treatment with MAD (Sutherland et al., 2014).

Studies already have shown that due to poor tolerance and compliance the clinical impact of CPAP significantly reduces, leading to residual OSA (Phillips et al., 2013; Vanderveken et al., 2013). Compared to CPAP, MAD shows higher compliance rates and fewer side effects (Dieltjens et al., 2012). A study conducted by Vanderveken et al. used the mean disease alleviation (MDA), calculated based on the compliance and therapeutic effectiveness, to determine the overall effectiveness of MAD therapy, and compared this with the overall effectiveness of CPAP therapy. This resulted in 51.1% overall effectiveness for MAD therapy which makes it comparable to the 50.0% CPAP effectiveness determined by Grote et al. (Grote et al., 2000; Vanderveken et al., 2013). When looking at severe OSA, CPAP is generally seen as treatment option, since MADs are less successful in the treatment of severe OSA compared to mild and moderate OSA (Vanderveken et al., 2013). However, this perspective may be challenged by the study conducted by Phillips et al. which indicated similar health outcomes in patients with moderate to severe OSA for both CPAP and MAD treatments. This finding was, again, the result of greater efficacy of CPAP but inferior compliance compared to MAD (Phillips et al., 2013).

So although CPAP is commonly considered as gold standard, first line treatment, MAD appears to be equally effective. This information is crucial to consider when formulating treatment recommendations. As previously mentioned, MMA is not a first-line treatment but can offer a permanent solution for OSA, in contrast to CPAP and MAD. However, it is necessary for a patient to undergo a successful MAD treatment before considering and initiating MMA treatment. However, incorporating MAD as first-line treatment option, rather than only relying on CPAP, might exceed the MMA trajectory start-up for eligible patients who express a preference for MMA because patients then do not have to go through CPAP treatment first if they do not want to opt for this.

The last part of this study required participants to rate the importance and impact of therapy-related characteristics and side effects. The most influential factor for treatment choice was the guarantee of treatment success, followed by the non-surgical nature and quick start-up of a treatment. Regarding side effects, temporary nerve damage associated with MMA was perceived as the most radical, followed by teeth displacements and complaints related to the masseter muscles and jaw joint, both potential side effects of MAD.

The results of regression analyses indicated significant associations between treatment choices and both the treatment-related characteristics and side effects. The alignment of characteristics and side effects with the treatment choices suggest that patients understood the brief explanation of the treatments. Regarding the characteristics, CPAP was linked to guarantee of success, rapid treatment start-up, and lifelong commitment to a mouthpiece or appliance that requires power, while no statistically significant associations were found for MAD. However, six characteristics showed statistical significance for MMA and a significant model was constructed using two of these characteristics, including no lifelong commitment to a mouthpiece and no noise from a device during the night, resulting in a model with an 8.5% false prediction rate for MMA choice.

Side-effects were also examined. Association analyses revealed that, for patients choosing CPAP, the pressure of a face mask seemed to be less radical compared to those not choosing CPAP. For MAD patients choosing MAD increased salivation, and complaints of the masseter muscles and jaw joint were significantly less radical to those not choosing MAD. For patients choosing MMA all of the following seemed less radical than to the participants not choosing MMA: Increased salivation, teeth displacement, complaints of the masseter muscles and jaw joint, related to MAD treatment and temporary discomfort after surgery, and temporary nerve damage, related to MMA treatment. This reaffirms that the participants' understood the explanations of the treatments.

3.4.3 Limitations and future perspectives

It is important to acknowledge certain limitations of this study, such as its focus on only three treatment modalities, including CPAP, MAD, and MMA, while there are many other treatments available. Further, the study might have had selection bias due to exclusion of non-Dutch-speaking patients and by including only those patients who visit the sleep centre. Due to the observed differences between our study population and the general population, which may have resulted in the exclusion of certain population groups, it is not possible to draw conclusions that can be generalized to the broader population.

In future studies, a study population that does represent the general population should be used. In addition, conducting this study among patients who have already undergone a certain period of treatment may provide completely different results due to their treatment experiences. Therefore, it may be valuable to explore this aspect in future research.

4 Journey

4.1 Objectives

- Which treatment proposal do OSA patients receive after their first diagnostic PSG?
- Do patients initiate treatment?
- Which treatment do OSA patients choose?

4.2 Material and methods

4.2.1 Study design and patient enrolment

The aim of this study has been achieved through an observational, descriptive case report study involving patients who were part of a previous study conducted by Dr. Ellen Collier in which they wanted to assess craniofacial measurements using 3D stereophotogrammetry and determine whether certain measurements are more typical of OSA patients and correlate with its severity (Collier et al., 2023).

In this study, the PSG results and treatment proposals for all 91 patients, who participated in the previous study, were analysed. Participants without OSA, thus an AHI<5, or those without any treatment proposal were excluded from the analysis. For the remaining participants, their subsequent treatment trajectory was determined by reviewing their electronic patient records.

Exclusion criteria

- AHI<5
- Patients without treatment proposal

4.2.2 Data collection and statistical analysis

All data for this study was obtained from electronic patient records and compiled into an Excel file. This comprehensive dataset encompassed various types of information, including demographic details, such as sex, age, and BMI, PSG results, including the AHI and OAHI, VAS snoring score, and ESS sleepiness score, and other characteristics such as the referring physician, treatment recommendations, and the ultimate treatment decision made by each patient.

The Excel file was imported into JMP® (Pro version 16.0.0, SAS Institute Inc., Cary, NC, 1989-2019), where all statistical analyses were conducted. To assess the normality of the data, the Shapiro-Wilk test and visual examination of histograms were employed. Descriptive statistics were applied to summarize the patient population, with continuous variables presented as mean, standard deviation, and range, and categorical variables reported as frequencies and percentages. To provide insights into any potential associations or influences between predictor variables and a categorical outcome variable, nominal logistic regressions were conducted.

4.3 Results

4.3.1 Patient enrolment and demographics

For this study, all 91 subjects from the study conducted by Collier et al. (Collier et al., 2023) were screened. Only participants with OSA, thus an AHI≥5, and that received a treatment proposal were included in the analysis. This resulted in a cohort of 72 patients (Figure 27). In the following section, the demographic information of the participants and the results of their PSG will be discussed. It should be noted that due to missing values in the patient records, some information may be incomplete or unavailable. Therefore, for each variable, the number of available results will be indicated to account for any missing values.

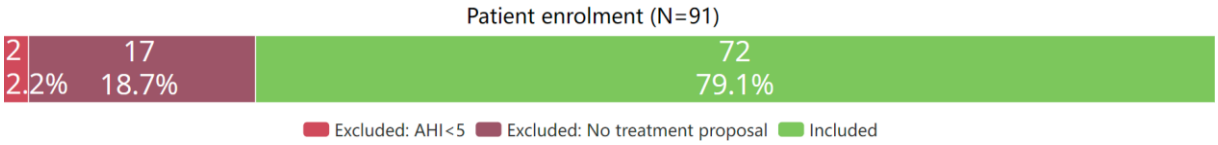


Figure 27: Patient enrolment. *Patient without an OSA diagnosis or a treatment proposal were excluded from statistical analysis.*

Among the 72 participants, 70.8% were male individuals. The average age of the study population was 47±12 years old, and the mean BMI was 30±7 kg/m^2. Similar to the approach taken in the previous section, a categorical variable was created for the BMI in this analysis as well (Table 5).

Table 5: Patient demographics of the study population *Categorical data are presented as number and percentage. The percentage is based on all 72 participants, unless specified otherwise. Continuous data are presented as mean±SD, median, and range.*

Variable	N	Categorical variables		Continuous variables		
		N	%	Mean±SD	Median	Range
Sex	**72**					
- Male		51	70.8%			
- Female		21	29.2%			
Age (years old)	**72**			47±12	37	[21 – 72]
BMI (kg/m²)	**71**			30±7	28	[21 – 50]
BMI categorical						
- Normal		12	16.9%			
- Overweight		29	40.8%			
- Obesity class I		15	21.1%			
- Obesity Class II/III		15	21.1%			

The majority of the participants (55.2%) underwent a diagnostic PSG at the request of their general practitioner. The remaining participants (44.8%) were referred by various specialists, including ear, nose and trhoat (ENT) doctors, cardiologists, obesity consultants, pneumologists, neurologists, and psychiatrists (Figure 28).

