RELATIONSHIP BETWEEN PULSE TRANSIT TIME, OXYGEN DESATURATION INDEX & BLOOD PRESSURE WITH APNOEA-HYPOPNEA INDEX IN OBESE PATIENTS

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ABSTRACT

Background Obesity is a complex chronic disease that can impact sleep quality. In assessing sleep physiology, polysomnography is one of the methods used to record physiological parameters related to sleep, such as Apnea-Hypopnea Index (AHI), Pulse Transit Time (PTT), and Oxygen Desaturation Index (ODI). These parameters can be used to establish a diagnosis of sleep disordered breathing. Objective to know the relationship between AHI with Pulse Transit Time (PTT), Blood Presure and Oxygen Desaturation Index (ODI) in patient with obesity. Methods This study is a cross-sectional analytical study conducted at RSUPN Cipto Mangunkusumo assessing the relationship between polysomnography examination parameters, namely AHI, ODI and PTT, in obese patients (BMI ≥25 kg/m2). Results Obese patients with increasingly severe AHI were found to have significantly higher ODI (p<0.001), with a median ODI in the mild AHI group of 11.00, moderate 32.50, and severe 68.00. PTT between AHI groups were not significantly different (p=0.907). No significant relationship was found between ODI and PTT (r=-0.010, p=0.952). A positive correlation was found between systolic blood pressure and AHI score (r = 0.221, p = 0.030). Discussion The positive correlation between AHI and ODI in this study is in accordance with the results of previous studies. ODI has the potential to be a screening parameter for sleep disordered breathing and a predictor of AHI in obese populations. PTT in previous studies was found to be ineffective in assessing sleep quality because it was influenced by age and other factors. Increased systolic blood pressure in previous studies has also been associated with increased AHI scores. Conclusion ODI in obese patients correlates well with AHI. PTT was not found to be associated to either ODI or AHI. High systolic blood pressure is correlated with higher AHI.

Keywords: polysomnography, apnea-hypopnea index, pulse transit time, oxygen desaturation index, sleep disordered breathing, obesity

ABSTRAK

Latar Belakang Obesitas adalah penyakit kronis yang kompleks yang dapat mempengaruhi kualitas tidur. Dalam menilai fisiologi tidur, polisomnografi merupakan salah satu metode yang digunakan untuk merekam parameter fisiologis yang berhubungan dengan tidur, seperti Apnea-Hypopnea Index (AHI), Pulse Transit Time (PTT), dan Oxygen Desaturation Index (ODI). Parameter-parameter ini dapat digunakan untuk menegakkan diagnosis gangguan pernapasan saat tidur. Tujuan penelitian untuk mengetahui hubungan antara AHI dengan Pulse Transit Time (PTT), Tekanan Darah dan Indeks Desaturasi Oksigen (ODI) pada pasien obesitas. Metode Penelitian ini merupakan penelitian analitik potong lintang yang dilakukan di RSUPN Cipto Mangunkusumo yang menilai hubungan antara parameter pemeriksaan polisomnografi, yaitu AHI, ODI dan PTT, pada pasien obesitas (IMT ≥25 kg/m2). Hasil Pasien obesitas dengan AHI yang semakin berat ditemukan memiliki ODI yang lebih tinggi secara signifikan (p<0,001), dengan median ODI pada kelompok AHI ringan 11,00, sedang 32,50, dan berat 68,00. PTT antara kelompok AHI tidak berbeda secara signifikan (p=0,907). Tidak ada hubungan yang signifikan ditemukan antara ODI dan PTT (r=-0.010, p=0.952). Korelasi positif ditemukan antara tekanan darah sistolik dan skor AHI (r = 0.221, p = 0.030). Diskusi Korelasi positif antara AHI dan ODI dalam penelitian ini sesuai dengan hasil penelitian sebelumnya. ODI berpotensi menjadi parameter skrining untuk gangguan pernapasan saat tidur dan prediktor AHI pada populasi obesitas. PTT pada penelitian sebelumnya ditemukan tidak efektif dalam menilai kualitas tidur karena dipengaruhi oleh usia dan faktor lainnya. Peningkatan tekanan darah sistolik pada penelitian sebelumnya juga dikaitkan dengan peningkatan skor AHI. Kesimpulan ODI pada pasien obesitas berkorelasi baik dengan AHI. PTT tidak ditemukan berhubungan dengan ODI atau AHI. Tekanan darah sistolik yang tinggi berkorelasi dengan AHI yang lebih tinggi.

