Journal of Complementary and Alternative Medical Research

Volume 21, Issue 2, Page 43-55, 2023; Article no.JOCAMR.97647
ISSN: 2456-6276

Relationship between Degrees of Nasal Obstruction and Obstructive Sleep Apnea

Lina Marlina [a*], Wendy Hendrika [b] and Marsya Adinda [a]

[a] *Department of Otorhinolaryngology - Head and Neck Surgery, Faculty of Medicine, Universitas Kristen Indonesia, Jakarta, Indonesia.*
[b] *Department of Surgery, Medical Faculty, Universitas Kristen Indonesia, Jakarta, Indonesia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JOCAMR/2023/v21i2435

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/97647

Original Research Article

Received: 23/01/2023
Accepted: 25/03/2023
Published: 10/04/2023

ABSTRACT

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder caused by repeated upper airway obstruction. In OSA patients, 46.5%-58% reported having symptoms of hypersomnolence or excessive daytime sleepiness, and it was the most common symptom. Nasal obstruction is considered a risk factor for sleeping and breathing problems and a common problem in OSA sufferers. Nasal obstruction in the general population can reach 30-40% and is a problem that is often consulted in primary or secondary health services. This study aimed to determine the relationship between the degree of nasal obstruction and OSA in students of the Faculty of Medicine, Indonesian Christian University, Class of 2018-2020. This study uses an analytic observation method with a cross-sectional approach. The number of samples of 74 people was obtained by purposive sampling technique. Respondents who met the criteria were assessed for the degree of nasal obstruction using the NOSE scale questionnaire, while OSA was assessed

**Corresponding author: E-mail: lina.marlina@uki.ac.id;*

using the ESS questionnaire, and then the data were analyzed using the Chi-Square Test. The results of the Chi-Square statistical test obtained p value = 0.041. So it was concluded that there was a significant relationship between the degree of nasal obstruction and OSA in students of the Faculty of Medicine, Indonesian Christian University Class of 2018-2020.

Keywords: Degree of nasal obstruction; OSA.

1. INTRODUCTION

According to Purwowiyanto et al., sleep apnea is known as stopping breathing during sleep in Indonesian. There are two types of sleep apnea: Obstructive Sleep Apnea (OSA) and Central Sleep apnea (CSA) [1]. OSA is a sleep-related respiratory disorder that occurs due to an upper airway obstruction for at least 10 seconds, either complete or partial, that impedes breathing during sleep. Complete cessation of airflow is characterized by apneic conditions, while hypopnea conditions are characterized by partial [2].

For someone suffering from OSA, symptoms that can be found are loud snoring witnessed by those around them, waking up at night, nocturia, sleep that is not refreshing, and excessive sleepiness during the day or called Excessive daytime sleepiness (EDS) resulting in a decrease in the sufferer's quality of life. EDS is the most common behavior associated with OSA. Research by Bjorvatn et al. found that the prevalence of mild to severe OSA patients was reported as 46.5-58% experiencing Excessive daytime sleepiness (EDS).

The examination that is considered the gold standard in diagnosing OSA is polysomnography [3]. In the general population, the prevalence of OSA is more in men, which is between 3-7%, while in women, it is 2-5%. Polysomnography increased prevalence to 24% in men and 9% in women. However, using these devices is expensive, time-consuming, and requires trained operators, so many sufferers of OSA go undetected. Therefore, some experts suggest using a questionnaire as a detection for OSA [4].

Currently, the Ephworth Sleepiness Scale (ESS) is a tool that is widely used to assess EDS in OSA patients. ESS consists of 8 questions with total scores ranging from 0-24. A person is associated with EDS and is considered at high risk of OSA if he scores more than 10. [5] Research conducted by Rosenthal LD et al. shows that ESS with a cut-off value of 10 and AHI ≥ 5 has a sensitivity of 66% and a specificity of 48 %.12

In healthy conditions, individuals usually breathe through the nose whether asleep or awake, and only 0-4% of sleep time are reported to breathe through the mouth. Nasal or nasal obstruction is the subjective perception of discomfort or difficulty breathing air through the nostrils/nostrils. In the general population, sufferers of nasal obstruction are reported to reach 30-40% and are a common problem for consultation in primary or secondary health services [6].

