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Elevated Risk of Cardiometabolic Illness and the Prevalence of Obstructive Sleep Apnea Among the Population of Tebing-Tinggi City, North Sumatra, Indonesia: a Correlational Study

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ABSTRACT

Background: Obstructive Sleep Apnea (OSA) is a prevalent sleep-related breathing issue, marked by repeated full or partial blockages of the upper airways. It's a primary respiratory condition that heightens the chances of cardiometabolic diseases. In our research, we explored the link between the increased risk of cardiometabolic ailments and the potential for OSA.

Method: We studied 75 participants during community service activities and investigated the association between the high risk of cardiometabolic disease and the risk of OSA in the Society of Tebing-Tinggi City. We measured variables such as gender, age, weight, height, Body Mass Index (BMI), blood pressure, heart rate, random blood glucose, waist and neck circumference, and total cholesterol. Subsequently, we categorized the data and performed chi-square tests to analyze the associations between various factors and the risk of OSA. Variables with $p<0.05$ are considered eligible for multivariate analysis using binary logistic regression.

Results: We identified that 42 patients had a high risk of OSA (59.2%), while 33 patients had a low risk (40.8%). The study identified significant links between OSA risk and gender, age, blood pressure, and neck circumference (p-values <0.001, <0.001, and 0.01 respectively). In contrast, BMI, heart rate, glucose levels, waist size, and cholesterol did not show a significant connection to OSA risk. This indicates that certain factors like gender, certain age groups, hypertension, and neck circumference are important in assessing OSA risk. However, BMI, heart rate, random blood glucose, waist circumference, and total cholesterol are not significant factors in determining the risk of OSA (p=0.2, p=0.4, p=0.2, p=0.1, p=0.9).

Conclusions: A higher risk of cardiometabolic diseases (older age, gender, hypertension, neck circumference) was positively associated with the risk of OSA.

Keywords: Cardiometabolic, Obesity, Obstructive Sleep Apnea (OSA)

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Abstrak

Latar Belakang: Obstructive Sleep Apnea (OSA) adalah masalah pernapasan terkait tidur yang lazim, ditandai dengan penyumbatan penuh atau sebagian saluran udara bagian atas yang berulang. Ini adalah kondisi pernapasan secara primer meningkatkan kemungkinan penyakit kardiometabolik. Dalam penelitian ini, kami mengeksplorasi hubungan antara peningkatan risiko penyakit kardiometabolik dan potensi OSA.

Metode: Dipelajari 75 peserta selama kegiatan pengabdian masyarakat dan menyelidiki hubungan antara risiko tinggi penyakit kardiometabolik dan risiko OSA pada masyarakat Kota Tebing-Tinggi. Kami mengukur variabel seperti jenis kelamin, usia, berat badan, tinggi badan, Indeks Massa Tubuh (IMT), tekanan darah, detak jantung, glukosa darah acak, lingkar pinggang dan leher, dan kolesterol total. Selanjutnya, kami mengkategorikan data dan melakukan tes chi-square untuk menganalisis hubungan antara berbagai faktor dan risiko OSA. Variabel dengan $p<0,05$ dianggap memenuhi syarat untuk analisis multivariat menggunakan regresi logistik biner.

Hasil: Kami mengidentifikasi bahwa 42 pasien memiliki risiko tinggi OSA (59,2%), sementara 33 pasien memiliki risiko rendah (40,8%). Studi ini mengidentifikasi hubungan yang signifikan antara risiko OSA dan jenis kelamin, usia, tekanan darah, dan lingkar leher (p-nilai <0,001, <0,001, dan 0,01 masing-masing). Sebaliknya, IMT, denyut jantung, kadar glukosa, ukuran pinggang, dan kolesterol tidak menunjukkan hubungan yang signifikan dengan risiko OSA. Ini menunjukkan bahwa faktor-faktor tertentu seperti jenis kelamin, kelompok usia tertentu, hipertensi, dan lingkar leher penting dalam menilai risiko OSA. Namun, IMT, denyut jantung, glukosa darah acak, lingkar pinggang, dan kolesterol total bukanlah faktor signifikan dalam menentukan risiko OSA ($p = 0,2$, $p = 0,4$, $p = 0,2$, $p = 0,1$, $p = 0,9$).

Kesimpulan: Risiko penyakit kardiometabolik yang lebih tinggi (usia yang lebih tua, jenis kelamin, hipertensi, ukuran lingkar leher) dikaitkan secara positif dengan risiko OSA.