Kata kunci: polysomnography, apnea-hypopnea index, pulse transit time, oxygen desaturation index, sleep disordered breathing, obesity

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How to cite this article :

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INTRODUCTION

1. Obesity is a complex chronic disease associated with not only an increased risk of metabolic dysfunction, but also various sleep disorders, including sleep disordered breathing (SDB), insomnia, and primary snoring. Obstructive sleep apnea (OSA) is an SDB prevalent in obese patients attributed to increased tongue fat deposition, narrowing of the pharyngeal airway, and abdominal obesity. SDB may set up a vicious cycle in obese patients due to the increase in appetite secondary to increased ghrelin and decreased leptin levels associated with sleep deprivation. This vicious cycle of sleep deprivation, increased appetite, and increased BMI in obese patients with SDB highlights the importance of diagnosing SDB in obese patients [1]
2. Polysomnography is a sleep test measuring brain activity and vital sign parameters during sleep. Some of the parameters of polysomnography are the apnea-hypopnea index (AHI), pulse transit time (PTT), and oxygen desaturation index (ODI). [1]
3. The severity of OSA is conventionally quantified by the AHI. AHI is the number of events of apnea or hypopnea during sleep, divided by the duration of sleep. [2]
4. PTT is the duration it takes for a pulse wave to travel from aortic valve to the pulse signal captured by the plethysmographic finger probe. PTT is an autonomic marker used based on fluctuations of the autonomic nervous system associated with apneas and hypopneas. ODI measures the average desaturation episodes per hour, serving as a marker of nocturnal respiratory disturbance. [3,4]

METHODS

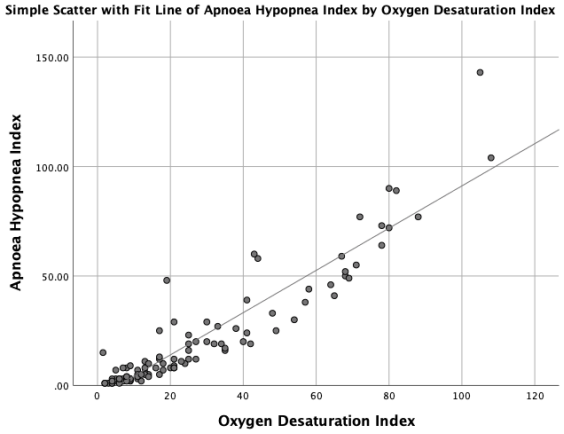
5. This is a cross-sectional study conducted in RSUPN Cipto Mangunkusumo. Patients eligible for this study were patients between 18 to 65 years of age with a BMI of $\geq 25 kg/m^2$. Patients with underlying respiratory diseases such as chronic obstructive pulmonary disease (COPD) and arrhythmia such as atrial fibrillation were excluded. The patients underwent polysomnography and the AHI, ODI, and PTT parameters were recorded according to the criteria by the American Academy of Sleep Medicine (AASM). [4]
6. Apnea is defined as the cessation of airflow for ≥10s while hypopnea is defined by ≥30% reduction in airflow for ≥10s with a ≥4% drop in PaO2 or cortical arousal from sleep.[1] The AHI were further categorized into mild (AHI <15), moderate (AHI 15-30), and severe (AHI>30). A desaturation episode is defined as a decrease in mean SpO2 of ≥3% over the last 120s for ≥10s. [2]
7. Pulse transit time was defined as the interval between electrocardiographic R wave and the point where the pulse waveform is at 50% of the height of the wave's ascent. [3]
8. This study has been approved by the Ethics Committee of Faculty of Medicine, Universitas Indonesia with regards of the protection of human rights and welfare in medical research.
9. Statistical analyses were performed with SPSS software version 26. Data distributions were assessed with Shapiro-Wilk and Kolmogorov Smirnov. Kruskal-Wallis test was done to analyze ODI differences across different AHI severity, while ANOVA was done to compare PTT across different AHI severity. Spearman's and Pearson correlation analyses were done to assess correlation between numeric data.