Some structural problems that can cause reduced nasal patency are nasal septal deviation, turbinate hypertrophy, and collapsed nasal valves. In addition, inflammatory diseases of the nasal mucosa, such as allergic and non-allergic rhinitis and chronic rhinosinusitis with or without nasal polyps, can cause nasal obstruction [7]. According to Li CH et al., the most common diseases causing nasal obstruction are allergic rhinitis and chronic rhinosinusitis, with an estimated prevalence in Europe of 25% and 11%. Although rare, nasal obstruction can also occur due to structural changes such as deviated nasal septum [8].

Nasal obstruction is considered a risk factor for sleep disturbances due to velocity and airflow resistance changes [9]. In people with OSA, nasal obstruction is a common problem. Research conducted by Pittaway et al. reported that nasal obstruction in healthy young adult women could cause OSA [10]. Sianturi et al., in their research, found a significant relationship between OSA and allergic rhinitis (p = 0.000) [11]. Then a study by Shah JA et al. also found a significant relationship between OSA with a deviation of the nasal septum (p = 0.0004) and inferior turbinate hypertrophy (p = 0.03) [12]. Another study by Sunderram J et al. found an association between OSA and rhinosinusitis (p = 0.006) [13]. Assessment of nasal congestion symptoms can be done subjectively using validated questionnaires such as the Nasal

Obstruction Symptoms Evaluation (NOSE) scale, Visual Analogue Scale (VAS), and Sinonasal Outcome Test (SNOT-22).

Research related to nasal obstruction with OSA has been widely studied, but research on the relationship between the degree of nasal obstruction and OSA has never been conducted. Therefore researchers are interested in researching the relationship between the degree of nasal obstruction and OSA. Where the respondents studied were students of the Faculty of Medicine at the Indonesian Christian University Class of 2018-2020.

The problem in this study is "is there a relationship between the Degree of Nasal Obstruction and OSA in Indonesian Christian University Medical Faculty Students Class of 2018-2020?" The aim of the research, namely to find out the relationship between the degree of nasal obstruction and OSA in students of the Faculty of Medicine at the Indonesian Christian University Class of 2018-2020.

2. LITERATURE REVIEW

The upper respiratory tract generally consists of 5 parts: the nose, nasopharynx, oropharynx, hypopharynx, and larynx. Each part can be rigid and sturdy or semi-rigid and prone to collapse. Both rigid and semi-rigid areas can be occluded due to anatomic abnormalities and variations. The nose is a rigid region of the upper respiratory tract because of its bony components. The nasopharynx is defined as the area from the nasal concha's posterior aspect to the soft palate's horizontal plane. The nasopharynx is rigid proximally and semirigid distally. The oropharynx is a semirigid portion extending from the soft palate to the base of the tongue. The oropharynx can be subdivided into the posterior soft palate (retropalatal) and tongue (retroglossal) regions. The larynx is the most distal part of the upper respiratory tract and is the most rigid area because it comprises cartilage and muscle. In most OSA sufferers, upper airway collapse or collapse occurs in the nasopharynx and oropharynx because these areas are semi-rigid [14].

Sleep can be divided into two distinct neurophysiological states based on behavioral and electrographic characteristics: rapid eye movement (REM) and non-rapid eye movement (NREM) sleep. The effect of sleep on breathing can be seen especially in REM compared to NREM. Ventilation during NREM sleep exhibits a more regular breathing pattern than during wakefulness without a decrease in the average frequency. Meanwhile, REM sleep is characterized by increased respiratory frequency and reduced breathing regularity. Thus tidal volume decreases further in REM sleep than in NREM sleep, causing minute ventilation to decrease [15].

The wakefulness stimulus may originate from the supra pontine or reticular activating system (RAS) areas. During the waking state, the tonic input from the wakefulness stimulus to the respiratory center can compensate for the reduced chemical arousal and overcome other inhibiting factors so that respiratory arrest rarely occurs. It is different during sleep, where the wakefulness stimulus disappears so that ventilation is under metabolic control, which makes the respiratory system control very sensitive to transient reductions in $PaCO_2$. Then low or high CO_2 reserves during sleep tend for upper airway collapsibility to become apnea [16]. The effect of sleep is also seen in the upper airway muscles, which maintain patency and prevent collapse during inspiration. These muscles include m. genioglossus, m.tensor palatine, and sternohyoid are active during wakefulness and decrease during sleep. It can be seen when there is an increase in $PaCO_2$. The genioglossus muscle will react quickly in awake conditions and decreases during sleep.