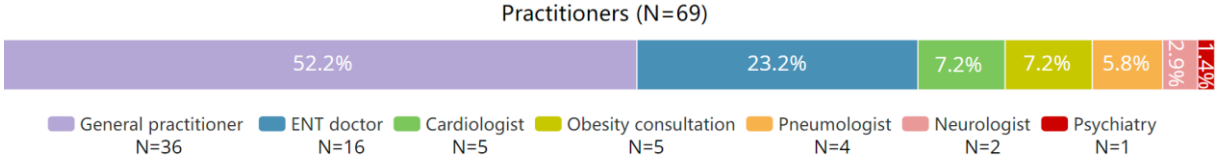


Figure 28: Referring practitioners. *Patients were either referred by their general practitioner or by a specialist such as the ENT doctor, cardiologist, obesity consultation, pneumologist, neurologist or psychiatrist.*

4.3.2 Polysomnographic results

As mentioned before, patients are required to complete general questionnaires in the sleep centre, including the VAS for snoring and ESS sleepiness test. For this cohort, the average VAS snoring score was 6±3. 65.6% of the participants had a VAS score ≥6, which is seen as socially disturbing (Rohrmeier et al., 2015). The ESS had an average of score of 10±5, with 45.7% of the participants exhibiting some form of increased daytime sleepiness of which 12.9% with severe excessive daytime sleepiness (Perotta et al., 2021).

Following the diagnostic PSG night, a report is generated including the AHI and OAHI. The average AHI was 25.1±21.3, ranging from 5.5 to 105.7, with an IQR of 10.1-30.5. The average obstructive apnea-hypopnea index (OAHI) was 22.8±18.1, ranging from 5.8 to 98.0, with an IQR of 10.9-26.9. Additionally, a categorical variable was created for the AHI in this analysis as well. However, the "no sleepapnea" category is not applicable since all participants had confirmed sleep apnea (Table 6).

Table 6: Polysomnographic results of the study population *Categorical data are presented as number and percentage. The percentage is based on all 72 participants, unless specified otherwise. Continuous data are presented as mean±SD, median, and range.*

Variable	N	Categorical variables		Continuous variables		
		N	%	Mean±SD	Median	Range
VAS snoring	**64**			6±3	7	[0 – 10]
- Not socially disturbing		22	34.4%			
- Socially disturbing		42	65.6%			
ESS (daytime sleepiness)	**70**			10±5	10	[0 – 18]
- Normal (ESS<10)		38	54.3%			
- Excessive (10≤ESS≤15)		33	32.8%			
- Severe excessive (ESS>15)		9	12.9%			
AHI	**72**			25.1±21.3	16.7	[5.5 – 105.7]
- Mild sleepapnea (5≤AHI<15)		27	37.5%			
- Moderate sleepapnea (15≤AHI<30)		26	36.1%			
- Severe sleepapnea (AHI≥30)		19	26.4%			
OAHI	**64**			22.8±18.1	16.6	[5.8 – 98.0]

VAS = Visual Analogue Scale for snoring; ESS = Epworth Sleepiness Scale; AHI = Apnea Hypopnea Index; OAHI = Obstructive Apnea Hypopnea index

Initially, a nominal logistic regression analyses was carried out to assess if there are associations between the OSA severity, expressed by the categorical AHI, and personal characteristics of the participants, including sex, age, and categorical BMI as well as the questionnaire responses comprising VAS snoring score and ESS sleepiness score.

There were no statistically significant associations found between the sex, VAS snoring, ESS and the OSA severity. The BMI of the participants, as a categorical variable, showed statistically significant association with the OSA severity with a p-value of 0.005. In addition, the age of the participants is also statistical significantly association with the OSA severity with a p-value of 0.0263. The age of the participants with mild sleepapnea(*) was significantly lower than the age of participants with moderate(+) or severe(+) sleepapnea (Figure 29).

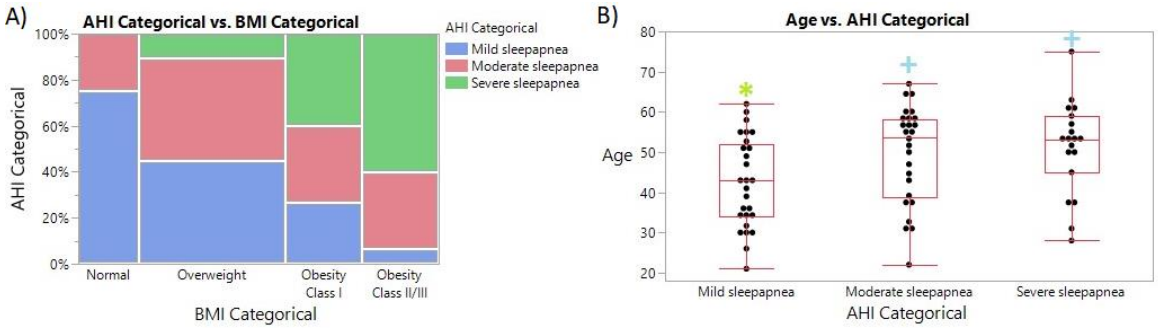


Figure 29: *A) The contingency plot between OSA severity represented as categorical AHI and the categorical BMI with p-value of 0.0005. B) The association between OSA severity represented as categorical AHI and the age of the participants with a significant p-value of 0.0263.*

4.3.3 Treatment proposals

Based on the sleep study results, that are compiled in a letter, a treatment is proposed. 25 participants (34.7%) received multiple treatment proposals of which 17 participants (23.6%) received two proposals, and 8 participants (11.1%) three proposals. This brings the total of treatment proposals to 104. These included CPAP (65.3%), MAD (30.6%), upper airway surgery (30.6%), SPT (9.7%), and CBT (5.6%) (Figure 30).

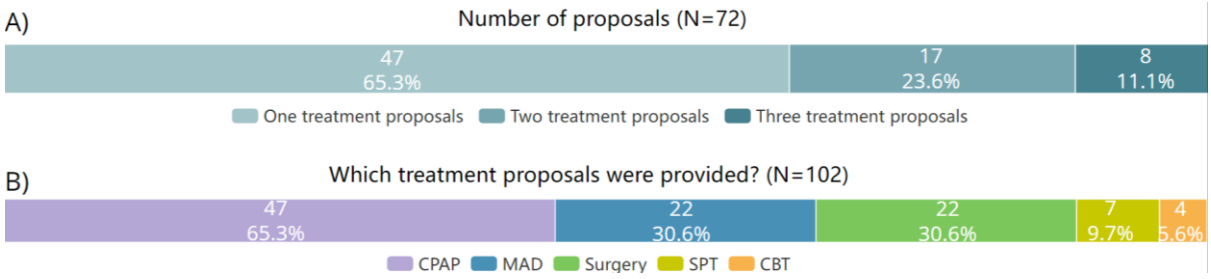


Figure 30: Treatment proposals. *A) The number of recommendations provided per individual. B) The treatment proposals provided to the participants. Percentages were calculated based on the total amount of participants (N=72).*

The next nominal logistic regression analysis explores whether there are variables that significantly influence the treatment proposals provided after the initial diagnostic PSG. The variables used for this analysis were patient related, including sex, age and BMI, PSG related including the OAHI, VAS snoring, and ESS, and practitioner related. There were no statistically significant associations found between the treatment proposals and the sex, VAS snoring and ESS or referring practitioner of the participants.

Regarding demographics, the participants' age, and BMI, showed a statistically significant association with p-values of 0.00012 and <0.0001, respectively. When looking at the age of the participants there is a statistically significant difference between CBT(+) and both CPAP(*) and surgery(*) as treatment proposal. Younger patients are more likely to receive a CBT treatment proposal, when compared to CPAP and MAD (Figure 31A). Patients with a higher BMI and OAHI value have a statistical significantly higher chance of receiving a CPAP proposal than compared to the other treatment proposals including MAD, surgery, and CBT, except the SPT with p-values of respectively 0.0585 and <0.0001 (Figure 31B-C).

