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Relationship of Thoracic Cage Expansion to VO2 Max and Vital Lung Capacity in Students

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Abstract
The COVID-19 pandemic in Indonesia is part of the 2019 corona virus disease (covid-19) pandemic that is currently taking place throughout the world. The government's efforts in dealing with the Covid-19 Pandemic by working from home (work from home) and studying from home (study from home) which have an impact on health, one of which is a decrease in the level of physical fitness due to lack of movement. A person's fitness is closely related to aerobic capacity as measured by VO2max. VO2max is influenced by the lungs vital capacity which is also affected by the size of the expanding thoracic cavity. The purpose of this study was to determine correlation between thoracic cage expansion, VO2max and lung vital capacity. A cross-sectional study was conducted involving 44 physiotherapy students who met the inclusion criteria as subjects. Data were analyzed using the Spearman test and the results obtained were ICS 3 with VO2max p=0.002, processus xypoideus with Vo2max p=0.000. While the results of ICS 3 with KVP p=0.003, processus xypoideus with KVP p=0.002. From these results it can be concluded that there is a relationship between thoracic cage expansion to VO2max and lung vital capacity.

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1. INTRODUCTION

The COVID-19 pandemic in Indonesia is part of the ongoing 2019 corona virus disease (covid-19) pandemic throughout the world [12]. This disease is caused by infection with the Severe Acute Respiratory Syndrome Coronavirus-2 (SARSCoV-2) virus [13]. This virus is transmitted between humans through direct contact or when an infected person sneezes, coughs, sings, talks, or even breathes (droplets) [8]. The government's efforts in dealing with the Covid-19 Pandemic are creating and implementing several policies, namely Large-Scale Social Restrictions (PSBB), forming a committee for handling Covid-19 and National Economic Recovery, as well as requiring all Indonesian people to implement health protocols such as always washing their hands with soap, wear a mask, and keep your distance from each other.

The government's policy of Large-Scale Social Restrictions (PSBB) by implementing prolonged work from home or study from home can make individuals less mobile. This can have health and psychological impacts such as weight gain, depression, neck and back muscle pain, dry eyes and the body becomes tired quickly, increased risk of heart disease and decreased vital lung capacity [6]. Vital Lung Capacity is the amount of air that can be exhaled after maximal inspiration [4]. Factors that influence lung vital capacity are age, gender, occupation, smoking, lung disease, and level of physical activity [6]. A person's fitness level of physical activity is closely related to aerobic capacity as measured by VO2max.

VO2max is the body's capacity to take in, transport and use oxygen in exercise. The

higher the VO2max value, the higher a person's fitness level. The presence of good cardiorespiratory endurance means a person will be able to carry out maximum physical activity for quite a long time [9]. The factors that influence VO2max are age, gender and physical activity. Apart from that, other factors that influence VO2max are the function of the lungs, heart and blood vessels (cardiovascular) and red blood cells [1]. VO2max is influenced by the vital capacity of the lungs which is also influenced by the size of the thoracic cavity. The thoracic cavity, which is usually called the cavum thoraxis, is a protective space for the respiratory organs, respiratory tract and lungs which is composed of bones and cartilage [10]. Meanwhile, the development of the thoracic cavity is the ability and strength of the respiratory muscles that will influence the ability of the thoracic cage to expand and contract when breathing. Measurement of thoracic expansion can be used as a measure to determine respiratory function. Based on the things above, this study aims to determine the relationship between thoracic expansion and lung vital capacity and vo2max.

2. RESEARCH METHOD

2.1. Types of research and research design

This type of research is correlation analytical observation research with design *cross-sectional*.

2.2. Time and Place of Research

This research was carried out from December 2022 to January 2023 at the Yogyakarta 'YAB' Academy of Physiotherapy Measurement Laboratory.

2.3. Research Subjects

The subjects of this research were 44 physiotherapy students at the YAB Yogyakarta Physiotherapy Academy who were selected based on a purposive sampling technique, namely sampling based on inclusion and exclusion criteria.

2.4. Data Collection Instruments and Techniques

a. Measurement of thoracic cage expansion using a measuring tape

In this way, the measuring tape is placed in 2 different places, namely at the third intercostal (ICS 3) parallel to the spinous process of the 5th thoracic vertebra for the upper thoracic cage and on the xypoid process parallel to the spinous process of the 10th thoracic vertebra for the lower thoracic cage. Measurements are taken by asking the subject to inhale slowly through the nose and pushing the measuring tape to expand the lungs as much or as hard as the subject can. Then the subject was asked to exhale through the mouth. Measurements are taken at the end of the inspiratory and expiratory cycle. The value of thoracic expansion is seen from the results of the inspiratory diameter minus the expiratory diameter [3].

