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FACTORS THAT INFLUENCE THE CARDIORESPIRATORY FITNESS INDEX IN PULMONARY TB PATIENTS OF PRODUCTIVE AGE

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ABSTRACT

Tuberculosis is an infectious disease that causes major deaths worldwide and is a major global health threat for the last 25 years. Pulmonary tuberculosis is characterized by damage and necrosis of lung tissue, unlike other lung infections which mainly affect the airways which can cause damage that causes a decrease in lung resistance in meeting the body's needs, including in meeting the capacity of the respiratory system in supplying oxygen to meet the needs of the lungs. Therefore, this study aims to analyze the factors that influence the Cardiorespiratory Fitness Index in pulmonary TB patients of productive age in Palembang City so that they can predict lung tissue damage that has occurred. This type of research is a quantitative observational analytic study with a cross sectional design. The research was carried out in September 2022 in the working area of the Palembang City Health Center. The results of this study indicate a significant relationship between Index Cardiorespiratory Fitness (VO2Max) and age (p=0.019), body mass index (p=0.016) and HDL levels (p=0.019) but there is no significant relationship to other research variables .

Keywords: *Tuberculosis, VO2Max, Index Cardiorespiratory Fitness*

1. INTRODUCTION

Tuberculosis is an infectious disease that causes major deaths worldwide and has been a major global health threat for the past 25 years.[1] It is estimated that nearly 2 billion people (about a quarter of the world's population) are infected with *M. tuberculosis.* About 10 million people suffer from TB disease and 1.6 million people die each year.[2,3] Most cases of tuberculosis are found in low- and middle-income countries.

Eight countries accounted for two-thirds of the global total, including India (26%), Indonesia (8.5%), China (8.4%), Philippines (6.0%), Pakistan (5.7%), Nigeria (4.4%), Bangladesh (3.6%) and South Africa (3.6%).[4] In 2020 the number of tuberculosis cases found was 351,936 cases and was found in the age group 45 - 54 years, which was 17.3%, followed by the age group 25 - 34 years by 16.8% and 15 - 24 years 16.7%.[5] *Tuberculosis* is transmitted through aerosolized microdroplets from active tuberculosis patients when coughing, talking, or sneezing *M. tuberculosis* will then enter the airway into the lungs and infect the lungs. Pulmonary tuberculosis is characterized by damage and necrosis of lung tissue, unlike other lung infections that primarily affect the airways.[6,7] This damage often leads to diffuse fibrotic consolidation of lung tissue, leading to a general decrease in lung tissue complement. This will lead to a decrease in the lung's ability to meet the body's needs.[8,9]

Cardiorespiratory Fitness refers to the capacity of the circulatory and respiratory systems to supply oxygen for the production of energy needed during physical activity.[10] *The Cardiorespiratory Fitness* Index is an important variable in looking at a person's fitness level. The level of *Cardiorespiratory* Fitness can be described through a person's $_{VO2Max}$ Capacity.[11] VO2Max measurement can be done directly and indirectly. Direct VO2Max measurement using a computerized spirometer so that it has objective results. Indirect methods in the form of field tests a form of test designed to evaluate aerobic fitness by providing a measurable workload, such as running a certain distance. Measurement of fitness by estimation or prediction through heart rate is an indirect measurement of aerobic capacity.[12]

Seeing that tuberculosis disease can create damage that causes a decrease in lung endurance in meeting the needs of the body including in meeting the capacity of the respiration system in supplying oxygen for daily needs, this study aims to analyze the factors that influence *Cardiorespiratory Fitness Index* in pulmonary TB patients of productive age in Palembang City in order to predict lung tissue damage that has occurred.