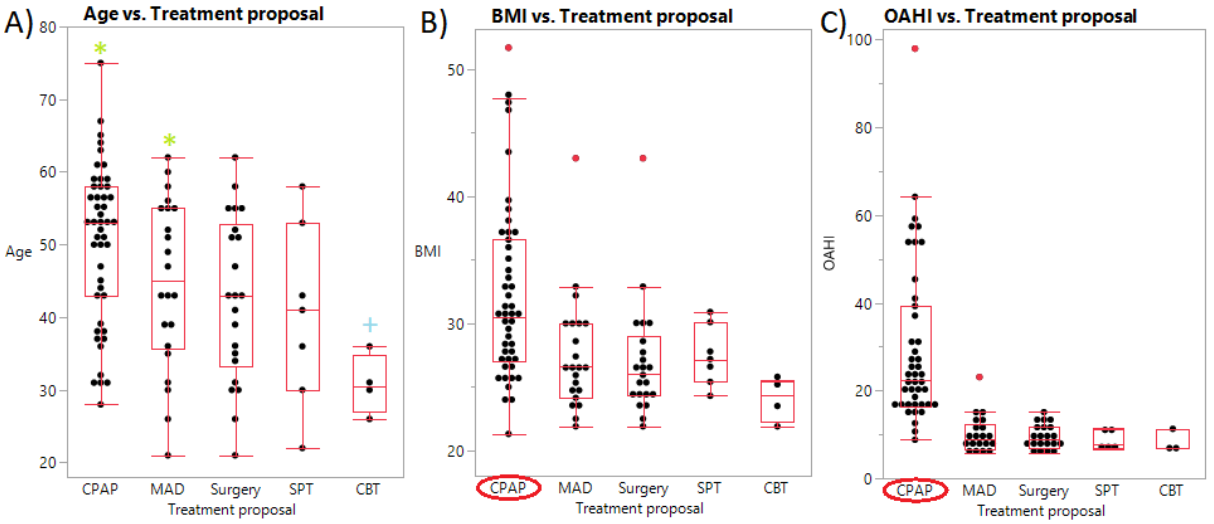


Figure 31: *These figures represent the associations between the treatment proposals and the A) age, B) BMI, and C) OAHI of the participants.*

4.3.4 Treatment choices

After receiving a treatment proposal, participants could opt to initiate treatment or not, and thereby follow the provided proposal or not. The follow-up information for 26 participants (36.1%) is not available. Among the remaining 46 participants, 38 (82.6%) decided to start a specific treatment, and of those, 37 participants (97.4%) followed the treatment proposal they received. There is only 1 participant who did not follow the proposal and chose MAD instead of CPAP therapy. CPAP therapy was chosen the most often (94.7%). The remaining participants opted for MAD treatment (5.3%) (Figure 32).

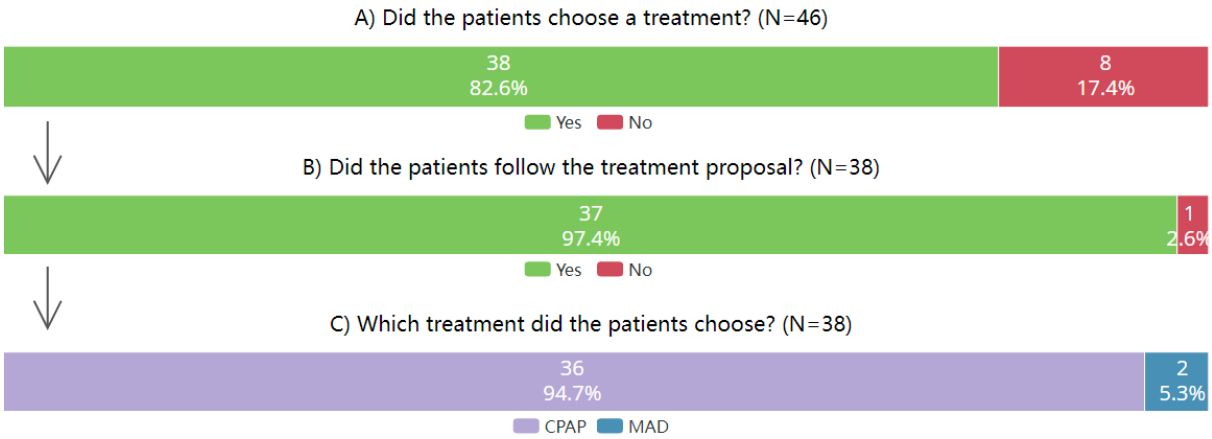


Figure 32: Treatment choices of the participants. *A) Treatment choice: Whether a participant started a treatment or not is only known for 46 out of 72 participants (63.8%). B) Did patients follow the treatment proposals?: For the 38 out of 46 participants who did start a treatment, only 1 participant did not follow the provided treatment proposal: this participant started MAD therapy instead of the proposed CPAP therapy. C) Chosen therapy: 36 participants (94.7%) chose to start CPAP treatment, the other 2 participants (5.3%) started MAD treatment.*

Nominal logistic regression was done to analyse whether treatment initiation, was influenced by other variables including demographics and PSG results, including questionnaire responses, and the OAHI. The regression revealed that the initiation of treatment could be influenced by age (p=0.0018) and OAHI (p=0.0027), as these showed statistically significant associations. Older participants and participants with higher OAHI values were more likely to initiate a treatment (Figure 33).

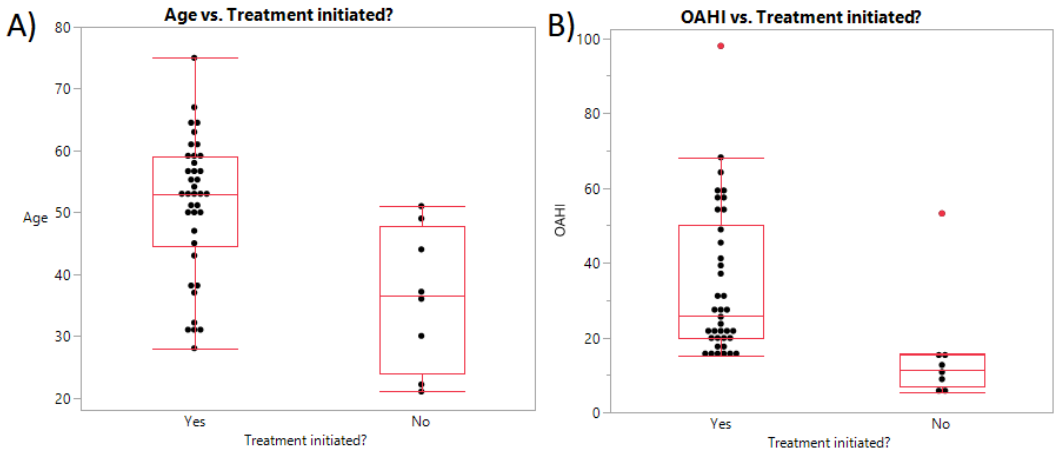
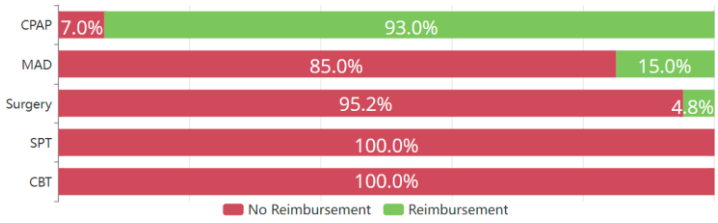


Figure 33: *These figures represent the predictive value of A) the age with p=0.0018, and B) OAHI with p=0.0027 on whether a patient initiated treatment or not.*

4.3.5 Reimbursement

Patients might be eligible to receive reimbursement for both CPAP and MAD therapy under the apnea convention if they have an OAHI≥15. Among the 72 participants, 28 (38.1%) were ineligible for reimbursement, while the remaining 44 (61.9%) were. This section examines whether the variable reimbursement affects the provided treatment proposals.

The impact of the reimbursement category on the treatment proposal is statistically significant ($p > 0.0001$). This relationship is illustrated in Figure 34, which displays treatment eligibility for each of the treatment proposals. The table on the right side presents the count of participants, categorized by treatment proposal, distinguishing between those with and without reimbursement.



	No Reimbursement		Reimbursement	
CPAP	3	7.0%	40	93.0%
MAD	17	85.0%	3	15.0%
Surgery	20	95.2%	1	4,8%
SPT	5	100.0%		
CBT	3	100.0%		

Figure 34: Reimbursement eligibility per treatment proposal.