***Kata kunci**: Kardiometabolik, Obesitas, Obstructive Sleep Apnea (OSA)*

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1 Introduction

Cardiovascular diseases (CVDs) are the primary cause of death worldwide. In 2019, they were responsible for about 17.9 million deaths, making up 32% of all global fatalities. Heart attacks and strokes accounted for 85% of these deaths.[1] Notably, a significant 75% of these deaths occurred in low- to middle-income nations. In the same year, of the 17 million early deaths (those below 70 years of age) from noncommunicable diseases, CVDs were responsible for 38%. The majority of CVDs can be avoided by tackling lifestyle-related risks like smoking, poor diet, lack of exercise, and excessive alcohol consumption.[2] Early detection of CVD is crucial for effective treatment and counseling. In Indonesia, based on medical diagnoses, 1.5% of the population, or about 1,017,290 individuals, suffer from heart disease, with a roughly equal distribution between males and females.[3,4]

Physical inactivity is a significant, alterable risk factor contributing to cardiovascular disease and is among the top causes of death globally. Its detrimental effects are on par with obesity and smoking. Annually, physical inactivity is responsible for approximately 5.2 million deaths and contributes to 6-10% of major non-communicable diseases worldwide. The cardiometabolic risk profile consists of interconnected risk elements like abdominal obesity, hypertension,

dyslipidemia, hyperglycemia, and hyperinsulinemia. Adults exhibiting multiple such risk factors face a heightened risk of type 2 diabetes and cardiovascular diseases. Conditions like dyslipidemia, glucose intolerance, diabetes, and metabolic syndrome, although often without apparent symptoms, are closely tied to elevated cardiovascular disease rates. A study in Medan involving 100 participants found that 9% had raised blood sugar, 41% exhibited central obesity, and 66% had heightened cholesterol levels.[5]

Obstructive sleep apnea (OSA), a prevalent sleep condition affecting 2-4% of middle-aged individuals, results from recurrent upper airway blockages, leading to periodic low oxygen levels and disrupted sleep. OSA is now identified as an independent risk factor for multiple cardiovascular problems, including hypertension and stroke.[6] Metabolic issues like diabetes and lipid metabolism disturbances are also linked to OSA. The rise in global obesity rates has amplified OSA prevalence. There's a marked connection between metabolic syndrome, OSA, and elevated cardiovascular risks. In essence, OSA increases the chances of cardiovascular ailments.[5]

The pandemic of COVID-19 that has affected the world and Indonesia since March 2020 is believed to have played a role in the increased incidence of cardiometabolic diseases.[7] Self-isolation, limited mobility, and restrictions on gatherings, which are strategies to prevent the spread of COVID-19, have turned out to be a double-edged sword as they hinder physical activity and exercise, which can help reduce the incidence of cardiometabolic diseases.[8] This situation potentially leads to an increase in cases of cardiometabolic diseases during this COVID-19 pandemic, alongside limited access to healthcare facilities. Based on these reasons, this study aimed to examine the relationship between the high risk of cardiometabolic and the risk of OSA in the society of Tebing-Tinggi City, North Sumatra.

2 Methods

2.1 Study design

This study is analytical research with a cross-sectional design, aiming to analyze the association between the high risk of cardiometabolic and the risk of OSA in the society of Tebing Tinggi. This study was conducted on the society of Tebing Tinggi which participates in the community service activities of the Department of Cardiology and Vascular Diseases in 2023 and after receiving the letter of ethical clearance.

2.2 Measures

The study samples consist of individuals from the community of Tebing Tinggi who participated in the community service activities conducted by the Department of Cardiology and Vascular Diseases. All participants undergo registration and complete a basic data form and informed consent. Subsequently, researchers conduct examinations on the samples including weight

measurement, height measurement, blood pressure measurement, heart rate measurement, waist circumference measurement, neck circumference measurement, blood glucose examination, and cholesterol examination. Additionally, an interview is conducted to fill out the STOP-Bang OSA questionnaire.

2.3 Statistical analysis

The processing and analysis of data used the SPSS Program. Categorical variables are presented with frequency (n) and percentage (%). Bivariate analysis to compare between two groups used the Chi-square test, if the criteria are not met, Fisher's exact test will be used. The variable was considered significant if the value was $p<0.05$. Variables with $p<0.25$ are considered eligible for multivariate analysis using binary logistic regression. The variable with a significant result of $p<0.05$ was shown in OR with 95% CI.

