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Original Article

Estimated VO2 max Analysis with Six-Minute Walking Test on Obese Patients in Primary Health Care in Makassar

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ABSTRACT

Introduction*: Obesity poses a severe threat to global health, making it a significant epidemiological concern that requires special attention. It is associated with several risk factors for various diseases. Alarmingly, one in three Indonesian adults is obese, with the obesity rate steadily increasing. Studies have shown that excess fat mass is linked to higher mortality and morbidity from cardiovascular disease, which is currently Indonesia's leading cause of death. To assess a person's functional capacity and ability for basic physical activity, the 6-minute walking test (6MWT) is utilized, as it proves to be a powerful predictor of morbidity and mortality rates. Therefore, this study aims to analyze the association between VO2 max using 6MWT in obese patients of Makassar City.* ***Methods:*** *This study was a cross-sectional study.*

The samples comprised all obese individuals who provided signed approval letters and were registered at Makassar City's 20 Public Health Centers. Consecutive

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sampling was used to gather the samples. Subsequently, the samples were examined and categorized based on their level of obesity. The 6MWT results are then used with Nury's Formula to produce an estimated VO2max result. To analyze the association between VO2 max using 6MWT and obesity, statistical analysis was conducted using the Mann-Whitney test, with significant results indicated by ($p < 0.05$). ***Results:*** *A total of 163 participants comprised the study's sample, with the majority being female and aged 50 years or older. After filling out the questionnaire, data show that most of the obese participants had a family history of cardiovascular disease (CVD), experienced significant stress levels, and had average BMIs falling into the category of obesity. According to the study, the average distance covered in the 6-minute walking test was 340.18 meters (±82.6 meters). When the study participants were ranked by their estimated VO2 max, the average value was 15.10±5.52 for those with first-degree obesity. Following them were participants with second-degree obesity, with results averaging 15.03±5.39 ($p = 0.021$).* ***Conclusion:*** *A significant inverse association exists between obesity and VO2 max, which means that the more obese a person is, the lower their VO2 max tends to be.*

1. INTRODUCTION

Obesity is a health problem that demands special attention due to its association with various disease risk factors. It poses a global epidemiological concern and is a serious threat to health[1]. Over the past decade, obesity prevalence has dramatically increased, becoming an epidemic in several countries, including Indonesia. Data from the Basic Health Research (Riskesdas) in 2018 reveals a nationwide obesity prevalence of 21.8% among individuals aged 15 and above. Obesity results from excessive fat accumulation due to an imbalance between energy intake and expenditure[3]. It is an independent risk factor for cardiovascular disease[1,2,3] and is also linked to higher morbidity and mortality rates, shortened life expectancy, and other adverse outcomes. Obesity can lead to illnesses like high blood pressure, atherosclerosis, left ventricular hypertrophy, insulin resistance, and diabetes mellitus. Maximal aerobic capacity (VO2 max) refers to the maximum amount of oxygen utilized in the muscular metabolic system[5,6,7]. A person's functional capacity, or ability to engage in basic physical activities, significantly impacts their health-related quality of life and is a robust predictor of morbidity and mortality rates. A decline in basic physical functions, like the ability to walk, can be a strong indicator of future cardiovascular events. The 6-minute walking test

(6MWT), introduced by the American Thoracic Society [8,9,10], enables the calculation of VO2 max. Early recognition of functional impairments in obese patients may allow prompt intervention to prevent more severe functional limitations[11,12]. Given the significance of the above information, conducting a study in the city of Makassar to assess VO2 max through a 6MWT examination in obese individuals holds crucial importance.

2. METHODS

2.1 Research Methods

This research adopts a correlational analytical approach with a cross-sectional design. The study utilized consecutive sampling to select samples from all obese individuals registered at Makassar City's 20 Public Health Centers who met the inclusion criteria and provided signed approval letters. Patients who meet the criteria will complete a questionnaire with basic parameter information. To measure stress and habit health, we use the Perceived Stress Scale (PSS) and Adolescent Food Habits Checklist (AFHC). Then, the participant will do 6MWT and walk as far as possible for 6 minutes. Patients will walk along this hallway between the markers as often as possible in 6 minutes. Then the 6MWT data is entered into the Nury formula below to get the VO2 max result[10]:

VO2 Max = (0,053 x d) + (0,22 x a) + (0,032 x h) – (0,164 x w) – (2,228 x s) - 2,287

d : distance (meters),
a : age (years),
h : height (centimeters),
w : weight (kilograms),
s : sex (male = 0, female = 1)

Subsequently, the result were analyzed based on the data and grouped according to the degree of obesity.

