

## CORRELATION BETWEEN DURATION SPENT IN FITNESS CENTER AND VO<sub>2</sub> MAX LEVEL AMONG ADULTS

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### Abstract

*VO<sub>2</sub> max or oxygen consumption maximum value is a gold standard indicator towards cardiovascular and aerobic endurance because it refers to the maximum amount of oxygen used by an individual in one minute during maximum physical activity. The study purpose was to see the correlation between duration spent in the fitness center and VO<sub>2</sub> max value among adults. This study used analytical study method, cross-sectional type. We chose the participant from members of Gold's Gym fitness center at Cihampelas, aged 18-45 years old, with 3 months minimum of activity, and exercise frequency around three times per week. The participants who had the cardiovascular and pulmonary disease, serious physical injury, had already exercised during the time of observation, or professionally trained athletes were excluded. We used Queen College step test for the instrument. There were 47 participants in this study. Spearman's correlation coefficient was calculated to measure the correlation between duration spent and VO<sub>2</sub> max, and the result was 0.77(95% CI 0.64; 0.85),  $p < 0.001$  which is categorized as strong correlation. From this study, we found that with the increase of duration spent in the fitness center, the VO<sub>2</sub> max level is also increasing, and vice versa. This result is supported by a study from the United States which finds a correlation between VO<sub>2</sub> max and performance times of recreational triathletes. In conclusion, there is a positive correlation between duration spent in the fitness center and VO<sub>2</sub> max level among adults.*

**Keywords:** *exercise, fitness center, physical fitness, VO<sub>2</sub> max*

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## INTRODUCTION

In contemporary western social order, the body fit is a representation of rank and identity, both for men and women.<sup>1</sup> Fitness is a combination of health and fitness of the body so that it can route the activity a day by day optimal, especially physical activity. Fitness basically covers the training and improvement of heart function, lung-pulmonary, and muscles of the body which increases the strength and flexibility of the muscles of the body. Fitness can also affect mental and emotional development. One of the benefits of fitness is the formation of strong and well-toned physique.<sup>2</sup>

Physical fitness as defined by The World Health Organization (WHO) is the capability of a person to perform muscular work under specified conditions and criteria, while exercise is defined as any bodily movement produced by skeletal muscles that result in energy expenditure. Exercises can be divided into two which are aerobic exercise and anaerobic exercise. Aerobic and anaerobic are divided base on the way of energy production, the metabolism and consumption of oxygen. Anaerobic exercise is a physical activity which requires a relatively large burst of energy in a short time, whereby it involves a quick energy production via glycolysis without the consumption of oxygen. Therefore, without the supply and utilization of adequate oxygen, hydrogen formed from glycolysis fails to oxidize and under these circumstances, pyruvate reacts with hydrogen to form lactate. Aerobic exercise is different compared to anaerobic exercise whereby it requires relatively smaller energy but is sustainable for a longer period of time (more than 2 to 3 minutes). In order to meet this requirement, the body uses aerobic metabolism pathways to produce more ATP per substrate as per needed. The improved aerobic function is influenced by a number of systems particularly muscle fibers with improved vascularization and increase in amount and size of mitochondria, increase in lung capacity and the cardiovascular system which facilitates oxygen requirement in the body. One of the compensation mechanisms to aid oxygen supply and utilization in muscles is an increase in muscle myoglobin oxygen storage and transport of oxygen via hemoglobin-erythrocytes.<sup>3,4</sup>

One of the physical tests that are used as an indicator of test the cardiovascular fitness and aerobic endurance is the maximal rate of oxygen consumption ( $\text{VO}_2$  max) test.  $\text{VO}_2$  max is the best index of exercise capacity and the gold standard for cardiopulmonary function or physical fitness. It is the result of cardiovascular output (CO) and arteriovenous oxygen ( $\text{AV-O}_2$ ) distinction at fatigue,

and the brilliant standard measure for a man's oxygen-consuming wellness. It refers to the maximal amount of oxygen the individual can utilize typically over one minute during an excruciating, maximal effort.<sup>5,6</sup>

Regularly  $\text{VO}_2$  max is measured straightforwardly by analyzing inhaled and exhaled breathing gasses in a laboratory setting amid maximal effort, and communicated either as absolute maximal measure of oxygen per minute (L/min) or as with respect to the person's weight as the maximal milliliters of oxygen the individual uses in one minute for every kilogram of body weight (mL/kg/min).<sup>7</sup> The average untrained healthy male will have a  $\text{VO}_2$  max of approximately 35–40 mL/(kg·min), while the average untrained healthy female will score a  $\text{VO}_2$  max of approximately 27–31 mL/(kg·min).<sup>8,9</sup> Individual  $\text{VO}_2$  max values can range from about 10 mL/kg/min in cardiac patients to proximate to 90 mL/kg/min among world-class endurance athletes.<sup>10</sup> Other factors that can influence  $\text{VO}_2$  max value are age, gender, genetics, training, and body composition.<sup>9</sup>

A study of an ideal physical fitness will be conducted in which the aim is to investigate the correlation between duration spend at the fitness center and  $\text{VO}_2$  max level among adults. The hypothesis of this study is that there is a correlation between duration spend at the fitness center and  $\text{VO}_2$  max level.