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder that is either partial (hypopnea) or complete (apnea) for at least 10 seconds during sleep. It results from obstruction or narrowing of the upper airway as the muscles relax during sleep, causing the soft tissue in the back of the throat to collapse. Respiratory arrest most often occurs for 10 to 30 seconds but can last up to 1 minute or longer, causing a sudden drop in blood oxygen saturation by 40% or more. Lack of oxygen causes a person to wake up from sleep to restore normal breathing [17].

The apnea-hypopnea index (AHI) is a measure used to measure sleep disturbances. AHI is defined as the sum of sleep apnea and hypopnea divided by the hours of sleep. There are three types of OSA degrees based on the America American Academy of Sleep Medicine, namely: a) mild OSA (AHI score 5-15); b) Moderate OSA (AHI score 15-30); and c) severe OSA (AHI value of more than 30).

OSA is most common in older men but can also affect women and children. The incidence of OSA increases after menopause which causes the incidence of postmenopausal men and women to be the same. Using the AHI index, globally, between the ages of 30 and 69, 936 million people are experiencing mild to moderate OSA, and 425 million are experiencing moderate to severe OSA. In other words, around 12% of the world's population suffers from OSA. China has the highest number of OSA sufferers, followed by the United States, Brazil, and India. The prevalence of OSA in China is estimated at 8.8% (66 million patients), in the United States at 14.5% (24 million patients), in India at 5.4% (29 million patients), Brazil at 26% (25 million patients) [18].

OSA risk factors include obesity, male sex, middle age, menopause in women, craniofacial and oropharyngeal structural abnormalities such as large neck circumference, retrognathia, nasal obstruction (nasal obstruction), tonsillar/adenoid hypertrophy, macroglassia. In addition, dislocation of the temporomandibular joint, high-arched palate, erythema/edema of the uvula, and restriction of retropalatal and retroglossal spaces are at risk for OSA. In children, the main cause of OSA is tonsil and adenoid hypertrophy, which can increase airway resistance. Whereas in adults, OSA is often associated with obesity [19].

Obstruction in adults most often occurs in the area behind the ovule and velopharynx (pallatum molle) and then the oropharynx or a combination of both. The most important upper airway dilator muscles are the genioglossus and tensor palatine muscles. These upper airway dilator muscles are necessary to maintain airway patency. OSA occurs due to narrowing or paralysis (collapse) of the upper airway during sleep. During sleep, upper airway resistance increases and increases if you have predisposing factors that support the upper airway to close so that the negative pressure generated by the respiratory muscles becomes greater than the ability of the dilator muscles to widen the upper airway [20].

In Table 1, you can see OSA's clinical signs and symptoms. Snoring has a high sensitivity in OSA. People suspected of OSA reported snoring so loudly every night that it disturbed other people's sleep. Excessive daytime or excessive sleepiness (hypersomnolence) during the day is a non-specific finding in OSA but is important in determining therapeutic options. Although relatively insensitive, choking, gasping, and morning headaches are highly specific for moderate to severe OSA [23]. OSA symptoms have a gradual onset and last many years in most patients. Excessive Daytime Sleepiness or hypersomnolence is the main symptom felt by OSA patients. Hypersomnolence or excessive daytime sacking is described as a tendency to fall asleep despite efforts to stay awake, and the patient may complain of fatigue or weakness [24]. Pouliot et al. [25] stated that some experts suggest a questionnaire for OSA detection. A questionnaire is expected to reduce Polysomnography (PSG) examinations in low-risk individuals. Hypersomnolence or feeling of excessive bags during the day can be measured quantitatively with the Epworth Sleepiness Scale (ESS). The sleep scale from the ESS is often used to determine the quantity the degree of sleep disturbance in OSA sufferers. The Epworth Sleepiness Scale consists of 8 questions, with each having a score of 0-3. The total score is the sum of 8 questions with a score range of 0-24. Scores greater than ten are associated with mild to moderate OSA [26].