We then categorized the functional capacity based on sex and distance in 6MWT as follows[10]:

Male: Distance >483 meters (normal); 434-483 meters (poor); and <434 meters (very poor)
Female: Distance >442 meters (normal); 405-442 meters (poor); and <405 meters (very poor).

2.2 Statistical Analysis

The data was analyzed using SPSS version 25, and the measurement results are presented in the form of tables. Categorical variables are expressed as numbers and frequencies, while continuous variables are presented as ratio ± SD or median. The Mann-Whitney test was employed to determine statistically significant differences between two groups of independent variables. A *p-value* <0.05 is considered significant for the statistical test results.

3. RESULTS

Sample Overview

In this study, 68.7% of the participants were female, and 79.7% were over 50 years old. The majority of obese individuals also reported significant levels of stress (92.3%), dyslipidemia (89.7%), and a family history of cardiovascular disease (CVD) (85.8%). The study revealed that every obese patient acknowledged leading an extremely unhealthy lifestyle, primarily due to poor dietary habits. The characteristics of the study's variables are described in Table 1.

Table 1. Sociodemographic Characteristics of Research Subjects

Variable		1st degree Obese (n= 100)	2nd degree Obese (n = 63)	Total (163)	*p- Value*
Gender	Woman	72 (44.2)	40 (24.5)	112 (68.7)	0,333
	Man	28 (17.1)	23 (14.2)	51 (31.3)	
Age	≥50 years	80 (49.7)	50 (30.0)	130 (79.7)	1,000
	<50 years	20 (12.2)	13 (8.0)	33 (20.2)	
Education Status	No	0 (0.0)	2 (3.0)	2 (1.2)	0,002*
	Elementary school	4 (2.5)	10 (6.1)	14 (8.6)	
	Junior High School	10 (6.1)	10 (6.1)	20 (12.3)	
	Senior High School	42 (25.7)	28 (17.1)	70 (42.9)	
	Bachelor	44 (27.0)	13 (8.0)	57 (35.0)	
Smoking History	Yes	15 (9.0)	18 (11.2)	33 (20.2)	0,057
	No	85 (52.2)	45 (27.6)	130 (79.8)	
Dyslipidemia	Yes	88 (54.0)	62 (37.7)	150 (89.7)	0,036*
	No	12 (7.4)	1 (0.6)	13 (10.2)	
Family history of CVD	Yes	85 (52.2)	55 (33.7)	140 (85.9)	0,857
	No	15 (9.0)	8 (5.2)	23 (14.1)	
Stress	Yes	99 (60.3)	52 (32.0)	151 (92.3)	<0,0001*
	No	1 (0.6)	11 (6.7)	12 (7.3)	
Poor diet	Yes	100 (61.3)	63 (38.6)	163 (100)	-
	No	0 (0.0)	0 (0.0)	0 (0.0)	

Data presented as n (%). Data were analyzed using Pearson's Chi-Square test . **p* is significant when < 0.05

The patients in this study had an average walking distance of 340.18 ± 82.6 meters, falling into the category of very poor performance.

The distance depends on the patient's degree of obesity.

The majority equally showed low mileage, with average values of 399.33 for the first-degree and 293.01 for the 2nd-degree obese patient, respectively, among the total patients who were classified as first-degree obese (100 persons). This suggests that there are differences between each category of obesity degrees in the results of the 6MWT mileage. The Mann-Whitney test was used to statistically examine these findings, and the results were found to be statistically significant (p = 0.015)**.** The study's variables are described in Table 2.

Table 2. Average mileage 6MWT based on characteristics of obese patients

Variable	n	Mileage		*p-value*
		Mean ± SD	Median (min-max)	
Degrees of Obesity				
1st degree	100 (61,3 %)	399.33 ± 80.4	396 (200 –478)	*0*.015*
2nd degree	63 (38,6 %)	293.01 ± 74.4	300 (99 – 450)	

Data were analyzed using the Mann-Whitney Test, p is significant when < 0.05

Estimating VO2 Max Depending on Obesity Level

The 6MWT results are then used with Nuri's Formula to produce an estimated VO2max result*.* The Nury formula is the appropriate predictor of maximum oxygen uptake for healthy Indonesian adult as it is designed using Indonesian subjects (Mongoloid). The Nury formula, which consists of five variables, is more applicable because it does not require any measurement tools or specific competency[9,10,11,19]. This study showed that the average estimated VO2 max value among the study subjects was 14.99 ± 5.5. When sorting the estimation from largest to smallest, subjects with first-degree obesity had the highest average VO2 max, which was 15.10 ± 5.52. This was followed by subjects with second-degree obesity, which was 12.03 ± 5.39. The Mann-Whitney Test was used to examine these findings statistically, and the results were statistically significant (p = 0.021). The study's variables are described in Tables 3.