This study was approved by the Health Ethics Committee from the Faculty of Medicine, University of North Sumatra.

3 Results

All subjects in this study (n=75) are 27(36%) men and 48 (64%) women. The most age group was 51-60 (42.7%) years old, the most BMI was obesity class I (42.7%), and neck circumference >40 cm: 7 (9.3%). We found 33 (44%) subjects with hypertension, 45 (6.8%) subjects with tachycardia, 35 (5.3%) subjects with hyperglycemia, 474 (71.6%) subjects with central obesity 20 (26.7%) and neck circumference >40 cm, 7 (9.3%) subjects was hypercholesterolemia, and 42 (59.2%) subjects with high risk of OSA [Table 1].

Table 1 Baseline characteristics

Variable	n(%)
Gender (n=75)	
Male	27 (36%)
Female	48 (64%)
Age (year)(n=75)	
19-30	3 (4%)
31-40	8 (10.7%)
41-50	26 (34.7%)
51-60	32 (42.7%)
>60	6 (8%)
BMI (kg/m2)	
Underweight (<18.5) 13 (2.0)	2 (2.7%)
Norm weight (18.5-24.9)	11 (14.7%)
Overweight (25.0-29.9)	12 (16%)
Obesity class I	32 (42.7%)
Obesity class II	18 (24%)
Blood pressure	
Normal	42 (56%)
Hypertension	33 (44%)
Heart rate	
<60 bpm	0 (0%)
60-100 bpm	72 (96%)
>100 bpm	3 (4%)
Random blood glucose (mg/dL)	
<200	74 (98.7%)
≥200	1 (1.3%)
Waist circumference (cm)**	
Normal	55 (73.3%)
Obesity	20 (26.7%)
Neck circumference (cm)	
≤40	63 (84%)
>40	12 (16%)
Total cholesterol (mg/dL)	
<200	68 (90.7%)
≥200	7 (9.3%)
Risk of OSA	
Low risk (score 0-1)	33 (44%)
High risk (score ≥2)	42 (56%)

* NHLBI Obesity Education Initiative
**Ministry of Health Republic of Indonesia (Normal: male <90 cm, female <80 cm)
*** Ministry of Health Republic of Indonesia (Normal: <200 mg/dL)

Based on Table 2, we conducted a multivariate analysis using binary logistic regression. Multivariate analysis showed a significant association between males (OR 8.7; 95% CI 2.6–29.4; p<0.001), age 51-60 years old (OR, 2.1; 95% CI 1.2–3.9; p=0.008), and hypertension (OR, 3.5; 95% CI 1.3–9.4; p=0.01).

Table 2 Association between Cardiovascular Risk Factors and OSA

Variable	Low-Risk OSA	High-Risk OSA	P Value
Gender			
Male	4	23	0.001*
Female	29	19	
Age (year)			
19-30	2	1	
31-40	5	3	
41-50	16	10	0.03*
51-60	9	23	
>60	1	5	
BMI (kg/m2)			
Underweight (<18.5) 13 (2.0)	0	2	
Norm weight (18.5-24.9)	5	6	
Overweight (25.0-29.9)	8	4	0.2
Obesity class I	14	18	
Obesity class II	6	12	
Blood pressure			
Normal	24	18	
Hypertension	9	24	0.01*
Heart rate (bpm)			
<60	0	0	
60-100	31	41	0.4
>100	2	1	
Random blood glucose (mg/dL)			
<200	32	42	0.2
≥200	1	0	
Waist circumference (cm)			
Normal	27	28	0.1
Obesity	6	14	
Neck circumference (cm)			
≤40	33	30	0.001*
>40	0	12	
Total cholesterol (mg/dL)			
<200	30	38	0.9
≥200	3	4	