As previously emphasized, only two types of therapy were selected: CPAP and MAD. In both cases, it is crucial to determine whether a patient is entitled to receive a reimbursement. Therefore, a nominal logistic regression analysis was conducted to assess the impact of reimbursement eligibility on the initiation of therapy. The regression results indicate that the eligibility for reimbursement statistical significantly influences the treatment proposal ($p < 0.0001$).

All individuals who initiated therapy have the right on reimbursement (100.0%). Out of all participants entitled to reimbursement, only two chose not to start therapy. These two participants underwent a second diagnostic PSG, resulting in one participant no longer being diagnosed with OSA, while the other decided to commence CPAP therapy following the second PSG results. Notably, none of the participants without reimbursement initiated therapy. For 26 participants, their status of therapy initiation remains unknown. However, it is worth mentioning that 22 (84.6%) of these individuals were not entiteled to receive reimbursement for CPAP or MAD therapy. Hence, it is plausible that these individuals have not initiated therapy, and as a result, no follow-up information is available for them. Among the 4 participants (15.4%) who qualified for reimbursement, all of them received CPAP as a treatment recommendation (Figure 35).

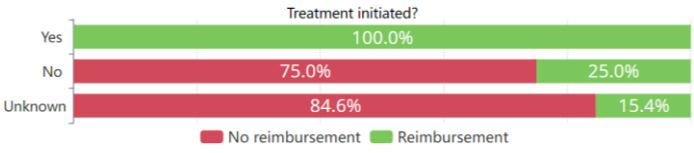


Figure 35: Treatment initiation based on reimbursement eligibility

	No Reimbursement		Reimbursement	
Treatment started			38	100.0%
No treatment started	6	75.0%	2	25.5%
Unknown	22	84.6%	4	15.4%

Finally, this study examined whether the treatment proposal was influenced by the referring practitioner and reimbursement. To investigate this, a new variable was introduced to replace the treatment proposal variable. The variable was divided into three categories: CPAP, where the patient received only a CPAP proposal, CPAP+, where the patient received a combined proposal of CPAP and another treatment, and No CPAP, where the patient received a treatment proposal that did not include CPAP. Among the 72 participants, 40 individuals were classified in the CPAP category, 7 participants fell into the CPAP+ category, and the remaining 25 participants were categorized in the No CPAP group (Figure 36).

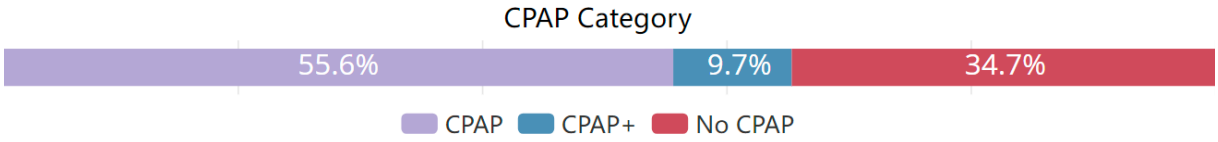


Figure 36: CPAP category grouping variable

To evaluate whether the CPAP treatment category, and consequently the treatment proposal, is influenced by the referring practitioner and reimbursement eligibility, a nominal logistic regression was conducted. The results of this regression indicated that there was no significant influence of the practitioner on the treatment proposals when the participant was not eligible for reimbursement ($p = 0.6073$). However, a statistically significant influence of the practitioner on the treatment proposals was observed when the patient was eligible for reimbursement ($p = 0.0156$).

Upon examining Figure 37, it becomes evident that non-eligible patients have a low likelihood of receiving a CPAP proposal. As a result, it is apparent that none of these participants received a standalone CPAP proposal. Instead, any CPAP proposal they received was always combined with another treatment proposal. This combined proposal scenario was observed in only three out of the 28 participants (10.7%).

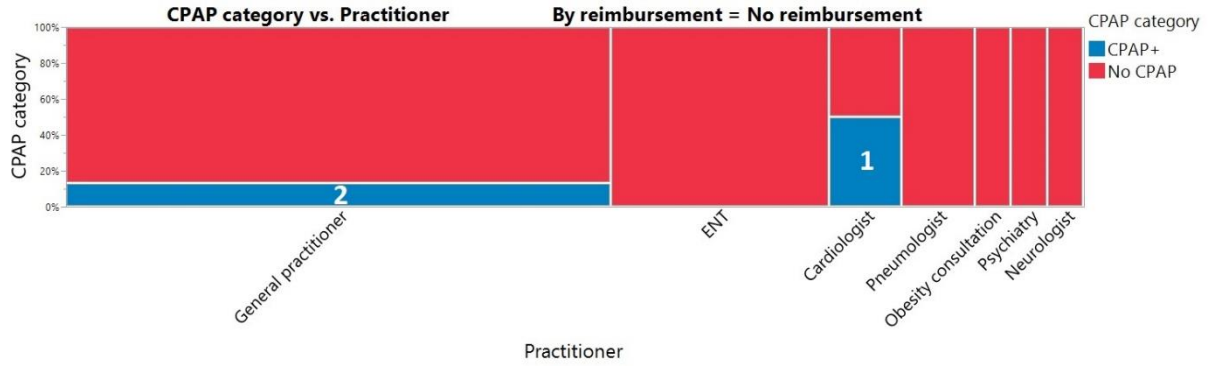


***Figure 37: Treatment proposals based on the referring practitioner by reimbursement eligibility**. This figure displays the treatment proposals in categories by referring practitioner in case of no reimbursement.*

In cases where a patient is eligible for reimbursement, the opposite effect is observed (Figure 38). Every eligible patient receives a CPAP proposal, either as a standalone proposal (90.2%) or as part of a combined proposal (9.8%). Interestingly, these combined proposals are exclusively offered to two reffering practitioners: the ENT doctor and the neurologist. Regarding the neurologist, the CPAP proposal was combined with an SPT device since the participants exhibited POSA. On the other hand, the combined proposals consisting of CPAP and MAD, exclusively occurred among ENT doctors. An overview of the number can be found in table 7.

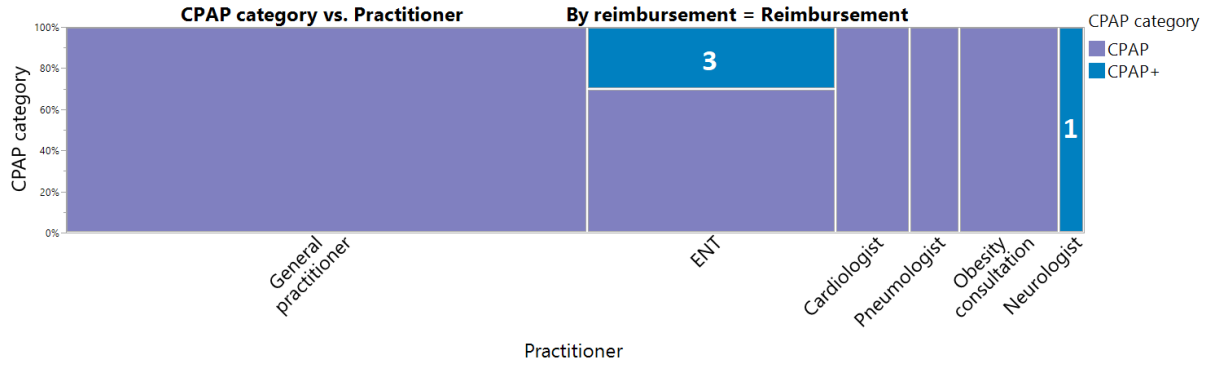


***Figure 38: Treatment proposals based on the referring practitioner by reimbursement eligibility**. This figure displays the same, but for participants with reimbursement.*

Table 7: Treatment proposals based on the referring practitioner by reimbursement. *The table contains the values that are visually represented in the graph above.*

	No Reimbursement				Reimbursement			
	CPAP+		No CPAP		CPAP		CPAP+	
General practitioner	2	13.3%	13	86.7%	21	100.0%		
ENT doctor			6	100.0%	7	70.0%	3	30.0%
Cardiologist	1	50.0%	1	50.0%	3	100.0%		
Pneumologist			2	100.0%	2	100.0%		
Obesity consultation			1	100.0%	4	100.0%		
Neurologist			1	100.0%			1	2.0%
Psychiatry			1	100.0%				
Total	3	10.7%	25	89.3%	37	90.2%	4	9.8%

4.4 Discussion

4.4.1 Trajectory

Since OSA is seen as a major public health concern due to its high social and economic burden, effective diagnostic and therapeutic strategies are needed (Faria et al., 2021). Obesity is recognized as major modifiable risk factor for OSA, ant thus, weight loss is recommended for all overweight and obese OSA patients. Research has shown that a weight loss of 10% results in an 26% reduction of the patients AHI (Choi, 2021). In addition to obesity, there are other risk factors, such as male sex and older age (Yeghiazarians et al., 2021). This study confirms that both obesity and age are risk factors, since older participants and participants with higher BMI category were associated with more severe OSA. However, there was no statistically significant impact of sex, VAS snoring or ESS, meaning that the sex and level of burden experienced by the patients is not linked to their knowledge.