Table 3. Distribution of V̇O2 max Estimates According to the Degree of Obesity

Variable	n	Mean ± SD	Median (min-max)	*p value*
Degrees of Obesity				
1st degree	100	15.10 ± 5.52	16.53 (1.68-27.30)	0,021*
2nd degree	63	12.03 ± 5.39	14.80 (1.22-26.00)	

*Data were analyzed using the Mann-Whitney Test, p is significant when < 0.05

4. DISCUSSIONS

In this study, obese patients were evaluated and categorized as "very poor" based on Nury classification, their average mileage was 340.18 ± 82.6 meters[10]. This study's findings align with a previous study conducted by Hanifah[12], which focused on 6MWT results in overweight patients, revealing an average distance of 248 meters. Furthermore, Larsson[13] discovered that obese individuals generally cover less distance in the 6MWT than healthy control subjects. Moreover, this study indicated that the 6MWT distance in patients with obesity is influenced by various patient characteristics, including age. Excessive fat accumulation due to overeating and lack of exercise leads to an increased body mass index, resulting in the cardiovascular system working harder to supply oxygen to cells and body tissues due to narrowed blood vessels. Enlarged fat cells require more nutrients and elevate heart rates to meet their oxygen demands, which, in turn, leads to a decline in overall fitness levels. Heavier patients experience early fatigue due to the inefficiency of their cardiorespiratory system. This reduced fitness level is attributed to the higher aerobic energy required for movement in overweight individuals[5,14].

Another innovative study compared the 6MWT results of obese patients before and after weight loss therapy. The average initial data for these patients was 548 (487–590) meters, with a sample corresponding to around 251 persons. After 6 months of weight loss intervention therapy, the average distance covered increased to 599 (522–640) meters, and the change was statistically significant with a *p-value* of 0.015. These substantial outcomes indicate a clear relationship between the 6MWT figure and obesity intervention therapy. The patients affected by the primary outcome will experience an impact on their 6MWT statistics, leading to a notable rise in fitness levels[15].

Assessing V̇O2 max of Obese Patients Based on Characteristics of the Degree of Obesity

It was found that there are differences in the results of the 6MWT miles between each classification of obesity degrees based on the degree of obesity. This result was determined to be statistically significant (p = 0.021). The findings of this study are consistent with those of earlier research, which indicated that patient mileage declines even before an individual becomes obese or overweight. The study enrolled 100 individuals with varying BMIs, and the results showed that achieving the 6MWT mileage decreased as weight increased. This may help explain why mileage drops were observed in the obese group as a whole[16].

After analyzing the mileage, the VO2 max values of each research subject were also examined. The 6MWT has been acknowledged as a straightforward and safe technique for evaluating functional capacity in cardiac rehabilitation. The average VO2 max estimate in this study was 14.99 ± 5.5. Using the Nury algorithm, the VO2 max value is calculated by entering basic variables such as distance, age, height, and weight. Mileage had the strongest link with VO2 max estimation among these four factors[9,10,11]. This number is lower than the average VO2 max estimate for healthy Indonesian

individuals given by Nuri et al., which is 21.9 ± 3.51. This shows that obese patients have lower functional capacity than healthy individuals. This is because obesity is accompanied by a rise in myosin isoform IIx (IIb) mRNA chains and a decrease in type I muscle fibers, which significantly impact lowering oxygen uptake. Thus, type II fiber can cause a blockage of fat accumulation in adipose tissue or intramuscular triglycerides, leading to a reduction in skeletal muscle oxidation. As a result, a decrease in type I muscle fibers and an increase in type II muscle fibers lead to a reduction in the amount of oxygen taken up by working muscles[17,18].

5. CONCLUSION

There is an inverse association between VO2 max estimation using 6MWT in obese patients in Makassar City.

Ethics

This research was approved by the Biomedical Research Ethics Commission on Humans, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia. Based on a letter of recommendation number 169/UN4.6.4.5.31/PP36/2023, protocol number UH23020141.

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Conflict of Interest Statement:

The author declares that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.