*significant with Pearson chi-square test

4 Discussion

Several studies have provided evidence of sympathetic excitation in patients with OSA.[11] Further studies have since confirmed elevated catecholamine levels both in plasma and urine of OSA patients,[12] and several randomized controlled trials have demonstrated a significant fall with CPAP therapy.[13] Using microneurography as a more direct measurement of sympathetic nervous system activity, Somers et al demonstrated increased muscle sympathetic nervous activity (MSNA) during wakefulness in OSA versus obese controls.[14] Systemic inflammation parallels these changes as evidenced by increased splenocyte proliferation and cytokine expression.[15] Importantly, normoxic recovery reverses the systemic and vascular inflammation associated with the early stages of the atherosclerotic process suggesting a potential therapeutic target.[16] The visceral adipose tissue has emerged as a potential source organ of pro-inflammatory mediators in OSA suggested by studies in vivo and in vitro demonstrating that IH induces a pro-inflammatory phenotype of the adipose tissue.[17,18,19] Oxidative stress ensues

when the generation of reactive oxygen species (ROS) exceeds the capacity of cellular antioxidant mechanisms to eliminate them. At low or moderate concentrations, ROS plays a key role in the regulation of various cell functions and biological processes. At higher levels, however, ROS may lead to oxidative stress and subsequent cell damage.[20,21] Substantial evidence arising predominantly from cell culture and animal studies links oxidative stress to the pathogenesis of endothelial dysfunction and atherosclerosis mainly through disruption of the vasoprotective nitric oxide (NO) axis and by mediating vascular inflammation.[22] The contribution of oxidative stress to CVD in OSA has been hypothesized for several years. The repetitive episodes of hypoxia, are followed intermittently by rapid reperfusion injury which is known to inflict cell damage through ROS production.[23] However, the contribution of oxidative stress to cardiovascular perturbations in the human condition of OSA remains controversial. A study conducted in China on 9076 subjects based on the National Health and Nutrition Examination Survey (NHANES) 2005-2008 showed a significant association between hypertension and risk of OSA (OR, 1.2; 95% CI 1.1–14; p<0.001)[2] and study of Zhao et al (2018) with (OR, 1.9; 95% CI 1.2–3.0; p=0.002) [9]. A study conducted in Africa on 75 subjects showed that being older and having a higher body mass index was associated with OSA (p=0.02, p=0.02)[24]. This study is similar to the study we conducted, which found that older age (>50 years old) and higher body weight (obesity class II) are associated with an increased risk of OSA (p<0.001, p<0.001).[24]A study conducted in Madrid, Spain on 809 subjects showed that only severe OSA had an independent association with dyslipidemia when compared to non-OSA subjects (OR, 1.71; 95% CI 1.0-2.6; p=0.019).[25] But, in this study, we found that total cholesterol is not a significant factor in determining the risk of OSA (p= 0.9).

5 Conclusions

The higher risk of cardiometabolic diseases (older age, hypertension, obesity, neck circumference > 40 cm) was positively associated with the risk of OSA. This suggests that certain factors such as gender, certain age groups, hypertension, and neck circumference are important in assessing OSA risk.

REFERENCES

[1] Martina Meszaros, Adam Domonkos Tarnoki, David Laszlo Tarnoki, Daniel Tamas Kovacs, Bianka Forgo , Jooyeon Lee, et al. Obstructive sleep apnea and hypertriglyceridemia share common genetic background: Results of a twin study. Journal of Sleep Research. 2020 Aug 1;29(4).e12979

[2] Gao J, Shi L, Zhu X, Liu J. Association of obstructive sleep apnea with cardiometabolic diseases and cardiovascular mortality. Clinical Respiratory Journal. 2023;1-7.

[3] World Health Organization. Cardiovascular diseases (CVDs). 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).

[4] Ministry of Health Republic of Indonesia. Laporan Nasional Riskesdas 2018. Available from: https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas- 2018_1274.pdf

[5] Kallio, Petri; Pahkala, Katja; Heinonen, Olli J.; Tammelin, Tuija; Hirvensalo, Mirja; Telama, Risto. Physical inactivity from youth to adulthood and adult cardiometabolic risk profile. Preventive Medicine. 2021 Apr 1;145.

[6] Sarastri Y, Raynaldo AH, Ilyas KK, Lubis DA. Cardiometabolic profile screening as an early detection of cardiometabolic risk. Journal of Endocrinology, Tropical Medicine, and Infectious Disease. 2022 Vol. 04 (2):70-76.

[7] Stephanie André, Fabio Andreozzi, Chloé Van Overstraeten, Sidali Ben Youssef, Ionela Bold, Sarah Carlier, et al. Cardiometabolic comorbidities in obstructive sleep apnea patients are related to disease severity, nocturnal hypoxemia, and decreased sleep quality. Respiratory Research. 2020 Jan 29;21(1).