Besides recommending weight loss, CPAP, oral appliances such as MAD, and upper airway surgery are considered the primary therapeutic methods for treating OSA. SPT and CBT are seen as additional adjunctive treatment options (Choi, 2021). This study showed that age, BMI and OSA severity statistical significantly influenced the treatment proposal that has been provided to the participants. Younger participants were more likely to receive CBT as treatment proposal, compared to CPAP and MAD treatment. In addition, there was a clear association between the BMI and OAHI values, since participants with higher BMI and OAHI were more likely to receive a CPAP proposal than any other treatment, including MAD, upper airway surgery, CBT, and SPT. This might be explained by the fact that CPAP is seen as the gold standard for patients with moderate to severe OSA (Nogueira et al., 2018), associated with higher OAHI and BMI values.

Regarding treatment initiation, this study found that patients who initiated treatment tended to be older and had higher OAHI values. As mentioned, higher age is associated with a more severe form of OSA, characterized by a greater frequency of apnea/hypopnea events and more severe consequences of the disease (Muraja-Murro et al., 2014). Therefore, it can be logically inferred that individuals with more severe OSA and thus higher OAHI values are more inclined to initiate a specific treatment. These finding can be partially confirmed by a study conducted by Liao et al. in which patients with more severe OSA were also more likely to initiate treatment (Liao et al., 2018). However, in contrast to this study, Liao et al. found that patients starting treatment were rather younger than older (Liao et al., 2018). Once again, no associations were found between patients' VAS snoring and ESS score. This implies that the burden experienced by the patients was not linked to the decision of whether or not to initiate treatment.

In the study of Liao et al. the most common treatments were upper airway surgery (47.3%), CPAP (31.8%), behavioural modifications (9.6%), MAD (3.3%), and other treatments (8%). However, this current study showed that 94.7% of the study population that initiated treatment chose CPAP therapy, and other 5.3% chose to initiate MAD treatment. This means that upper airway surgery was not a preferred choice and that CPAP was chosen more often, but a similar trend can be observed for MAD treatment. The difference sample sizes used in both studies, with 72 participants in the current study and 4,097 participants in the study of Liao et al., might attribute to these differences in treatment choices.

As mentioned, one may be eligible for reimbursement of both CPAP and MAD therapy if the OAHI≥15 (RIZIV, 2020). This study showed that non-eligible patients, with OAHI<15, tend to have a considerably low likelihood of being recommended CPAP as a treatment option. Contrarily, an opposing effect is observed among individuals who are eligible for reimbursement. These patients are significantly more prone to receiving a treatment proposal involving CPAP, whether it is recommended as a standalone treatment or combined with another approach. This may again be explained by the fact that CPAP is seen as gold standard to treat moderate to severe OSA, characterized by an OAHI≥15 (Nogueira et al., 2018). The low number of combined proposals for patients entitled for reimbursement frequently involves MAD treatment, which was typically prescribed when the

referring practitioner is an ENT doctor. However, it is worth noting that the number of MAD treatment proposals, as either standalone or combined proposal, for patients eligible for reimbursement is surprisingly low.

This finding is remarkable since, as mentioned above, both CPAP and MAD therapy tend to have overall effectiveness, with CPAP having higher efficacy, but lower compliance compared to MAD (Grote et al., 2000; Vanderveken et al., 2013). Moreover, research has shown that this is not only the case for mild to moderate OSA, but also for moderate to severe OSA (Phillips et al., 2013). In other words, MAD should also be considered as valuable first-line treatment option for patients entitled to reimbursement of their treatment. A more inclusive approach regarding treatment recommendations can ensure that patients receive the most suitable and effective interventions for their condition.

4.4.2 Limitations and future perspectives

It is important to note certain limitations of this study, starting with the rather small sample size of 72 patients. Furthermore, follow-up results were unknown for a portion of this study population, further reducing the size of the study group. In addition, it is important to note that this study population only chose CPAP and MAD as treatment options, excluding a significant portion of other potential treatments for OSA.

In future research, a larger patient group could be examined to gain further insights into the current treatment recommendations for individuals recently diagnosed with OSA, as well as their treatment preferences. Additionally, monitoring of this patient cohort over an extended period could help capture their treatment trajectory.

5 Conclusion

This study examined the knowledge, mindset, and treatment journey of individuals recently diagnosed with OSA. The findings clearly indicate that the average baseline OSA and treatment knowledge of recently diagnosed OSA patients is moderate. As a result, it is crucial to provide patients with a comprehensive explanation of all available treatment options following their diagnosis. Furthermore, the study highlights the significance of involving patients in the decision-making process regarding treatment, since it has been found that patients have different preferences when it comes to treatment options. Thus, when proposing a treatment to a patient, it is important to not only consider the polysomnography results, and to automatically choose the gold-standard treatment, but also to prioritize patient's preferences. By taking these into account, it might become possible to initiate the appropriate therapy for the patients more rapidly, leading to enhanced satisfaction and both improved compliance and adherence.

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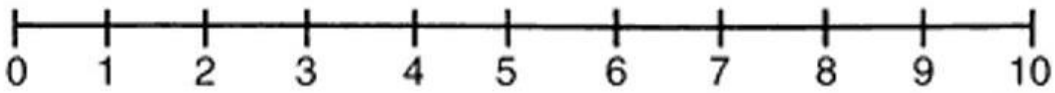
7 Annex

7.1 Annex 1: VAS snoring

Plaats op de lijn hieronder een vertikaal streepje op de plaats die het beste de mate van snurken tijdens de afgelopen weken aangeeft, zoals beschreven door uw bedpartner/omgeving/… :



Geen snurken

Zeer intens snurken

(Score 10: partner dient apart te slapen omwille van het snurken)

7.2 Annex 2: ESS

Wij vragen u zich een aantal dagdagelijkse situaties voor te stellen en daarbij aan te willen geven wat de kans is dat u in die situatie (ongewenst) zou indutten. Zet een kruisje in het vakje dat volgens u heden het best op u van toepassing is:

Situaties	**Kans om in te dutten**			
	Onbestaande	**Klein**	**Redelijk**	**Groot**
Iets zit te lezen				
TV kijken				
Passief zitten in een openbare plaats (bvb. theater of een vergadering)				
Als passagier in een wagen met een rit gedurende een uur zonder onderbreking				
Neerliggen om uit te rusten in de namiddag wanneer de omstandigheden het toelaten				
Neerzitten en met iemand spreken				
Rustig zitten na het middagmaal zonder alcohol				
In de wagen wanneer u enkele minuten moet wachten in de file				

Volgende scoring wordt gebruikt: onbestaande = 0, klein = 1, Redelijk = 2, Groot = 3. Een score > 10 geeft aanleiding tot verhoogde kans op slaperigheid.

7.3 Annex 3: Questionnaire

Informatie voor de patiënt en toestemmingsformulier

Psychologie van potentiële patiënten met obstructief slaapapneu (OSA)
Welke factoren spelen mee in de keuze voor een behandeling?