The physical examination associated with an increased risk of OSA includes examining the respiratory, cardiovascular, and nervous systems. Obesity and signs of narrowing of the upper airway are prominent physical examinations in OSA patients. A body mass index above 30kg/m2 is a risk factor for OSA. Presence of signs of upper airway narrowing such as large neck circumference (Men >17in or 43.2 cm; Women >15in or 38.1cm), Mallapati score 3 or 4 macroglossia, tonsillar hypertrophy, uvula that is elongated or enlarged, signs of nasal obstruction (polyps, septal deviation, turbinate hypertrophy) and retrognathia should be given special attention [27]. In addition, supporting examinations such as polysomnography and portable monitoring can be carried out [28]. OSA can be managed through lifestyle changes, weight loss, continuous positive airway pressure (CPAP) treatment, mouth brace, and surgical management [29].

OSA sufferers who are not treated can be at risk of experiencing myocardial infarction, congestive heart failure, ischemic stroke, to cardiovascular death. The impact of OSA is often felt in high financial and health costs due to the risk of experiencing work accidents, driving accidents, and decreased work productivity. Pregnant women with OSA can impact their pregnancies, such as experiencing preeclampsia, gestational hypertension, premature labor, and low birth weight babies [30].

Nasal obstruction or Nasal congestion is defined as the subjective perception of discomfort or difficulty inhaling air through the nostrils/nostrils. The term stuffy nose can be used synonymously with nasal obstruction. Despite the lack of precise data, nasal congestion symptoms may affect 30-40% of the general population. Diseases with complaints of nasal obstruction that are commonly found are allergic rhinitis, rhinosinusitis, and polyps. The prevalence of allergic rhinitis varies from 10% to 40% in the global population. A survey of 61,655 adults throughout the United States reported that 14% had rhinitis. In the survey, as many as 60% reported the most common symptom found was nasal congestion. In France, studies related to rhinosinusitis have been carried out. The first study of 4611 rhinosinusitis patients found that 66% had nasal congestion, and the second study of 755 found 70% had nasal congestion. In addition, nasal congestion is also the main symptom of nasal polyps. The prevalence of polyps in the general population is 2-4% [31].

The prevalence of nasal obstruction caused by anatomical structures, according to the June 2018 edition of the ENT journal in 1,906 patients in nine US states was obtained by patients with nasal septal deviation, inferior turbinate hypertrophy, and collapse of the nasal valve by 80%, 77%, and 73% [32]. The most common occurrences of nasal obstruction found in congenital disorders are Atresia choana, Congenital Nasal Pyiriformis Aperture Stenosis (CNPAS), and Dacrocystocele [33].

Structural abnormalities of the nose can be found in septum deviation, turbinate hypertrophy, and collapse of the nasal valves. The most common structural abnormality is a nasal septal deviation which can cause a unilateral sensation of chronic nasal congestion. Patients may report a history of nasal trauma. Physical examination usually reveals an anterior septal deflection. This condition may also show compensation with turbinate hypertrophy away from the deviation [34].

Nasal congestion is a significant health problem associated with sleep disturbance and reduced quality of life. Nasal congestion can be assessed objectively and subjectively. A subjective assessment of nasal congestion can be carried out using questionnaires such as NOSE, VAS, and SNOT-22 [35].

1. In 2004, Stewart et al. [36] introduced the NOSE (Nasal Obstruction Symptoms Evaluation) scale to measure the subjective burden of nasal congestion felt in the last month. This questionnaire consists of 5 questions, each with a score on a scale of 0-4. After that, the total score of all questions is multiplied by five to obtain a total score of 0-100. A score of 0 indicates no nasal obstruction, mild nasal obstruction with a score of 5-25, moderate 30-50, severe 55-75, and very severe if > 80.
2. VAS (Visual analog scale) is a psychometric response scale used to measure the characteristics or attitudes of the subject in many disorders. In nasal congestion, VAS is usually used to determine the severity of nasal congestion before and after surgery [37].
3. SNOT-22 is a questionnaire that specifically assesses the quality of life of patients with rhinosinusitis. Questions on the SNOT-22 can be divided into four sections: 1. nasal symptoms; 2. facial/ear symptoms; 3. sleep disturbance; 4. psychological changes [38].