2. METHOD

This type of research is an analytic observational quantitative research with a *cross sectional* design. The study was conducted in September 2022 in the Palembang City Health Center working area. The sample of this study were some productive-age pulmonary TB patients undergoing treatment in the Palembang City Health Center work area with a minimum of 45 patients taken proportionally at each Health Center in Palembang City by *purposive sampling.* The variables of this study were age, gender, body mass index, blood pressure, oxygen saturation, physical activity, total cholesterol, triglycerides, LDL, HDL, pulse and maximum oxygen volume (VO2Max) which were analyzed univariately to obtain an overview of the statistical size and frequency distribution of each variable studied and bivariate analysis with the *Chi Square* test was used to analyze the effect of *Cardiorespiratory Fitness Index* on pulmonary TB patients of productive age in Palemban City.

3. RESULTS

A total of 90 respondents were selected in this study. Respondents were pulmonary TB patients who were undergoing treatment at the Palembang City Health Center work area. Univariate analysis was conducted on 90 respondents to see the distribution of the variables studied, namely age, gender, BMI, blood pressure, oxygen saturation, physical activity, total cholesterol, triglycerides, LDL, HDL, pulse and maximum oxygen volume ($_{VO2Max}$). The results of univariate analysis showed gender variations in this study consisted of men (66.7%) and women (33.3%). The age of respondents varied with the youngest age being 18 years and the oldest 59 years with an average age of 40 years (40.02 ± 12.59). The distribution of other variables can be seen in Table 1.

Bivariate analysis aims to see

whether or not there is a relationship between the independent variable and the dependent variable tested using the *Chi Square* test, with a meaning limit of $p < 0.05$. So that if the results of the study show a P value <0.05, it is said that H0 is rejected, which means that the two variables have a statistically significant relationship. *Chi Square* statistical test results showed a relationship between age (p=0.019), body mass index (p=0.016) and HDL (p=0.019) with maximum oxygen volume levels (VO2Max) but no relationship was found in other variables. The results of bivariate analysis and *Chi Square* statistical test can be seen in Table 2.

Table 1. Variable distribution overview

Variables	Frequency (n= 90)	Percentage (%)
Age		
≤ 40	42	46,7
> 40	48	53,3
Gender		
Male	60	66,7
Female	30	33,3
IMT		
Underweight (<18.5)	28	31,1
Normal (18.5-22.99)	44	48,9
Overweight (23-24.99)	14	15,6
Obese (>25)	4	4,4
Blood Pressure		
Hypertension (≥140/90 mmHg)	16	17,8
Normal (<140/90 mmHg)	74	82,2
Oxygen Saturation		
Abnormal (<95%)	0	0
Normal (≥ 95%)	90	100
Physical Activity		
Lightweight	54	60,0
Medium	32	35,6
Weight	4	4,4
Total cholesterol		
Abnormal (≥ 200 mg/dl)	54	60,0
Normal (<200 mg/dl)	36	40,0
Triglycerides		
Abnormal (≥ 200 mg/dl)	4	4,4
Normal (<200 mg/dl)	86	95,6
LDL		
Abnormal (≥ 130 mg/dl)	56	62,2
Normal (<130 mg/dl)	34	37,8
HDL		
Abnormal (≤ 40 mg/dl)	42	46,7
Normal (>40 mg/dl)	48	53,3
Nadi		
Bradycardia (< 60x/min)	0	0
Normal (60-100x/min)	78	86,7
Tachycardia (>100x/min)	12	13,3
Maximal Oxygen Volume (VO2Max)		
Less	76	84,4
Average	14	15,6
Good	0	0