## METHOD

This study is an analytical study using the cross-sectional method. The data used are primary data which were collected from members of the fitness center, Gold's Gym in Cihampelas, Bandung. The inclusion criteria were participants aged from 18 to 45 years old, had been a member of Gold's Gym Cihampelas for at least three months, and had a frequency of training at least three times per week. The exclusion criteria were participants who had the cardiovascular and pulmonary disease, serious physical injury, had already exercised during the time of observation, or professionally trained athletes.

The sample size was estimated using the formula for correlation between two numerical variables. The probability of type I and type II error was decided as 0.05 and 0.2, respectively. Since there was no previous study that similar to this study, it was decided to perform simulation by trying several values of correlation coefficient  $r$ . It was determined that with  $r=0.4$ , the minimum required sample size is 47 participants. R version 3.3.0 for Windows operating system was used to perform

statistical analysis. All statistical tests were performed using level of significance of 0.05.

Subjects were assessed using Queen’s College step test which included 16.25 inches from the ground level platform, a stopwatch, and a metronome. The test was performed by the subjects stepping up and down on the platform (22 steps/minute for female, 24 steps/minute for male) for 3 minutes using four-step cadence, “up-up-down-down”. Then, subjects stop immediately on completion of the test, and the heart beats were counted for 15 seconds from 5-20 seconds of recovery then multiplied by 4. Then the results of the heart rate were calculated by using the following formula:<sup>11</sup>

- Men:  $VO_2 \text{ max (mL/kg/min)} = 111.33 - [0.42 \times \text{heart rate (bpm)}]$
- Women:  $VO_2 \text{ max (mL/kg/min)} = 65.81 - [0.1847 \times \text{heart rate (bpm)}]$ <sup>13</sup>

Subjects have agreed and signed an informed consent before being recruited in this study. Subjects have rights for privacy in which their personal data will not be published or described as written or in the photo, except if that information is crucial for scientific purpose and subjects have signed an agreement to publish their personal information. The procedures in this study are performed according to standard and after getting a recommendation and permission approval from Ethics Committee of the Faculty of Medicine Universitas Padjadjaran and are appropriate according to Helsinki Declaration 1975, which has been revised on 2000.

**RESULTS**

Forty-seven participants were recruited in this study. The mean age of participants was 26.91 years with standard deviation of 5.85 years. From 47 participants, 24 participants (51%) were male and 23 participants (49%) were female. The mean BMI was 22.21 kg/m<sup>2</sup> with a standard deviation of 1.68 kg/m<sup>2</sup>. All participants had normal weight.

Participants were then divided into two main group in order to look at the characteristic of VO<sub>2</sub> max level. On the male group, the median of VO<sub>2</sub> max is 47 with minimum and maximum value 39 and 63. On the female group, the median of VO<sub>2</sub> max is 46 with minimum and maximum value 33 and 57.

The normality test was conducted using Saphiro-Wilk. The significance value obtained for VO<sub>2</sub> max data was 0,298 which means the VO<sub>2</sub> max data we have is normally distributed while the significance value for the duration data was 0.0001 which means the duration data we have is not

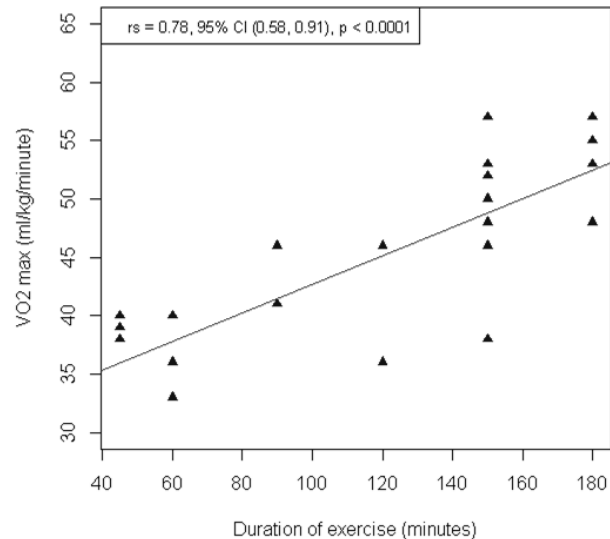
normally distributed. Because one of the data we have is not normally distributed, Spearman’s rank correlation coefficient was calculated. The correlation between duration spent in the fitness center and VO<sub>2</sub> max level was displayed in Figure 1.