Opdrachtgever van de studie:
UZA, dienst MKA

Onderzoekers
Dr. Ellen Collier, UZA
Pauline Vanhoof, Student Universiteit Antwerpen

Contactpersoon voor informatie
Dr. Ellen Collier, UZA, Drie Eikenstraat 665, B-2650 Edegem
Ellen.collier@uza.be

Pauline Vanhoof, UZA, Drie Eikenstraat 665, B-2650 Edegem
Pauline.vanhoof@uza.be

Commissie voor Medische Ethiek:
Ethisch comité UZA-UA
UZA, Drie Eikenstraat 665, B-2650 Edegem
Tel .32 3 821 38 97
Ethisch.Comite@uza.be

Informatie voor de patiënt

Op basis van uw slaaponderzoek wordt u uitgenodigd om vrijwillig deel te nemen aan een klinische studie waarbij u gevraagd wordt een vragenlijst in te vullen. Deze vragenlijst zal gebruikt worden om de voorkennis rond slaapapneu en verschillende behandelingsopties te testen, en na te gaan wat u zou verkiezen.

Alvorens u toestemt om aan deze studie deel te nemen, is het belangrijk dat u dit formulier leest. U heeft het recht om op elk ogenblik vragen te stellen over de mogelijke en/of bekende risico's die deze studie inhoudt. Deze klinische studie werd op 20/03/2023 goedgekeurd door de Commissie voor Medische Ethiek van het Universitair Ziekenhuis Antwerpen.

Naast de gegevens die verzameld worden tijdens het invullen van deze vragenlijst, worden ook volgende gegevens uit uw dossier op tijdstip van uw slaaponderzoek verzameld:

→ Leeftijd
→ Geslacht
→ Apneu/hypopneu indices (indices die de ernst van de slaapapneu bepalen)
→ Reden slaaponderzoek Visuele analoge schaal (VAS) om de intensiteit van het snurken te bepalen
→ Epworth Sleepiness Scale (ESS) om de mate van vermoeidheid te bepalen
→ Type D Scale-14 (DS14) om de gevoeligheid voor chronische stress te bepalen
→ Medische voorgeschiedenis

Het invullen van de vragenlijst neemt ongeveer 15-20 minuten in beslag. Uw persoonsgegevens en antwoorden worden strikt vertrouwelijk verwerkt. Om uw privacy te garanderen worden uw gegevens gepseudonimiseerd. Dit betekent dat uw naam, voornaam, geboortedatum en woonplaats vervangen worden door een code. Verdere verwerking gebeurt via de gepseudonimiseerde gegevens.

Uw studiegegevens worden elektronisch (d.w.z. in de computer) of handmatig verwerkt en geanalyseerd om de onderzoeksvragen te kunnen beantwoorden. U heeft het recht aan de onderzoeksarts te vragen welke gegevens er over u worden verzameld in het kader van de studie en wat de bedoeling ervan is. U heeft ook het recht aan de onderzoeksarts te vragen om u inzage te verlenen in uw persoonlijke informatie en er eventueel de nodige verbeteringen in te laten aanbrengen. Alle persoonsgegevens zullen verwerkt worden in overeenstemming met de Europese Algemene Verordening Gegevensbescherming (General Data Protection Regulation (AVG/GDPR) – EU2016/679) en de Belgische wet van 30 juli 2018 die deze verordening verder uitwerkt. Vragen betreffende het beheer van uw gegevens kan u stellen aan de onderzoeksarts, uw behandelend arts of aan de functionaris voor de gegevensbescherming van het UZA via email: dpo@uza.be.

Indien u toestemt deel te nemen aan dit onderzoek betekent dit dat u toestemming geeft tot het gebruik van uw gecodeerde medische gegevens voor bovenstaande doeleinden. Indien uw studiedeelname voortijdig gestopt wordt, zal uw initiële toestemming het gebruik toelaten van uw studiegegevens met betrekking tot de periode dat u in de studie ingesloten was.

U neemt geheel vrijwillig deel aan deze studie en heeft het recht te weigeren er aan deel te nemen. U heeft het recht om uw deelname aan de studie op elk ogenblik stop te zetten, zelfs nadat u het toestemmingsformulier ondertekend heeft. Uw beslissing om al dan niet aan deze studie deel te nemen of om uw deelname aan de studie stop te zetten zal geen enkele invloed hebben op uw verdere behandeling.

Wij kunnen u niet garanderen dat, indien u toestemt om aan deze klinische studie deel te nemen, u persoonlijk enig rechtstreeks voordeel zal halen uit uw deelname aan deze studie. Deelnemen aan deze studie zal voor u geen bijkomende kosten met zich meebrengen.

Deze studie bevat informatie rond verschillende behandelingsopties voor slaapapneu. Het is niet gezegd dat, indien u slaapapneu zou hebben, u in aanmerking komt voor deze drie behandelingen. Mocht u over deze vragenlijst en/of uw deelname aan deze studie specifieke vragen hebben, zijn wij steeds bereid tot verdere toelichting via onderstaande contactgegevens.

Ellen Collier
03/821.34.47
Ellen.collier@uza.be

Pauline Vanhoof
pauline.vanhoof@uza.be

Toestemmingsformulier

Psychologie van potentiële patiënten met obstructief slaapapneu (OSA)
Welke factoren spelen mee in de keuze voor een behandeling?

Hierbij bevestig ik, ondergetekende (_____) dat ik over de studie ben ingelicht en de informatie gelezen en begrepen heb.

- → Ik heb hierbij voldoende informatie ontvangen met betrekking tot de voorwaarden en de duur van de studie.
- → Ik heb begrepen dat ik mijn deelname aan deze studie op elk ogenblik mag stopzetten nadat ik mijn arts hierover heb ingelicht, zonder dat dit mij enig nadeel kan berokkenen.
- → Ik geef toestemming aan de verantwoordelijken van de opdrachtgever (Pauline Vanhoof/Ellen Collier) om inzage te hebben in mijn patiëntendossier. Mijn medische gegevens zullen strikt vertrouwelijk behandeld worden. Ik ben mij bewust van het doel waarvoor deze gegevens verzameld, verwerkt en gebruikt worden in het kader van deze studie.
- → Ik ga akkoord met de verzameling, de verwerking en het gebruik van deze medische gegevens, evenals de uitgevoerde metingen, zoals beschreven in het informatieblad voor de patiënt.
- → Ik weet dat ik het recht heb om mijn gegevens in te zien en te verbeteren. Als ik klachten heb over het beheer van mijn gegevens weet ik dat ik me kan richten tot de onderzoekers, mijn arts, of the functionaris voor de gegevensbescherming van het UZA, dpo@UZA.be
- → Ik stem geheel vrijwillig toe om deel te nemen aan deze studie en om mee te werken aan alle gevraagde onderzoeken. Ik ben bereid informatie te verstrekken i.v.m. mijn medische geschiedenis, mijn geneesmiddelengebruik en eventuele deelname aan andere studies.
- → Ik ga ermee akkoord dat mijn huisarts/specialist en andere zorgverleners die bij mijn behandeling betrokken zijn, indien nodig, op de hoogte worden gebracht van mijn deelname aan dit onderzoek.

Gelieve u handtekening te plaatsen en de datum in te vullen, indien u akkoord gaat om deel te nemen aan de studie.

Datum Handtekening

Ik bevestig hierbij dat ik (_____) heb ingelicht en dat hij (zij) zijn (haar)toestemming heeft gegeven om deel te nemen aan de studie.

PAULINE VANHOOF Datum

Demografisch luik

1. Met welk geslacht identificeert u zichzelf?

- ○ Man
- ○ Vrouw
- ○ Anders, namelijk _____
- ○ Wil ik liever niet zeggen

2. Wat is uw geboortedatum? (DD/MM/JJJJ)

DD _____
MM _____
JJJJ _____

3. Wat is uw huidige woonsituatie?

- ○ Gehuwd of samenwonend met partner
- ○ Samenwonend met familie of vrienden
- ○ Alleenwonend

4. Hoeveel inwonende kinderen heeft u?

- ○ 0
- ○ 1
- ○ 2
- ○ 3 of meer

Ga naar vraag 6 indien 0 geselecteerd wordt

5. Wat is de leeftijd van uw kinderen?

- ☐ < 1 jaar
- ☐ 1 - 2,5 jaar
- ☐ 2,5 - 6 jaar
- ☐ 6 - 12 jaar
- ☐ 12 - 18 jaar
- ☐ ≥ 18 jaar

6. Wat is uw opleidingsniveau?

- ○ Geen diploma
- ○ Secundair onderwijs
- ○ Professionele bachelor
- ○ Academische bachelor
- ○ Master of hoger

7. Welke van de volgende beschrijft uw huidige werksituatie het beste?

- ○ Werkloos
- ○ Huisvrouw/Huisman
- ○ Parttime (< 28 uur/week)
- ○ Fulltime (≥38 uur/week)
- ○ Gepensioneerd
- ○ Invaliditeit
- ○ Student

Ga naar vraag 12 indien Parttime/Fulltime niet geselecteerd zijn.