Table 2. Chi Square Test Results

Variables	Maximum Oxygen Volume (VO2Max) (n=90)		Total	*p value*
	Less	Medium		
Age				
≤ 40	40 (95,2)	2 (4,8)	42 (100,0)	
> 40	36 (75,0)	12 (25,0)	48 (100,0)	0,019
Gender				
Male	48 (80,0)	12 (20,0)	60 (100,0)	
Female	28 (93,3)	2 (6,7)	30 (100,0)	0,129
IMT				
Underweight	26 (92,9)	2 (7,1)	28 (100,0)	
Normal	38 (86,4)	6 (13,6)	44 (100,0)	0,016
Overweight	8 (57,1)	6 (42,9)	14 (100,0)	
Obesity	4 (100,0)	0 (0)	4 (100,0)	
Blood Pressure				
Normal	12 (75,0)	4 (25,0)	16 (100,0)	
Hypertension	64 (86,5)	10 (13,5)	74 (100,0)	0,264
Physical Activity				
Lightweight	46 (85,2)	8 14,8)	54 (100,0)	
Medium	26 (81,3)	6 (18,8)	32 (100,0)	0,604
Weight	4 (100,0)	0 (0)	4 (100,0)	
Total cholesterol				
Abnormal	42 (77,8)	12 (22,2)	54 (100,0)	0,066
Normal	34 (94,4)	2 (5,6)	36 (100,0)	
Triglycerids				
Abnormal	4 (100,0)	0 (0,0)	4 (100,0)	
Normal	72 (83,7)	14 (16,3)	86 (100,0)	1,000
LDL				
Abnormal	44 (78,6)	12 (21,3)	56 (100,0)	0,094
Normal	32 (94,4)	2 (5,9)	34 (100,0)	
HDL				
Abnormal	40 (95,2)	2 (4,8)	42 (100,0)	0,019
Normal	36 (75,0)	12 (25,0)	48 (100,0)	
Nadi				
Takikardi	12 (100,0)	0 (0)	12 (100,0)	0,201
Normal	64 (82,1)	14 (17,9)	78 (100,0)	

4. DISCUSSION

Univariate analysis showed that the average age of patients was 40 years old with 48 (53.3%) respondents over 40 years old and 42 (46.7%) under 40 years old. This study is different from previous studies where the age of pulmonary TB patients was more at the age of under 40 years (64.5%).[13] This difference can be caused by different sample sizes and differences in the demographics of each region. In addition, in old adulthood, the body's immune factor begins to decline so that it is prone to infection.[14] In addition, age over 40 is still a productive age that has a high risk of developing pulmonary TB due to the tendency to interact with many people.[13]

There are differences in the number of pulmonary TB patients based on gender. In this study, the number of pulmonary TB respondents was more in male respondents, namely 60 people (66.7%) compared to 30 women (33.3%). The incidence of pulmonary TB is more common in the male gender because men have high mobility than women, so the possibility of exposure is greater, besides unhealthy living habits such as smoking and consuming alcohol which can reduce the body's defense system which is often done by men can be an agent of pulmonary TB disease.[15]

IMT results in pulmonary TB patients in this study were more normal IMT results (48.9%) compared to underweight (31.1%), overweight (15.6%), and obesity (4.4%). The results of this study are different from previous studies, which showed more underweight patients (51.6%) compared to normal BMI (43.4%) and obesity (5%)[13]. This is because patients with active pulmonary TB experience drastic loss and among them show signs of mineral and vitamin deficiencies. This is due to several factors, with decreased appetite and food intake as well as metabolic losses and changes associated with inflammatory and immune responses being among the factors. TB patients will generally experience an increase in body mass index after 6 months of treatment with OAT (anti-tuberculosis drugs). An increase in BMI in TB patients is a good marker of decreased likelihood of relapse TB infection. This is only possible in patients with normal BMI. In overweight BMI, the possibility of TB reinfection may occur if the excessive BMI leads to metabolic diseases that can increase the risk of TB reinfection such as diabetes mellitus.[16]

The results of this study showed that pulmonary TB patients with hypertension were 17.8% less than those with normal blood pressure (82.2%). This is because there is no change in blood pressure when patients suffer from tuberculosis and there is no relationship between blood pressure and tuberculosis disease. However, blood pressure can increase if there are comorbidities.[17]

The results of oxygen saturation and pulse in this study showed that all respondents had normal oxygen saturation. The results of this study are in accordance with previous research, namely all respondents have normal oxygen saturation and pulse. The results of normal oxygen saturation and pulse indicate that lung parenchymal function is still good or in a period of improvement. This

indicates a good prognosis for pulmonary TB patients.[18]

