



## The Higher Levels of Physical Activity Associated with Higher VO<sub>2</sub>max among Elderly

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### ABSTRACT

**Background:** The elderly are very sensitive to disease and health problems. The lack of economic support, such as nutritious food as the source of energy, is the most often cause of health problems in the elderly. Reduced energy in the elderly's body causes the elderly's lack of physical activity, which affects the VO<sub>2</sub>max level of the elderly.

**Objective:** The purpose of this study was to determine the relationship between physical activity and VO<sub>2</sub>max in the elderly.

**Methods:** The research design was a cross-sectional study conducted in March 2021 with a population of all elderly in Banjar Tegalnarungan, Sobangan Village, Mengwi District, Bali, Indonesia, who met the inclusion and exclusion criteria. The sampling

technique in this study was total sampling and obtained 38 people. This study used the International Physical Activity Questionnaire questionnaire and 6 Minutes Walking Test to measure the physical activity levels and VO<sub>2</sub>max, respectively. Data were analyzed by computer software, namely Somers'd to determine the relationship between physical activity and VO<sub>2</sub>max in the elderly.

**Results:** The results showed a significant relationship between physical activity and VO<sub>2</sub>max, resulting in  $p < 0.001$ .

**Conclusion:** There is a significant positive relationship between physical activity and VO<sub>2</sub>max in the elderly, which represents the higher the physical activity level, the higher VO<sub>2</sub>max belongs to the elderly.

**Keywords:** Elderly, physical activity, VO<sub>2</sub>max.

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### INTRODUCTION

The elderly population in Indonesia is increasing every year. According to world health organization, the elderly population is estimated to increase from 10% to 22% in the next four decades.<sup>1</sup> The elderly are very susceptible to disease caused by reduced body resistance and the influence of the external environment.<sup>2</sup> Currently, the physical fitness of the elderly in Indonesia is still lacking, the morbidity rate of the elderly is high.<sup>3</sup> Lack of energy stored in the body of the elderly is a result of the lack of physical activity in the elderly. The use of energy in each physical activity depends on the intensity of the muscles' work, including the light, moderate, and heavy intensities. Physical activity can improve health and physical fitness in the elderly if done regularly and correctly.<sup>4</sup>

Maintaining fitness and physical condition is good for the elderly that will slow down the degenerative process. However, there are still many elderly who lack physical activity because of a lack of maintaining fitness and physical condition properly.<sup>5</sup> The walking distance can measure aerobic fitness and physical fitness in the elderly as the 6-minute walk test is a fitness test for the elderly and is designed to test the functional fitness of the elderly. It is an adaptation of Cooper's 12-minute

test run.<sup>6</sup>

The VO<sub>2</sub>max is an indicator of the use of oxygen by the heart, lungs, and muscles for metabolism. VO<sub>2</sub>max in sports health shows the level of physical fitness or a person's physical capacity. Increasing age over 30 will increase body fat and muscle mass, whereas the VO<sub>2</sub>max decreases gradually, indicating a decline in fitness and physical health.<sup>7</sup>

A person with good fitness has a higher VO<sub>2</sub>max value and can perform more vigorous activities than a person whose fitness is not in good condition. The measurement of the VO<sub>2</sub>max value is helpful to analyze the effects of a physical activity program and determine the ability of the cardiorespiratory system.<sup>8</sup> This study was conducted to seek the relationship between physical activity and VO<sub>2</sub>max in the elderly.

### METHODS

#### Study participants

This study used a cross-sectional analytic study design, which took samples from the population according to the selection criteria. This research took place in Banjar Tegalnarungan, Sobangan Village, Mengwi Districts. Research and data collection was carried out in March 2021, which was carried out in two days.

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The population in this study was the elderly in Banjar Tegalarungan, Sobangan Village, Mengwi Districts, who met the inclusion and exclusion criteria. The inclusion criteria were: (a) Elderly aged 60-74 years; (b) Elderly who can communicate verbally; and (c) Able to follow simple instructions and commands. The exclusion criteria were: (a) Not using walking aids; (b) Do not have cardiovascular disease and neurological diseases such as heart disease, stroke, asthma; and (c) No fracture or disability.

Data were collected door to door interviewed to find subjects who met the inclusion criteria and were willing to be the research sample to take measurements of physical activity and VO<sub>2</sub>max level. Physical activity levels were recorded using the International Physical Activity Questionnaire (IPAQ), and the VO<sub>2</sub>max levels were measured with the Six Minutes Walking Test (6MWT) then calculated using the VO<sub>2</sub>max formula.

#### Physical Activity Levels Measurement

Physical activity data were collected by interviewing the subjects using the IPAQ. The implementation of the IPAQ data collection is as follows: (a) Instruct the subject to remain calm and not tense before the researcher conducts interviews and collects data. (b) Explain to the subject the purpose of data collection and interviews using the IPAQ is to determine the subject's daily physical activity by asking the subject's high, moderate and low physical activity every day for the last seven days. (c) The researcher recorded all the answers given by the subject and

then calculated to categorize whether included in the high, medium, or low physical activity.