RESULTS

A total of 100 obese patients were involved in this study. Out of the 100 patients, AHI was calculated in 97 patients, PTT in 38 patients, and ODI in 97 patients. Data were excluded pairwise for further analysis.

23.71% obese patients (n=23) were found to have severe AHI and 20.62% patients (n=20) had moderate AHI. The mean PTT was 306.1, with a standard deviation of 17.2. Median ODI was 20.00 (3.5–36,5).

(A)



(B)

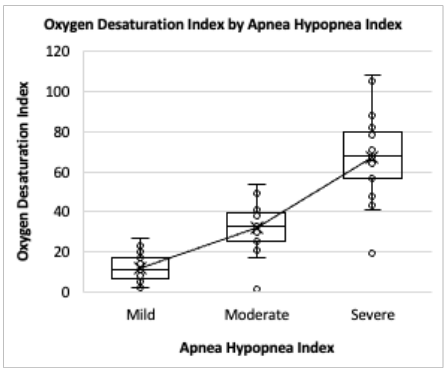
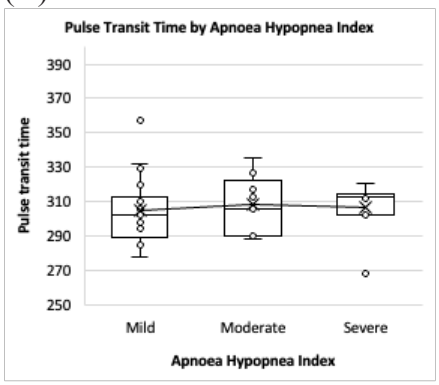
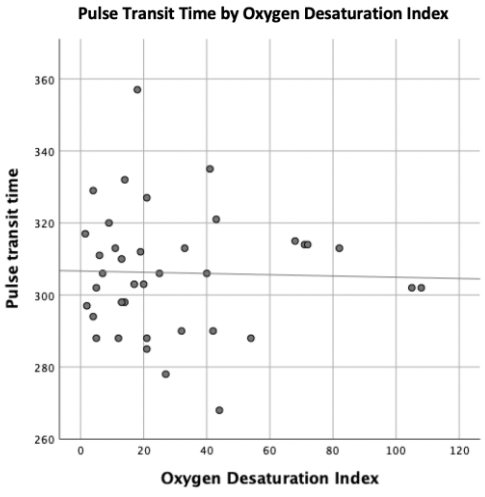


Figure 1. (A) Scatter plot of apnea hypopnea index by oxygen desaturation index in obese patients (B) Oxygen desaturation index in mild, moderate, and severe apnea hypopnea index in obese patients

ODI was found to have a significantly strong positive correlation with AHI score (r=0.929, p<0.001) (figure 1(A)). This correlation persists even when AHI was categorized into mild, moderate, and severe (p<0.001) as seen in figure 1(B). The median ODI of mild, moderate, and severe AHI patients are 11.00 (6.75–17.00), 32.50 (25.00–39.50), and 68.00 (57.00–80.00) respectively. PTT between AHI groups were also not significantly different (p=0.907) (figure 2(B)). No significant correlation was found between ODI and PTT (r=-0.010, p=0.952) (figure 2(C)).

(A)





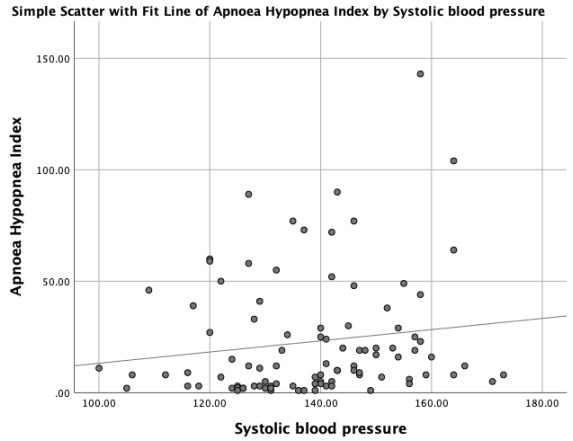
(B)

Figure 2. (A) Pulse transit time by apnea hypopnea index (B) Pulse transit time by oxygen desaturation index

More than half of obese patients involved in this study had stage 2 hypertension (57%, n=57), followed by 25% with stage 1 hypertension, and 3% with hypertensive crisis.