Based on the results of this study, pulmonary TB patients tend to have light physical activity (60%), some have moderate physical activity (35.6%), and only a few have heavy physical activity (4.4%). The results of this study are different from previous studies, namely moderate (54.3%) and heavy (33.7%) physical activity more than light physical activity (12%).[19]

The lipid profile of respondents in this study had many abnormal results. Total cholesterol levels in the study were found to be normal as much as 40% and abnormal as much as 60%, triglycerides (normal = 95.6%, abnormal = 4.4%), LDL (normal = 37.8%, abnormal = 62.2%), and HDL (normal = 46.7%, abnormal = 53.3%). The results of this study are in accordance with previous research where there was a significant increase (p- value <0.001) in total cholesterol, LDL, and HDL from baseline to the treatment period of weeks 6 and 10.[20] This is due to the body's response to MTB bacterial infection during the acute phase and treatment response. In the acute phase, MTB has the use of fat rather than carbohydrates so that cholesterol levels decrease. However, after undergoing treatment, MTB bacteria begin to decrease so that cholesterol levels return according to the patient's nutritional intake, physical activity, and lifestyle.[20,21] In addition, low cholesterol levels including LDL and HDL correlate with more extensive pulmonary TB disease, such as larger caseous lesions and severe fibroencapsulation.[22]

The results of the *Cardiorespiratory Fitness Index* (VO2Max) of respondents in this study did not have good VO2Max results and most were in the poor category (84.4%) and the average category (15.6%). In pulmonary TB patients, damage to the lung parenchyma as well as TB sequele or TB lesions in the lungs will affect respiratory function which affects lung vital capacity as indicated by VO2Max results which show the ability of body tissues to bind oxygen during activity. The healing of lung tissue in post-pulmonary TB patients can be divided into complete or normal recovery without leaving lung defects, recovering by leaving lung defects (sequele). Healing with sequele will affect body activity and lung function.[23]

The results of statistical tests with the *Chi Square* test showed that there was a relationship between age (p=0.019), body mass index (p=0.016) and HDL (p=0.019) to VO2Max and there was no relationship between gender (p=0.129), blood pressure (p=0.264), physical activity (p=0.604), total cholesterol (p=0.066), triglyceride (p=1.000), LDL (p=0.094), and pulse (p=0.201) to VO2Max in patients with pulmonary TB of productive age in Palembang City.

The results of the study are in line with previous research, which found a relationship between age and VO2Max (p=0.02). The decrease in VO2Max with age occurs because the lungs, heart, and blood vessels begin to decline in function. There are studies that state that the age of 20-30 years is the peak age of heart and lung endurance and then will experience a decline, this is due to increasing age so that a person will reduce various sports activities and tend to choose to

work a lot. After the peak age, VO2Max will decrease with age. As age increases, physical exercise routines and activities decrease, so VO2Max resistance also . As a person gets older, energy requirements also decrease, and there is a decrease in muscle strength leading to faster fatigue.[24,25]

The same results found in previous research, there is a relationship between BMI and VO2Max (p=0.000). This is because physiological factors play an important role in the decreased oxygen consumption in individuals with a high body mass index. In obesity there is an increase in type II muscle fibers and a decrease in type I muscle fibers that have an important effect on reducing oxygen uptake, where in obesity there is an increase in myosin chain isoform IIx (IIb) mRNA. Thus, type II fibers can result in fat sequestration of storage in skeletal muscle (intramuscular triglycerides) or adipose tissue and followed by decreased oxidation in skeletal muscle.[26]