The nose contributes 50% of the total upper airway resistance, performs many important physiological functions, including humidification and air filtration, and is the main respiratory route during sleep. According to the Starling resistor model, apnea can occur when nasal obstruction produces negative intraluminal pressure in the

Table 1. Manifestations of OSA [21,22]

Snore	Nocturia
Excessive sleepiness during the day	Memory Impairment
Respiratory arrest reported by family	Difficult Concentration
Sleep is not refreshing	Morning headaches
Choking and gasping during sleep	Irritability and mood swings
Insomnia and waking up repeatedly	Decreased libido and erectile dysfunction

oropharynx, causing the oropharynx to collapse. As compensation, the process of breathing switches to the mouth. However, oral breathing during sleep is physiologically unfavorable and unstable, resulting in a 2.5 times higher increase in narrowing of the pharyngeal lumen and posterior collapse of the tongue resulting in more frequent apnoea [39].

3. RESEARCH METHODS

This research is an analytical study to determine the relationship between the degree of nasal obstruction and OSA in students of the Faculty of Medicine at the Indonesian Christian University class of 2018-2020 using a cross-sectional design. The Faculty of Medicine conducted the location of this research at the Indonesian Christian University, Jl. Major General Sutoyo No. 2, RT.2/RW.11, Cawang, Kec. Kramat Jati, City of East Jakarta. Data collection was carried out from January-February 2022. The population for this study was students of the Faculty of Medicine at the Indonesian Christian University class of 2018-2020. The sample of this research was the 2018-2020 Indonesian Christian University Faculty of Medicine students who met the inclusion and exclusion criteria. The technique for determining the sample in this study is non-probability sampling with purposive sampling, which is a technique for determining the sample with certain considerations and objectives. The research instruments used were the ESS (Ephworth Sleepiness Scale) questionnaire and the NOSE (Nasal Obstruction Symptoms Evaluation) scale. The steps taken in collecting data for research are: a) Collecting questionnaires that have been distributed through the Google form; b) Selecting samples based on inclusion and exclusion criteria; c) Managing and analyzing data using IBM SPSS (Statistical for Social Science) and Microsoft Office Excel programs; and d) Make a report on the results of the analysis. Processing of data collected through questionnaires using the IBM SPSS (Statistical for Social Science) program and the Microsoft Office Excel program.

4. RESULTS AND DISCUSSION

This research was obtained using primary data from filling out the NOSE and ESS questionnaires distributed online in a Google form in January-February 2022. The degree of nasal obstruction was assessed using the NOSE questionnaire, and OSA was assessed using the ESS questionnaire. Respondents in this study were students of the Faculty of Medicine at the Indonesian Christian University Class of 2018-2020. In this study, it was found that 74 people met the inclusion and exclusion criteria using a non-probability sampling technique with purposive sampling.

Table 2. Characteristics of respondents for nasal obstruction

Characteristics	Frequences	Percentage (%)
Age		
18	3	4,1
19	16	21,6
20	19	25,7
21	30	40,5
22	6	8,1
Gender		
Male	12	16,2
Female	62	83,8
Nasal obstruction		
Mild	30	40,5
Moderate	15	20,3
Severe	20	27
Very Severe	9	12,2
Total	74	100%

Table 2 shows the characteristics of nasal obstruction respondents based on age, sex, and degree of nasal obstruction. Of 74 respondents with nasal obstruction, the most age group was 21, amounting to 30 people (40.5%), and the least at 18, amounting to 3 people (4.1%). Regarding gender, 62 people (83.8%) were women, and 12 (16.2%) were men. Based on the degree of nasal obstruction, 30 people (40.5%) experienced mild nasal obstruction, 15 people (20.3%) experienced moderate nasal obstruction, 20 people (27%) experienced severe nasal obstruction, and nine people (12.2%) experienced very severe nasal obstruction.

Table 3 of 74 respondents with nasal obstruction obtained as many as 48 respondents experienced OSA, of which two people (4.2%) were 18 years old, 12 people (25%) were 19 years old, ten people (20.8%) were 20 years old, 20 people (41.7%) aged 21 years, and four people (8.3%) aged 22 years. Based on gender, 40 respondents (83.3%) experienced nasal obstruction in women and eight people (16.7%) in men.