b. VO2max measurement using the bleep test

It is a test that uses musical rhythms and its implementation, namely the rhythm is gradual from one stage to the next, the frequency increases by: (a) Turn on the bleep test guide tape or CD, (b) Next you will hear a single "TUT" sound at regular intervals. (c) Test participants are expected to reach the end that coincides with the first "TUT" signal sounding and then turn around and run in the opposite direction, (d) Furthermore, every time the "TUT" signal sounds, test participants must be able to reach one of the specified paths. taken, (e) After reaching a one minute interval called level or level one which consists of seven turns or shuttles, (f) After reaching a one minute interval it will decrease so that completing the next level the participant must run faster, (g) Every time the participant takes the test To complete the 20m distance, one foot must step on or cross the 20m boundary or line, (h) Each participant must try to run as long as possible according to the rhythm set by the cassette or CD, (i) If the participant fails to reach the 20m dividing line 2

times consecutively then it will be stopped or has been declared not strong enough to carry out the test [11].

c. Measurement of vital lung capacity using a spirometer

In this way, position your body relaxed and stand facing the spirometry. Perform maximum inspiration and continue with maximum expiration (inhale long and deeply then exhale completely and uninterruptedly). The experiment was carried out three times and the best results were taken, record the data results [14].

2.5. Data analysis

The analysis technique in this research is descriptive analysis, carried out to describe the characteristics of research subjects according to the independent variables studied and bivariate analysis to determine the relationship between thoracic cage expansion and vo2max and lung vital capacity using the Spearman correlation statistical test.

3. RESEARCH RESULTS AND DISCUSSION

3.1 Research result

Table 1. Frequency distribution based on gender, age, body mass index (BMI), physical activity

Characteristics	Category	Frequency	Percentage (%)
Gender	Man	19	43.2
	Woman	25	56.8
Total44100			
Age	18-21	42	95.45
	22-25	2	4.55
Total44100			
Mass Index Body (BMI)	Underweight	6	13.63
	Normal	11	25.0
	Overweight	18	40.91
	Obesity	9	20.46
Total		44	100
Activity Physique	Low	23	52.3
	Currently	17	38.7
	Tall	4	9.0
Total		44	100

Based on table 1, it can be explained that the respondents are gender, age and BMI. The majority of respondents were female (56.8%), most of them were in the 18–21-year age range (95.45%), most of their BMI was in the overweight category (40.91%) and physical activity was 52.3% in the low category.

Table 2. Correlation Test of Thoracic Cage Expansion on VO2max and Capacity

		Lung Vitals	
		VO2max	**KVP**
ICS 3	r*	0.452	0.438
	p*	0.002	0.003
Proc. Xypoideus	r*	0.587	0.452
	p*	0,000	0.002

*r (strength of correlation), *p (p value)

Based on table 2. Testing the correlation hypothesis using the Spearman test obtained the results of ICS 3 with VO2max p = 0.002 with a correlation strength of 0.452, processus xypoideus with Vo2max p = 0.000 with a correlation strength of 0.587. Meanwhile, the results of ICS 3 with KVP p= 0.003 with a correlation strength of 0.438, processus xypoideus with KVP p= 0.002 with a correlation strength of 0.452. From these results it can be concluded that there is a relationship between thoracic cage expansion and vo2max and lung vital capacity, while the strength of the correlation is moderate.

3.2 Discussion

From the research results, a significant relationship was found between thoracic cage expansion and VO2 Max and Lung Vital Capacity. This is in line with research by Reddy et al., (2019) that there is a relationship between thoracic cage mobility and lung function in healthy smokers, non-smokers and COPD patients [8] as well as research by Zedda (2013) and Parwata (2021) regarding the relationship between cage expansion. thoracic on lung vital capacity obtained positive results. Vital Lung Capacity is the amount of air that can be exhaled after maximal inspiration [4]. Factors that influence lung vital capacity are age, gender, occupation, smoking, lung disease, and level of physical activity [6]. A person's fitness level of physical activity is closely related to aerobic capacity as measured by VO2max.

VO2max is the body's capacity to take in, transport and use oxygen in exercise. The higher the VO2max value, the higher a person's fitness level. The presence of good cardiorespiratory endurance means a person will be able to carry out maximum physical activity for quite a long time [9]. The factors that influence VO2max are age, gender and physical activity. Apart from that, other factors that influence VO2max are the function of the lungs, heart and blood vessels (cardiovascular) and red blood cells [1]. VO2max is influenced by the vital capacity of the lungs which is also influenced by the size of the thoracic cavity. The same thing is also supported by research conducted by Wahyudi TA et al (2018), regarding breathing exercises for divers, which states that the results after exercise can lead to an increase in VO2 max values, an increase in vital lung capacity, and an increase in thoracic expansion. The highest VO2 max has the best expansion of thorax capacity and VO2 max itself has a close correlation with lung vital capacity, so that thorax expansion indirectly influences the increase or decrease in lung vital capacity. If thoracic expansion decreases, the vital capacity of the lungs will also decrease, and vice versa.

4. CONCLUSION

Based on the results of research that has been carried out, it can be concluded that there is a relationship between thoracic cage expansion and Vo2max and vital lung capacity in students.

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