The same research results were also found in previous studies, there was no relationship between VO2Max and lipid profiles, namely total cholesterol (p=0.247), LDL (p=0.699), HDL (p=0.538), and triglycerides (p=0.956).[27] Different results in other studies found that there was a relationship between total cholesterol and VO2Max (p=0.045) and other studies also found that there was a relationship between cholesterol and VO2Max (p=0.000).[26] Excessive amounts of body fat will inhibit heart function. This occurs because the muscles are actively working, fail to extract oxygen due to disproportionate fat tissue deposition. Disproportionate fat deposits cause the musculoskeletal system to fail to obtain sufficient amounts of oxygen during activity resulting in decreased oxygen uptake used for intracellular metabolism, especially musculoskeletal cells. Therefore, an increase in total body fat percentage will result in a decrease in VO2Max.[26,28] High levels of triglycerides and *low density lipoprotein* (LDL), and low *high density lipoprotein* (HDL). This causes too heavy a load to interfere with heart function. The high fat in the body will become an obstacle and cause additional burden on cardiorespiratory function. This decreased function will result in decreased oxygen uptake for intracellular metabolism, especially musculoskeletal cells. Due to disproportionate fat deposits, the musculoskeletal system cannot obtain the optimal amount of oxygen, resulting in low VO2Max values.[29]

5. CONCLUSION

Based on the results of research that has gone through the stage of analyzing the factors that influence *Cardiorespiratory Fitness Index* in Pulmonary TB patients at productive age, it is concluded that there is a significant relationship between age, body mass index and HDL levels in influencing *Cardiorespiratory Fitness Index* (VO2Max) with proven Chi Square statistical tests where age, body mass index and HDL. Other factors that are used as variables in this study do not have a significant relationship as factors that affect *Cardiorespiratory Fitness Index*. Age, body mass index and HDL factors affect VO2Max but

further and in-depth research is still needed regarding other factors that are not significantly related to this study.

REFERENCE

1. Furin J, Cox H, Pai M. Tuberculosis. Lancet. 2019;19(3):1-15.
2. World Health Organization. WHO Guidelines on Tuberculosis Infection Prevention and Control: 2019 Update. 2019.
3. Centers for Disease Control and Prevention. Epidemiology of Tuberculosis. Atlanta: CDC; 2019. 1-28 pp.
4. Ministry of Health RI. Tuberculosis Infodatin. Jakarta: Indonesian Ministry of Health; 2018.
5. Ministry of Health of the Republic of Indonesia. Indonesia Health Profile in 2020. Jakarta; 2021.
6. Alzayer Z, Nasser Y Al. Primary Lung Tuberculosis. Stat Pearls. 2022.
7. Jilani TN, Avula A, Gondal AZ, Siddiqui AH. Active Tuberculosis. Stat Pearls. 2022.
8. Latif S, Sharyar M, Shafee I, Ali J, Mannan A, Deedar S, et al. Six Minute Walk Test in People with Tuberculosis Sequelae. Pakistan J Med Heal Sci. 2022;16(03):935-7.
9. Ravimohan S, Kornfeld H, Weissman D, Bisson GP. Tuberculosis and lung damage: from epidemiology to pathophysiology. Eur Respir Rev. 2018;27(170077):1-20.
10. Raghuveer G, Hartz J, Lubans DR, Takken T, Wiltz JL, Mietus-Snyder M, et al. Cardiorespiratory Fitness in Youth: An Important Marker of Health: A Scientific Statement From the American Heart Association. Circulation. 2020;142(7):E101- 18.
11. Kriswanto ES, Setijono H, Mintarto E. The effect of cardiorespiratory fitness and fatigue level on learning ability of movement coordination. Cakrawala Pendidik. 2019;38(2):320-9.
12. Robianto A, Apriantono T, Kusnaedi. Comparison of CPET (Cardio Pulmonary Exercising Test) Method with Cooper 2400 Meter Running Test Method in VO2Max Measurement. J Health Sports Science. 2017;2(2):50-3.
13. Rahmatillah T, Acang N, Afgani A. Characteristics of Patients with Pulmonary TB at the Bandung Community Lung Health Center in 2017. Pros Educ Dr. 2017;1(1):518-25.
14. Prahasanti K. Overview of the incidence of infection in the elderly. Qanun Med. 2019;3(1):81-91.
15. Andayani S. Prediction of the Incidence of Pulmonary Tuberculosis Disease Based on Gender. J Nursing Muhammadiyah Bengkulu. 2020;8(2):135-40.
16. Fadhalna, Ihwan, Suwastika IN. Overview of Body Mass Index of Tuberculosis (TB) Positive Patients on Treatment at Gerdunas TB Paru Undata Hospital Palu, Central Sulawesi. J Biocelebes. 2017;11(1):9-12.
17. Tsani R. Clinical features of pulmonary tuberculosis at Dr. Kariadi Hospital Semarang during January-June 2011. J Kesehat Muhammadiyah. 2012;1(2):33-9.
18. Guessogo WR, Mandengue SH, Ndemba PBA, Medjo UO, Minye EE, Ahmaidi S, et al. Physical and Functional Follow-Up of Tuberculosis Patients In Initial Intensive Phase Of Treatment In Cameroon Using The 6-Min Walk Test. Korean Soc Exerc Rehabil. 2016;12(4):333-9.
19. Kusumaningroh D, Susilowati T, Wulandari R. Relationship