A positive correlation was found between systolic blood pressure and AHI score (r = 0.221, p = 0.030). However, no significant correlation was found between diastolic blood pressure and AHI score (r=0.117, p=0.255).

(A)



(B)

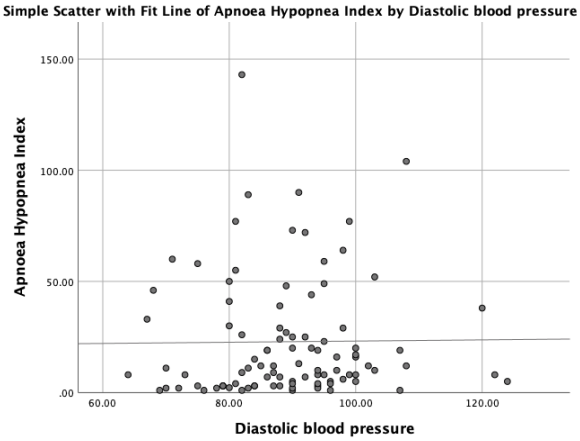


Figure 3. Scatter plot of apnea hypopnea index by (A) systolic and (B) diastolic blood pressure in obese patients

DISCUSSION

10. Respiratory arrest during sleep in SBD patients causes hypoxemia and hypercapnia. Desaturation episodes is one of the major causes of complication related to SBD and ODI is a polysomnography parameter that measures this desaturation episodes per hour.[5] ODI has been consistently shown to be correlated with AHI and is a good predictor of AHI in several previous studies. [2,5,6]
11. Varghese et al[2] previously calculated the sensitivity and specificity of different ODI cut-off points for screening of severe OSA and found that a cut-off point of ODI>15 has a sensitivity of 100% and specificity of 53.6% for severe OSA, hence excluding the possibility of severe OSA in patients with ODI<15. The findings of our study support this data, as 100% of obese patients with severe AHI in our study were found to have ODI>15. [6]
12. While AHI from polysomnography is the gold standard for assessing parameters related to sleep disordered breathing, the cost and limited availability might limit its use. The strong positive correlation found between ODI and AHI shows the potential of nocturnal oximetry using ODI as a promising alternative in grading OSA severity in obese patients. [6]
13. However, despite its shown potential as a predictor of AHI, ODI alone cannot be used in patients with underlying diseases causing hypercapnia and cannot indicate the origin of hypoxemia. Oximetry readings can also be influenced by factors such as peripheral vascular disorders and movement during sleep, which could lead to inaccurate interpretation. [7]
14. Apnea and hypopnea in SDB are also associated with fluctuations in the autonomic system and PTT is an autonomic marker that has been used for assessment of SDB. [3]
15. PTT has been shown to potentially detect microarousals in patients. [8]
16. Previous studies showed a significant correlation between PTT arousal and AHI, especially in children. [10,11]
17. However, another study found that PTT has a low level of effectiveness as a SDB screening tool in the elderly

population attributed to physiological changes that occur with aging.[3]

18. In contrast to the previous study in middle aged groups, our study found no significant correlation between PTT and AHI in adult obese patients. The previous study also showed that PTT is influenced by BMI.Hence, it appears that PTT is highly influenced by age and BMI, necessitating further studies to appropriately interpret PTT results in clinical practice. [9]
19. Our study showed a positive correlation between systolic BP and AHI. The findings of previous studies. [12,13]
20. also show positive correlation between both systolic and diastolic BP. Hypertension is highly associated with SDB, particularly OSA, and OSA has been shown to be an independent risk factor for hypertension. [14]
21. Severe OSA has also been linked to resistance to antihypertensive medication due to frequent intermittent sympathetic stimulation. These findings show the importance of screening for SDB in obese patients with hypertension for an improved patient care. [15]

CONCLUSION

Our results demonstrates that ODI in obese patients correlates well with AHI and ODI can potentially be a good predictor of SDB. PTT was found to have no correlation with AHI nor ODI in the obese population. High systolic BP is correlated with SDB in obese patients.

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