#### VO<sub>2</sub>max Measurement

Measurement of VO<sub>2</sub>max is using the 6MWT that was only carried out once. The procedure of the 6MWT measurement is as follows: (a) Set the track distance as far as 25 meters and a stopwatch to count for 6 minutes. (b) Explain to the subject that this test aims to assess how far the subject can walk for 6 minutes and should not run. The subject may slow down, stop or rest if necessary. Give examples on the subject in a loop. (c) Position the patient on the starting line. The researcher must stand near the starting line during the exercise. Don't walk with the subject. As soon as the subject starts walking, turn on the timer. (d) Tell the subject not to talk to anyone during the test. Pay attention to the subject, and don't forget to count the laps passed. Researchers can encourage the subject but not to speed up the pace. Tell the test time every minute to 2, 4, and 6 (stop). (e) Record the number of turns and how far the subject covered. The formula to calculate the VO<sub>2</sub>max of the 6MWT is  $(0.06 \times 6MWT \text{ distance}) - (0.104 \times \text{Age}) + (0.052 \times \text{BW}) + 2.9$ .<sup>9</sup>

#### Data analysis

The data obtained were then analyzed using the SPSS computer application. Descriptive statistics are to describe age, gender, and occupation and describe the interpretation of the results of physical activity and VO<sub>2</sub>max. Somers'd analysis analyzed the relationship between the independent variable (i.e., physical activity levels) and the dependent variable (i.e., VO<sub>2</sub>max). Connecting physical activity with VO<sub>2</sub>max, the value is set at 0.05, where the relationship between variables is considered significant if a significance value or *p*-value <0.05 is obtained.

## RESULTS

#### Characteristics of Subjects

The characteristics of the respondents in this study were the elderly aged 60-74 years in Banjar Tegalarungan, Sobangan Village, Mengwi, with a total population of 77 people. This study uses inclusion criteria found 38 respondents included all. Of 38 samples, 6, 20, and 12 people had low, moderate, and high physical activities, respectively. Most of the samples of 19 people had the fair level, seven people had the very good level, six people had the poor level, and six people had the good level of the VO<sub>2</sub>max. The characteristics of the subjects in this study can be seen in [Table 1](#).

**Table 1. Characteristics of respondents**

Characteristics	Frequency	Percentage
Sex		
Male	23	60,5%
Female	15	39,5%
Age		
60-64	9	23,7%
65-69	14	36,8%
70-74	15	39,5%
Physical Activity Levels		
Low	6	15,8%
Moderate	20	52,6%
High	12	31,6%
VO <sub>2</sub> max Levels		
Poor	6	15,8%
Fair	19	50,0%
Good	6	15,8%
Very Good	7	18,4%
Total	38	100%
VO <sub>2</sub> max, maximal oxygen consumption.		

**Table 2.** Cross Table of Physical Activity on VO2max

Physical Activity Levels	VO2max Levels								Total	P-value	
	Poor		Fair		Good		Very good				
	F	%	F	%	F	%	F	%			
Low	5	13,2%	1	2,6%	0	0%	0	0%	6	15,8%	0,000
Moderate	1	2,6%	17	44,7%	2	5,3%	0	0%	20	52,6%	
High	0	0%	1	2,6%	4	10,5%	7	18,4%	12	31,6%	
Total	6	15,8%	19	50,0%	6	15,8%	7	18,4%	38	100%	

F, frequency; VO2max, maximal oxygen consumption.

### Hypothesis testing

**Table 2** shows as many as five respondents with low physical activity categories with poor VO2max value categories (13.2%) and with a fair VO2max value one respondent (2.6%). Respondents with moderate physical activity categories with poor VO2max values were one person (2.6%), with a fair VO2max value of 17 respondents (44.7%), and with a good VO2max value of 2 respondents (5.3%). Respondents with a high physical activity category with a fair VO2max value category one respondent (2.6%), with a good VO2max value four respondents (10.5%), and with a very good VO2max value seven respondents (18.4%).

The results of this study were to determine the relationship between physical activity to VO2max in the elderly in Banjar Tegalnarungan, Sobangan Village, Mengwi. The Somers'd statistical test was carried out with the p-value was set at 0.05, where the relationship between variables was considered significant if the significance value or value  $p < 0.05$ . Based on **Table 2**, the results of data analysis using the Somers'd method obtained a p-value = 0.000 represented a significant relationship between physical activity and VO2max in the elderly in Banjar Tegalnarungan, Sobangan Village, Mengwi.