Based on the results of the bivariate analysis in Table 4, it was found that 15 people (50%) had mild nasal obstruction with OSA, and 15 people (50%) did not have OSA. In moderate nasal obstruction, 11 people (73.3%) had OSA, and four people (26.7%) did not have OSA. In severe nasal obstruction, 13 people (65%) had OSA, and seven people (35%) did not have OSA. In very severe nasal obstruction, there were nine people (100%); all respondents had OSA. The results of the chi-square test obtained a p-value of 0.041 which means that H1 is accepted, or it can be said that there is a significant relationship between the degree of nasal obstruction and OSA in 2018-2020 Medical Students.

The results of this study, from 74 respondents with nasal obstruction, the largest age group was obtained, namely at the age of 21 years, totaling 30 people (40.5%). Complaints of nasal obstruction in adulthood can be caused by various diseases such as deviation of the nasal septum, chronic rhinosinusitis with or without polyps, rhinitis from various causes (e.g., allergies, hormonal, pregnancy), benign or malignant tumors, turbinate hypertrophy, Empty Nose Syndrome (ENS).), antrochoanal polyps, systemic disease, and concha bullosa.

Based on gender, the highest frequency of nasal obstruction was found in the female group, namely 62 people (83.8%). Some diseases with symptoms of nasal obstruction are more common in women, such as chronic rhinosinusitis, non-allergic rhinitis, and turbinate hypertrophy [40]. Chronic rhinosinusitis is more common in women than men due to differences in anatomical size, sensitivity to tobacco, and hormonal factors. Non-allergic rhinitis is more common in women than in men. It can occur in rhinitis induced by pregnancy, menstruation, and oral contraceptive use [41]. As for allergic rhinitis, when children (age 0-10 years), the incidence of allergic rhinitis is higher in boys than girls. Conversely, when entering the ages of 11-17, allergic rhinitis is higher in girls than boys. However, when reaching adulthood, 18-79 years, there is no difference in allergic rhinitis in men and women. It is still unclear how sex hormones directly influence the sensitization process in females and males. Epidemiological and experimental studies show that female sex hormones increase the memory of immunological responses to allergens, while male hormones dampen these responses more, causing women to be more at risk of allergic rhinitis than men. Concha hypertrophy in women is also influenced by hormones. Enlargement and blockage of the turbinate mucosa can occur due to the effects of progesterone, pregnancy, and the menstrual cycle.

Table 3. Characteristics of respondents with nasal obstruction with OSA

Characteristics	**OSA**			
	Yes		**No**	
	N	**%**	**N**	**%**
Age				
18	2	4,2	1	3,8
19	12	25	4	15,4
20	10	20,8	9	34,6
21	20	41,7	10	38,5
22	4	8,3	2	7,7
Gender				
Male	8	16,7	4	15,4
Female	40	83,3	22	84,6
Total	48	100	26	100

Table 4. Relationship between the degree of nasal obstruction and OSA

Degrees of nasal obstruction	**OSA**						***p value***
	Yes		**No**		**Total**		
	n	**%**	**N**	**%**	**N**	**%**	
Mild	15	50	15	50	30	100	0,041
Moderate	11	73,3	4	26,7	15	100	
Severe	13	65	7	35	20	100	
Very Severe	9	100	0	0	9	100	
Total	48	64,9	26	35,1	74	100	

The highest degree of nasal obstruction in this study was mild in 30 people (40.5%). The NOSE score for mild nasal obstruction ranges from 5-25. Research conducted by Stefani K et al. in the general population in Australia found NOSE scores >45 related to OSA ($p < 0.001$), use of CPAP ($p = 0.018$), and cleft lip/palate ($p = 0.020$) >45.

In this study, out of 74 respondents with nasal obstruction, 48 people (64.9%) had OSA. Based on the sex of the 48 people, it was found that the most respondents with nasal obstruction experienced OSA were women, namely 40 people (83.3%), while in men, only eight people (16.7%). This research aligns with Zivana FH et al., where most respondents suffering from OSA in young adults were women compared to men. The number of OSA sufferers is more female than male because the nasal obstruction respondents in this study were more dominated by women, 62 people (83.8%) compared to men 12 people (16.2%), so the highest number of OSA sufferers was obtained, namely women.

This study is inconsistent with data showing that the prevalence of OSA in the general population is higher in men than in women, with a male: female ratio of 3:1 [42]. The mechanism underlying the incidence of OSA is more in males than females is not fully understood, but differences in fat distribution, upper airway anatomy, hormones, and aging are thought to play a role in these differences [43].