8. Welke van de volgende categorieën beschrijft uw beroep het best(e)?

- ○ Arbeider
- ○ Bediende
- ○ Vrij beroep
- ○ Anders, namelijk _____

9. Werkt u in een shiftensysteem?

- ○ Ja, zonder nachtdienst
- ○ Ja, met nachtdienst
- ○ Nee

10. Hoe fysiek belastend acht u uw job?

Zittend beroep — Zeer fysiek belastend

0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

11. Hoeveel concentratie vergt uw job?

Minimale concentratie — Zeer veel concentratie

0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

12. Wat is uw persoonlijk maandelijks netto inkomen?

- ○ < €1000
- ○ €1000 - €2500
- ○ €2501 - €5000
- ○ €5000
- ○ Wil ik liever niet zeggen

Graad van stresspercepti e

De volgende vragen hebben betrekking op de stress die u in het dagelijkse leven ervaart. Vink het vakje aan dat het best overeenkomt met uw ervaring of gedachten **gedurende de laatste maand.**

	Nooit	Bijna nooit	Soms	Vrij vaak	Heel vaak
Hoe vaak bent u de voorbije maand overstuur geweest door iets dat onverwacht gebeurde?	○	○	○	○	○
Hoe vaak hebt u de voorbije maand gevoeld dat u niet in staat was de belangrijke dingen in u leven te controleren?	○	○	○	○	○
Hoe vaak hebt u zich in de voorbije maand zenuwachtig en gestresseerd gevoeld?	○	○	○	○	○
Hoe vaak hebt u zich de voorbije maand zelfverzekerd gevoeld over uw mogelijkheid om uw persoonlijke problemen aan te pakken?	○	○	○	○	○
Hoe vaak hebt u de voorbije maand gevoeld dat het goed met u ging?	○	○	○	○	○
Hoe vaak vond u de voorbije maand dat u het hoofd niet kon bieden aan al de dingen die u moest doen?	○	○	○	○	○
Hoe vaak kon u de voorbije maand ergernissen in uw leven onder controle houden?	○	○	○	○	○
Hoe vaak had u de voorbije maand het gevoel dat u de dingen onder controle had?	○	○	○	○	○
Hoe vaak bent u de voorbije maand boos geworden door zaken die gebeurden en waar u zelf niets kon aan doen?	○	○	○	○	○
Hoe vaak hebt u de voorbije maand gevoeld dat problemen zich zo sterk opstapelden, dat u ze niet meer te boven kon komen?	○	○	○	○	○

Obstructief slaapapneu

1. Heeft u ooit al iets vernomen over obstructief slaapapneu (OSA)?

- ○ Ja
- ○ Nee

2. Via wie of waar heeft u deze informatie vernomen?

- ☐ Arts
- ☐ Internet
- ☐ Vrienden, familie of kennissen
- ☐ Media
- ☐ Anders, namelijk _____

Slaapapneu is een slaapstoornis die gekenmerkt wordt door het stoppen van de ademhaling (apneus) en/of een verminderen van de ademhaling (hypopneus) gedurende 10 seconden tijdens de slaap. Bij obstructief slaapapneu (OSA) treedt dit op door een vernauwde of afgesloten luchtweg. Het aantal apneus of hypopneus per uur slaap worden uitgedrukt in de apneu/hypopneu index (AHI). Men spreekt van mild tot matig slaapapneu bij een AHI van 5-30 en ernstig slaapapneu bij AHI ≥ 30. In België is er terugbetaling van een behandeling indien de obstructieve AHI (OAHI) ≥ 15.

Slaapapneu kent enkele symptomen die 's nachts en overdag kunnen optreden:

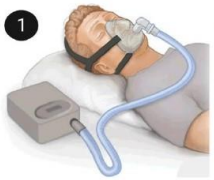
→ Zwaar snurken
→ Ochtendhoofdpijn
→ Ergernis voor de partner
→ Ontwaken 's nachts
→ Concentratiestoornissen
→ Problemen op het werk
→ Nachtzweten
→ Droge mond
→ Ademstilstanden
→ Vermoeidheid
→ Gemakkelijk overdag in slaap vallen
→ ...

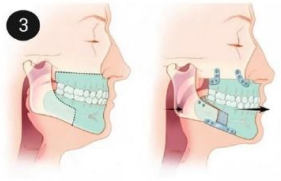
Patiënten die leiden aan slaapapneu hebben een verhoogd risico op aandoeningen van hart- en bloedvaten (hoge bloeddruk, hartinfarct, beroerte…). Verder is er een duidelijk verhoogd risico op werk- en verkeersongevallen door slaperigheid en concentratiestoornissen. Voor het stellen van de diagnose van OSA wordt er een slaaponderzoek uitgevoerd.

Onderstaande video legt uit wat OSA of obstructief slaapapneu betekent.
Video

Voor de behandeling van OSA zijn er verschillende opties beschikbaar. Hieronder worden er enkele weergegeven. Duid voor elk van de behandelingen aan of u ooit al iets vernomen heeft over deze behandeling (meerdere opties mogelijk).

1. CPAP Continuous positive airway pressure Slapen met een toestel
2. MRA Mandibulair repositieapparaat Slapen met een beugel
3. MMA Maxillo-Mandibulaire advancement osteotomie Chirurgische behandeling kaken





3. Zou u kiezen voor een of meerdere van onderstaande behandelingen?

	Ja	Nee	Weet ik niet
CPAP	○	○	○
MRA	○	○	○
MMA	○	○	○

4. Wat is voor u belangrijk bij de keuze van een behandeling?
(Maximum 2 antwoorden)

☐ Goede uitleg van de arts
☐ Mening van partner
☐ Ervaring van omgeving
☐ Aantal consultaties die de behandeling vereist
☐ Opvolging die de behandeling vereist
☐ Kosten van de behandeling
☐ Totale duurtijd van de behandeling
☐ Anders, namelijk _____

5. Wat zou voor u de voornaamste reden zijn om een behandeling te starten?
(Maximum 2 antwoorden)

☐ Zodat ik niet meer zou snurken
☐ Zodat ik beter uitgerust zou zijn
☐ Zodat mijn partner niet meer klaagt
☐ Zodat mijn concentratie zou verbeteren
☐ Zodat ik geen ademstoppen meer zou hebben 3
☐ Om mijn hart en bloedvaten te beschermen
☐ Zodat ik mijn werk beter kan uitvoeren
☐ Zodat ik 's avonds niet meer in slaap val voor tv
☐ Anders, namelijk _____

Uitleg verschillende behandelingen voor OSA

In het volgende onderdeel worden er 3 mogelijke behandelingen voor OSA uitgelegd. Het is de bedoeling dat u deze uitleg aandachtig leest om de rest van de vragenlijst te kunnen vervolledigen.

CPAP

Een continuous positive airway pressure (CPAP) behandeling bestaat uit een apparaat dat omgevingslucht aanzuigt en deze via een slang en een masker onder verhoogde druk uw luchtwegen inblaast tijdens de slaap. Hierdoor worden obstructies t.h.v. de keel, tong en strottenhoofd vermeden en zullen er geen of minder ademstops optreden.

Tijdens een slaaponderzoek, waarbij u met het CPAP toestel slaapt gaat men na of de ademhaling en slaapkwaliteit verbeterd. Als men verbetering waarneemt kan u de behandeling thuis opstarten. Echter niet iedereen verdraagt de behandeling even goed. Mogelijke klachten zijn: druk van het masker, neusklachten, droge mond…. Het is ook niet gemakkelijk om overal mee naartoe te nemen (bv. vakantie, zakenreizen…) en vereist stroomvoorziening.