### DISCUSSION

This study indicates more male subjects, namely 23 people (60.5%), while female respondents are 15 people (39.1%). There are differences in the need for physical activity in men and women that affect VO2max fitness. Men at the time of entering the elderly will do less physical activity and relax more. In contrast to older women, even though they have entered old age, they will continue physical activities to increase VO2max.<sup>5</sup>

This study found that the elderly aged 60-69 had moderate to excellent VO2max levels, which means that the elderly aged 60-69 tended to be fitter than

the elderly aged 70-74 had a predominantly low VO2max level. The increasing age of the elderly will result in dependency due to the inability of the elderly to carry out physical activities. The dependence experienced by the elderly results from the infrequent elderly exercise and physical activity, especially for elderly over 70 years who are at high risk of experiencing a decline in health conditions such as a decrease in VO2max conditions.<sup>5</sup>

The research results on the characteristics of respondents based on physical activity obtained that the elderly with moderate physical activity and high physical activity categories were more than the elderly in the low physical activity category. The possible reason for this finding is that the majority of the elderly are farmers who do moderate to strenuous physical activities such as hoeing and lifting heavy weights that are carried out almost every day and for more than 10 minutes. Therefore, on average, respondents in this study had moderate to high physical activity levels.

From the study results, the elderly with moderate and very good VO2max categories were more than the good VO2max category and less VO2max. This finding might explain that the elderly carried out the physical activity regularly reduced the heart's workload by increasing the heart muscle contraction that increased stroke volume and reduced the stimulation of the adrenal hormone. Thus, the heart's work became more efficient and resilient.<sup>10</sup> Performing physical activity regularly will positively impact a person's fitness and VO2max value. Besides increasing the efficiency of the work of the cardiorespiratory system, doing physical activity, for example, 3-5 times per week, can provide more oxygen to the body to metabolism more energy formation.<sup>6</sup> Physical activity can increase VO2max capacity between 10%-20%, especially with aerobic exercise, the heavier the exercise, the greater the effect obtained. The research found a significant relationship between physical activity

and VO<sub>2</sub>max. The results of this study are in line with the research of Ghomim (2017) which shows a significant relationship between 6MWT (fitness value) and physical activity with a  $p$ -value = 0.02 ( $p < 0.05$ ), which might explain the relationship between 6MWT and moderate physical activity, thus that the more physical activity, the higher the fitness value.<sup>6</sup> The results of this study are also in line with the research conducted by Febriyanti (2015) using another VO<sub>2</sub>max measurement method (i.e., the Harvard Step Test) and physical activity with the IPAQ that presented the significant results ( $p$ -value = 0.000). Physical activity might reduce the workload of the heart which increases heart and increase lung resistance.<sup>11</sup>

Physical activity is a movement or body change carried out by skeletal muscles by requiring energy to improve fitness and health. Therefore, regular exercise combined with a healthy diet will have a positive impact on a person's fitness and VO<sub>2</sub>max value.<sup>12</sup> Someone who has a good fitness level related to a higher VO<sub>2</sub>max value results in higher activity levels than those people who does not have a good fitness level.<sup>8</sup> The heavier the physical activity, the higher the oxygen consumption of the body requires. The ability of tissues to take up oxygen varies according to the level of VO<sub>2</sub>max they have. The duration of a muscle's ability to contract and relax depends on the VO<sub>2</sub>max level. Someone who had a lower VO<sub>2</sub>max level working with fast muscle contraction will get the muscle tired very quickly.<sup>6</sup> Heavy physical activity will cause an increase in the muscles' work. In order to supply adequate oxygen needs, it is necessary for the lungs to function properly with total lung ventilation about 20 times when doing physical exercise with maximum intensity.<sup>13</sup>

Physical activity in the elderly will decrease by increasing the age is also associated with the 6MWT and VO<sub>2</sub>max values. This study used 6MWT because it is a well-tolerated test that perfectly reflects daily activities and can be easily used in clinical practice. This test mainly measures the person walking on a hard and flat surface in 6 minutes and at the same time, it evaluates the response of cardiorespiratory systems.<sup>14</sup> The VO<sub>2</sub>max level will be better if the elderly are active from a young age. Age over 30 years received a decline rapidly in VO<sub>2</sub>max levels because the heart and lung endurance capacity decreased.<sup>15</sup> The elderly will find it easier to carry out strenuous activities if they are regular and diligent in doing physical activities or sports as the elderly in this study mostly had moderate to very good VO<sub>2</sub>max levels.

## CONCLUSION

Based on the study results, it can be concluded that there is a significant relationship between physical activity on VO<sub>2</sub>max, the higher levels of physical activity are associated with higher VO<sub>2</sub>max among the elderly.

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## CONFLICT OF INTEREST

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## AUTHOR CONTRIBUTION

DAPH conceived the study design, collected and analyzed the data, and drafted the manuscript; IAAS and IPPJ interpreted the data analysis and drafted the manuscript.

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