In this study, respondents had a Body Mass Index (BMI) in the normal category according to WHO criteria, which ranged from 18.5 to 24.9 kg/m2, so the incidence of OSA is not affected by BMI. Obesity is known as one of the factors causing OSA. In most populations, the prevalence of obesity in adults is higher in women than in men [44]. Thus it should be estimated that there are more OSA sufferers in women than in men. On the other hand, men suffer from OSA more, and this might be due to differences in fat distribution. Fat accumulation in the tongue area as weight gain is more seen in males than females. The tongue is an important factor in mediating upper airway size. Fat accumulation at the base of the tongue can change the shape of the tongue in the retroglossal area so that the size of the retroglossal airway decreases and increases the risk of OSA. In women, the distribution of fat is more peripheral, while in men, it is central, so fat accumulation in the upper airway area is lower, and the neck circumference is smaller in women than in men.

Differences in the length of the upper airway anatomy in men and women also play a role. Research conducted by Ronen et al. found that the length of the upper airways for both males and females was the same during prepuberty. However, this situation changes when entering puberty, where the upper airway in males becomes longer than in females. A longer upper airway in males increases the likelihood of collapse than in females who have a shorter and more stable upper airway [45]. A longer upper airway size results in a higher Prit in men. The critical closing pressure (Pcrit) is required to maintain a patent airway. Pcrit can be thought of as proportional to the pressure surrounding the lumen of the upper airway. The higher the pressure, the greater the chance of upper airway collapse [46].

The age characteristics of respondents with nasal obstruction with OSA were mostly found at the age of 21 years (41.7%). Research conducted by Yunika K et al. on young adults' OSA may be related to upper airway abnormalities such as septal deviation ($p=0.005$), tonsillar hypertrophy ($p=0.015$), and Mallampati score ($p<0.001$) [19]. OSA generally occurs at the age of> 65 years [47]. The aging process can modify the upper airway to become longer. The length of the upper airway can increase due to the loosening of the soft tissue around the area. In women, the incidence of OSA tends to increase after menopause, so the prevalence of OSA in the elderly between men and women tends to be the same [48]. The female hormones estrogen and progesterone have been investigated with inconsistent results. The administration of the hormone progesterone in postmenopausal women has been investigated to increase the activity of upper airway dilators, so it is suspected that progesterone plays a role in maintaining upper airway stiffness.

This study found a statistically significant relationship between the degree of nasal obstruction and OSA in Indonesian Christian University Medical Faculty students 2018-2020 ($p = 0.041$). Nasal obstruction found in pathological conditions such as nasal septal deviation, nasal polyps, sinusitis, turbinate hypertrophy, and allergic rhinitis can contribute to OSA. Research conducted by Sianturi et al. in young adults found a significant relationship between OSA and allergic rhinitis ($p = 0.000$), and there was no relationship between nasal septal deviation and OSA (p = 0.127) [11]. Meanwhile, a study conducted by Indra Setiawan found no relationship between allergic rhinitis and OSA at the ENT Poly, Muhammadiyah University Hospital, Malang (p=0.885). Another study conducted by Shah JA et al. found a significant relationship between OSA and nasal septal deviation (p = 0.0004) and inferior turbinate hypertrophy (p = 0.03). In contrast to the study of Sasongko P et al., in ischemic stroke patients, there was no association between OSA and nasal septal deviation (p = 1.00) and turbinate hypertrophy (p = 0.336) [49]. The study of Hui JW et al. found that patients with chronic rhinosinusitis without nasal polyps were at risk for OSA OR 1.98 (95% CI = 1.19–3.29) [50].

In this study, out of 74 nasal obstruction respondents, 15 people (50%) with mild nasal obstruction had OSA, 15 people (50%) did not have OSA, 11 people (73.3%) with moderate nasal obstruction had OSA, and four other people (26.7%) did not have OSA, 13 (65%) people with severe nasal obstruction had OSA and 7 (35%) other people did not have OSA, and in very severe nasal obstruction all respondents, namely nine people (100%) experiencing OSA. Based on these results, of all respondents with very severe nasal obstruction, nine people (100%) significantly experienced OSA compared to other degrees of nasal obstruction. The condition of very severe nasal obstruction is likely to cause an increase in nasal airway resistance. Increased resistance in the nose causes an increase in negative intraluminal oropharyngeal pressure so that the oropharynx can collapse and airflow obstruction arises. Thus OSA can also occur.