between Physical Activity and TB Treatment Phase with Nutritional Status in Pulmonary TB Patients. J Ners and Midwifery. 2018;5(1):1-7.

20. Ahmed N, Amjad I, Malik ZA, Naseer A, Raza M, Imtiaz A, et al. Effects of Anti- Tuberculosis Drugs on Lipid Profile in Pulmonary Tuberculosis. JDUHS. 2022;16(2):78-82.
21. Andrade L. Understanding the role of cholesterol in cellular biomechanics and regulation of vesicular trafficking: The power of imaging. Biomed Spectrosc Imaging. 2016;5(1):101-117.
22. Chidambaram V, Zhou L, Castillo JR, Kumar A, Ayeh SK, Gupte A, et al. Higher

Serum Cholesterol Levels Are Associated With Reduced Systemic Inflammation and Mortality During Tuberculosis Treatment Independent of Body Mass Index. Front Cardiovasc Med. 2021;8(1):1-12.

23. Naik NR, Patil CB, Indushekar V. Pulmonary Sequelae in Tuberculosis: Analysis of Clinical and Radiological Pattern in 172 Patients. J Evid Based Med Healthc. 2019;6(5):287-91.
24. Huldani, Achmad H, Arsyad A, Putra AP, Sukmana BI, Adiputro DL. Differences in VO2Max Based on Age, Gender, Hemoglobin Levels, and Leukocyte Counts in Hajj Prospective Pilgrims in Hulu Sungai Tengah Regency, South Kalimantan. Syst Rev Pharm. 2020;11(4):9-14.
25. Woo J, Derleth C, Stratton J, Levy . The Influence of Age, Gender, and Training on Exercise Efficiency. J Am Coll Cardiol. 2006;47(5):1049-57.
26. Lestari KDP, Wahyuni N, Nugraha MH satria, Tianing NW. The relationship between body mass index, total body fat percentage, and physical activity to the level of maximum oxygen volume in adolescent girls in South Denpasar. Maj Ilm Fisioter Indones. 2020;8(1):28-35.
27. Grzebisz-Zato´nska N, Grzywacz T, Wa´skiewicz Z. The Influence of Endurance Training on the Lipid Profile, Body Mass Composition and Cardiovascular Efficiency in Middle-Aged Cross-Country Skiers. Int J Enviromental Res Public Heal. 2021;18(1):1-10.
28. Radak Z, Zhao Z, Koltai E, Ohno H, Atalay M. Oxygen Consumption and Usage During Physical Exercise: The Balance Between Oxidative Stress and ROS- Dependent Adaptive Signaling. Antioxid Redox Signal. 2013;18(10):1208-46.
29. Gantarialdha N. Relationship between Body Mass Index and Cardiorespiratory Endurance Expressed in VO2Max. J Med Hutama. 2021;2(4):1162-8.