[8] Drager LF, Togeiro SM, Polotsky VY, Lorenzi-Filho G. Obstructive sleep apnea: A cardiometabolic risk in obesity and the metabolic syndrome. Vol. 62, Journal of the American College of Cardiology. Elsevier USA; 2013. p. 569–76.

[9] Xiaolong Zhao, Xinyi Li, Huajun Xu, Yingjun Qian, Fang Fang, Hongliang Yi, et al. Relationships between cardiometabolic disorders and obstructive sleep apnea: Implications for cardiovascular disease risk. 2018 Nov 21:280–90.

[10] Eugene C. Fletcher, Joanna Miller, James W. Schaaf, and Joyce G. Fletcher. Urinary Catecholamines Before and After Tracheostomy in Patients with Obstructive Sleep Apnea and Hypertension. Sleep 1987;10(1):35-44.

[11] J E Dimsdale, T Coy, M G Ziegler, S Ancoli-Israel, J Clausen. The effect of sleep apnea on plasma and urinary catecholamines. Sleep 1995;18:377-81.

[12] A. Elmasry, E. Lindberg, J. Hedner, C. Janson, G. Boman. Obstructive sleep apnoea and urine catecholamines in hypertensive males: a population-based study. Eur Respir J 2002;19:511-7

[13] M G Ziegler 1, P J Mills, J S Loredo, S Ancoli-Israel, J E Dimsdale. Effect of continuous positive airway pressure and placebo treatment on sympathetic nervous activity in patients with obstructive sleep apnea. Chest 2001;120:887-93

[14] Somers VK, Dyken ME, Clary MP, et al. Sympathetic neural mechanisms in obstructive sleep apnea. J Clin Invest 1995;96:1897-904.

[15] A. Elmasry, E. Lindberg, J. Hedner, C. Janson, G. Boman. Obstructive sleep apnoea and urine catecholamines in hypertensive males: a population-based study. Eur Respir J 2002;19:511-7

[16] Arnaud C, Beguin P, Levy P, et al. Normoxic Recovery Reverses Intermittent Hypoxia-Induced Systemic and Vascular Inflammation. Chest 2016;150:471-3.

[17] Alba Carreras, Shelley X. L. Zhang, Isaac Almendros, Yang Wang, Eduard Peris, Zhuanhong Qiao, et al. Resveratrol attenuates intermittent hypoxia-induced macrophage migration to visceral white adipose tissue and insulin resistance in male mice. Endocrinology 2015;156:437-43.

[18] Laureline Poulain, Amandine Thomas, Jennifer Rieusset, Louis Casteilla, Patrick Levy, Claire Arnaud, Maurice Dematteis. Visceral white fat remodeling contributes to intermittent hypoxia-induced atherogenesis. Eur Respir J 2014;43:513-22.

[19] Ryan S. Adipose tissue inflammation by intermittent hypoxia: a mechanistic link between obstructive sleep apnoea and metabolic dysfunction. J Physiol 2017;595:2423-30.

[20] Thannickal VJ, Fanburg BL. Reactive oxygen species in cell signaling. Am J Physiol Lung Cell Mol Physiol2000;279:L1005-28.

[21] K Hensley 1, K A Robinson, S P Gabbita, S Salsman, R A Floyd. Reactive oxygen species, cell signaling, and cell injury. Free Radic Biol Med 2000;28:1456-62

[22] Li H, Horke S, Forstermann U. Vascular oxidative stress, nitric oxide, and atherosclerosis. Atherosclerosis. 2014;237:208-19

[23] Eltzschig HK, Eckle T. Ischemia and reperfusion—from mechanism to translation. Nat Med 2011;17:1391-401.

[24] Johanna Roche, Dale E. Rae, Kirsten N. Redman, Kristen L. Knutson, Malcolm von Schantz, F. Xavier Gómez-Olivé, et al. Impact of obstructive sleep apnea on cardiometabolic health in a random sample of older adults in rural South Africa: building the case for the treatment of sleep disorders in underresourced settings. Journal of Clinical Sleep Medicine. 2021;12(7): 1423-34

[25] Elisabet Martínez-Cerón, Raquel Casitas, Raúl Galera, Begoña Sánchez-Sánchez, Ester Zamarrón, Aldara Garcia-Sanchez, et al. Contribution of sleep characteristics to the association bet 1987 Feb;10(1):35-44.