In this study, it cannot be said that the more severe the degree of nasal obstruction, the higher the incidence of OSA. This is because the percentage of OSA incidence between moderate and severe nasal obstruction obtained a higher percentage of moderate nasal obstruction at 73.3% compared to severe nasal obstruction at 65%. Assessment of the degree of nasal obstruction in this study used the NOSE questionnaire, which is subjective in nature, namely based on the patient's point of view where the patient's assumptions can experience errors so that they can affect the results of the degree of nasal obstruction. Assessment of nasal obstruction can be done subjectively or objectively. Several subjective tests that have been validated internationally include the Sinonasal Outcomes Test (SNOT)-22, Nasal Obstruction Symptom Evaluation (NOSE) Scale, Visual Analog Scale (VAS), and Total Nasal Symptom Score (TNSS). The advantages of subjective examination are cheap, easy, and effective, but bias can occur because it is based on patient complaints. Objective examinations such as rhinomanometry, acoustic rhinometry, and Peak Nasal Inspiratory Flow (PNIF) have the advantage that they are not based on patient assumptions. However, this examination requires experts, and not all health facilities provide these tools. Prizarky et al., in their study, found a low concordance between subjective examination using the NOSE questionnaire and objective examination using an iron spatula, where of the 95 subjects examined, with the NOSE questionnaire, 47 subjects (45.6%) were positive for nasal obstruction. In contrast, 89 subjects (86.4%) experienced positive nasal obstruction on the spatula examination iron. So it was reported that the suitability of the subjective sensation of nasal obstruction using the NOSE questionnaire with objective examination obtained low results. This indicates that subjective examination of patients with nasal obstruction can be biased or imprecise.

The condition of nasal obstruction causes the breathing process to switch to the mouth as an alternative. Breathing through the mouth during sleep causes the mandible to move downwards and displaces the tongue downwards, which causes a decrease in the diameter of the upper airway dilator muscles and a decrease in the diameter of the pharynx. It can cause OSA.

Normally breathing through the nasopharynx generates negative pressure which stimulates afferent nerves to increase activity of the upper airway dilator muscles. It is known as the negative pressure reflex. In people who experience nasal obstruction, it causes airflow through the nose to decrease so that breathing through the mouth becomes more dominant. Breathing through the mouth thwarts the negative pressure reflex from activating the upper airway dilator muscles.

Another factor is the nasal ventilation reflex. In healthy people, breathing through the nose during sleep activates nasal receptors, which have a direct effect on spontaneous ventilation resulting in an increase in respiratory rate and minute ventilation. Mouth breathing reduces activation of the nasal receptors, deactivates the nasal breathing reflex, and impairs spontaneous ventilation. Although the presence of nitric oxide (NO) in the mechanism of OSA is not fully understood, its presence of nitric oxide (NO) appears to play a role in maintaining upper airway patency by maintaining pharyngeal muscle tone. NO is produced in significant amounts in the nose and in the paranasal sinuses. Nitric oxide can increase the ability of the lungs to absorb and distribute oxygen throughout the body's tissues. With mouth breathing, nitric oxide production decreases, leading to altered muscle tone maintenance and spontaneous ventilation and sleep patterns.

5. CONCLUSION

The conclusions in this study are as follows: a) There were 74 students with nasal obstruction in medical Students Batch 2018-2020. Based on age, the most were in the 21 year old age group, 30 people (40.5%). Based on gender, the highest number was in the female group, amounting to 62 people (83.8%). Based on the degree of nasal obstruction, the highest was in the mild nasal obstruction group, amounting to 30 people (40.5%); b) 48 patients with nasal obstruction experienced OSA in medical Students Batch 2018-2020. A total of 40 people (83.3%) were female, and eight people (16.7%) were male; c) A significant relationship was found between the degree of nasal obstruction and OSA (p = 0.041) in medical Students Class of 2018-2020.

DISCLAIMER

This paper is an extended version of a Thesis document of the same author.

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CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/97647