CPAP-therapie is een zeer effectieve en niet-invasieve behandeling, maar geneest de aandoening niet. Daarom moet het apparaat iedere nacht en gedurende de hele nacht gebruikt worden, levenslang. Het voordeel is dat de behandeling onmiddellijk werkt en de klachten snel verdwijnen. Ook zal het risico op andere gezondheidsproblemen terug verkleinen.

Na de opstart van de behandeling moet u jaarlijks op raadpleging komen bij de longarts. Hierbij wordt het toestel uitgelezen en gaat men na of er aanpassingen nodig zijn. De CPAP behandeling wordt grotendeels terugbetaald, indien u het toestel correct en trouw gebruikt (minimaal 4uur per nacht), waardoor u zelf een maximale opleg van €0,25/dag betaald.

MRA

Een **mandibulair repositieapparaat (MRA**) is een beugel die de onderkaak iets naar voren verplaatst tijdens de slaap, waardoor obstructies t.h.v. de tong, strottenhoofd en vaak ook keel vermeden worden. Dit heeft tot gevolg dat er minder ademstops optreden en ook de andere klachten die OSA met zich meebrengt zullen verbeteren of verdwijnen.

Eerst gaat men aan de hand van een tandheelkundig onderzoek na of u in aanmerking komt voor een MRA. Wanneer de resultaten gunstig zijn wordt een simulatiebeet gemaakt, waarbij men gaat simuleren hoeveel de onderkaak naar voren moet komen. Aansluitend voert men een slaapendoscopie uit. Dit is een onderzoek waarbij u in een roes wordt gebracht, en men aan de hand van de simulatiebeet kan kijken of er effectief verbetering is van de obstructieklachten tijdens de slaap. Wanneer men beslist dat u in aanmerking komt voor de behandeling zal men een gebitsafdruk maken en de MRA produceren.

Een behandeling met een MRA is niet invasief, maar geneest de aandoening niet. Daarom moet men de beugel elke nacht en gedurende de hele nacht gebruiken, levenslang. Het nadeel van de behandeling is dat men niet op voorhand kan bepalen in hoeverre de beugel voldoende zal werken. De meeste klachten bij deze behandeling (gespannen kaakspieren, verhoogde speekselafgifte…) zijn tijdelijk, maar er zijn ook enkele blijvende klachten zoals minimale tandverplaatsingen en pijn t.h.v. de kaken.

Na de opstart van de behandeling moet u jaarlijks op raadpleging komen. De MRA behandeling wordt grotendeels terugbetaald, waardoor u zelf een maximale opleg van €0,50/dag betaald gedurende 6 maanden. De simulatiebeet kost €98 en wordt niet terugbetaald.

MMA

Maxillo-mandubulaire advancement osteotomie (MMA) is een invasieve chirurgische behandeling voor OSA waarbij de bovenkaak, onderkaak en soms de kin naar voren geplaatst worden. Hierdoor worden obstructies t.h.v. de keel, tong en strottenhoofd vermeden en zullen er geen of minder ademstops optreden. Hierdoor zullen ook de andere klachten die OSA met zich meebrengt verminderen of verdwijnen.

Aan de eigenlijke operatie gaat een heel proces vooraf dat tot een jaar in beslag kan nemen. Het gaat daarbij om:

→ Consultatie (intakegesprek) bij de orthodont en kaakchirurg om de behandeling te bespreken

→ Eventuele voorbereidende tandheelkundige behandelingen en/of chirurgische ingrepen zoals het behandelen van gaatjes, verwijderen van de wijsheidstanden

→ Behandeling met blokjes, bij de orthodont, om de stand van de tanden te corrigeren en voor te bereiden op de operatie

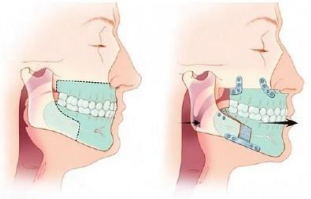
→ Consultatie bij de mond-, kaak- en aangezichtschirurg om beeldmateriaal en de afmetingen van de kaak en mond te nemen om zo de ingreep 3D te plannen (4 weken voor de ingreep)

Tijdens deze voorbereiding kan het MRA niet meer gedragen worden. Om uw slaapapneu afdoende te behandelen, wordt tijdelijk CPAP gegeven in afwachting van de ingreep.

Na deze voorbereiding kan de ingreep plaatsvinden waarbij de patiënt gemiddeld 1 nacht in het ziekenhuis verblijft. Na de operatie kan men te maken krijgen met te verwachte nevenwerkingen zoals zwelling van de kaken, minimale pijn, misselijkheid, tijdelijke gevoelsstoornissen in de lippen….

Na de operatie kan staat de patiënt gedurende 6 weken op zachte voeding. Bijkomend kan de patiënt nog niet meteen terug naar school of gaan werken. Gemiddeld zijn twee weken werkverlet nodig. Men moet hierbij rekenen op een herstelperiode van 6 weken waarbij men verschillende keren op controle moet komen. Jaarlijkse opvolging is bij deze ingreep niet nodig. Meestal wordt de patiënt 1 jaar na de ingreep nog eens teruggezien.

De ingreep zelf wordt terugbetaald door de mutualiteit, de orthodontie en voorbereiding van de ingreep niet. Deze kostprijs hangt af van de orthodontist en het ziekenhuis zelf. In het UZA bedraagt de kost voor de voorbereiding van de ingreep €1.500.



Vragen over verschillende behandelingen voor OSA

Nu zullen we u vragen **waarom u wel of niet zou kiezen** voor elk van deze behandelingen. Het is hierbij de bedoeling dat u steeds **maximum 2** antwoorden selecteert die, voor u, doorslaggevend zouden zijn bij het maken van die keuze.

1. Aangezien u nu meer informatie heeft gekregen over de verschillende behandelingen: Zou u een of meerdere van onderstaande behandelingen overwegen?

	Ja	Nee
CPAP	○	○
MRA	○	○
MMA	○	○

2. Welke van de behandelingen geniet uw voorkeur?
Rangschik deze, waarbij u uw voorkeursbehandeling bovenaan plaatst.

1	CPAP
2	MRA
3	MMA

Vragen over eigenschappen van de behandelingen

In het volgende onderdeel worden enkele belangrijke kenmerken van de 3 behandelingsopties aangehaald. We willen hierbij nagaan hoe belangrijk u ieder van deze kenmerken vindt in de keuze voor een behandeling.

3. Hieronder worden enkele van deze kenmerken weergegeven. Het is de bedoeling dat u de factoren rangschikt (door te slepen), waarbij u de factor die voor u het belangrijkst is bovenaan plaats

1	Niet invasief
2	Garantie op succes, bij correct gebruik van een toestel
3	Geen levenslange toewijding aan een toestel
4	Geen levenslange toewijding aan een toestel met stroomvoorziening
5	Geen jaarlijkse opvolging
6	Snelle opstart van een behandeling
7	Geen lawaai (30 dB) van een toestel tijdens de nacht
8	Ik wens een positieve verandering van mijn uiterlijk
9	Ik wens geen impact op mijn uiterlijk
10	Geen herstelperiode
11	Kostprijs van een therapie
12	Geen narcose vereist

4. Hoe ingrijpend denkt u dat u elk van onderstaande nevenwerkingen zou ervaren?

	Niet ingrijpend	Enigszins ingrijpend	Redelijk ingrijpend	Ingrijpend	Zeer ingrijpend
Druk van een gezichtsmasker	○	○	○	○	○
Maskerdrukplekken bij het ontwaken	○	○	○	○	○
Neusklachten (verstopte neus, niezen, korstvorming in de neus, bloedneus)	○	○	○	○	○
Droge mond tijdens de nacht	○	○	○	○	○
Verhoogde speeksel afgifte	○	○	○	○	○
Tandverplaatsingen	○	○	○	○	○
Klachten van kauwspieren en het kaakgewricht	○	○	○	○	○
Tijdelijke ongemakken na een operatie waaronder: pijn, zwelling, tintelingen...	○	○	○	○	○
Tijdelijke zenuwschade na operatie (6-12 maanden)	○	○	○	○	○

Einde vragenlijst

Hartelijk dank voor uw medewerking aan het onderzoek!
Heeft u nog opmerkingen en/of aanvullingen naar aanleiding van deze enquête? Laat deze dan hier achter.
Heeft u geen opmerkingen en/of aanvullingen, klik dan onderaan de pagina op 'Volgende'.

_____