**Table 1** Baseline characteristics of the participants

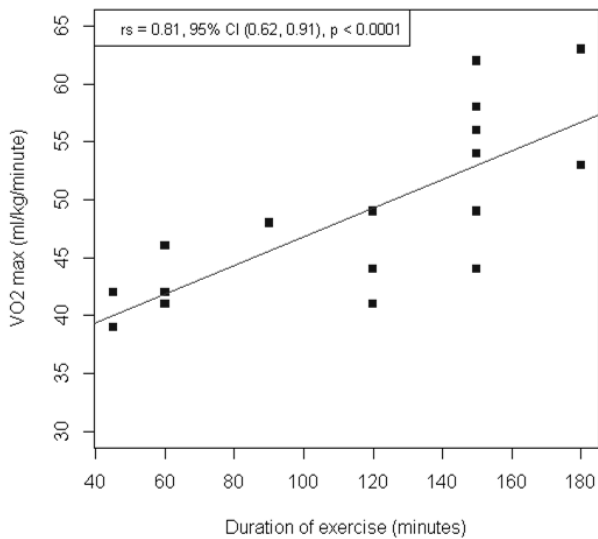
Characteristic	n =47
Age (years), mean (SD)	26.91 (5.85)
Gender, frequency (%)	
Male	24 (51)
Female	23 (49)
BMI (kg/m <sup>2</sup> ), mean (SD)	22.21 (1.68)
BMI category, frequency (%)	
Underweight	0 (0)
Normal	47 (100)
Overweight	0 (0)

**Table 2** VO<sub>2</sub> max value in participants

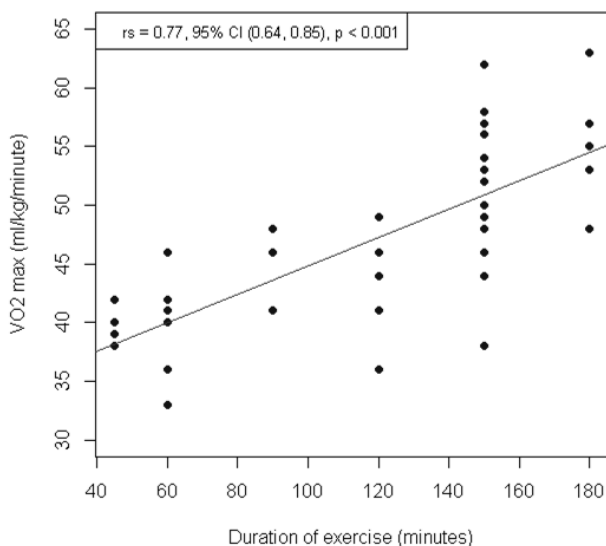
Gender	Median VO <sub>2</sub> max	Maximum VO <sub>2</sub> max	Minimum VO <sub>2</sub> max
Male	47	63	39
Female	46	57	33



**Figure 1** Scatterplot between duration and VO<sub>2</sub> max level in female



**Figure 2** Scatterplot between duration and VO<sub>2</sub>max level in male



**Figure 3** Scatterplot between duration and VO<sub>2</sub>max level in general

It was observed that the correlation coefficient between the duration spent in the fitness center and VO<sub>2</sub> Max level is 0.78 (95% CI 0.58;0.91) in the female, 0.81 (95% CI 0.62;0.91) in male, and 0.77 (95% CI 0.64; 0.85) in general. Hence, there was a positive significant correlation between duration of time spent in the fitness center and VO<sub>2</sub> Max in both female and male, and in general.

## DISCUSSION

From this study, the VO<sub>2</sub> Max value in the female group was observed as follows: VO<sub>2</sub> Max minimum value is 33 and the maximum value is 57.

Comparing with study in Semarang, Indonesia, which includes 20 females who undergo programmed physical exercise, it was obtained the following: VO<sub>2</sub> max minimum value is 31 and the maximum value is 51. There is a slight difference in the values from this study with their study which is caused by the different characteristics of the participants i.e. participant's ages. This study uses female participants with mean 27 with age range 19-38 while the study from Semarang uses female participants with mean 11.7 with age range from 11-13.<sup>12</sup>

The male participants in this study have VO<sub>2</sub> max median value of 47, the minimum value of 39, and the maximum value of 63. These values differ slightly from a study from Yogyakarta, Indonesia, which consists VO<sub>2</sub> max median value of 39, the minimum value of 31, and the maximum value of 43. There's a huge difference in VO<sub>2</sub> max values which might be caused by in another study, the participants were regular students who performed physical exercise only in P.E. class at school, once a week, compared to subjects in this study that went to fitness center more routinely.<sup>13</sup>

From this study, it was observed that with the increase of duration spent in the fitness center, the VO<sub>2</sub> max level is also increasing, and vice versa. This result is supported by a study from United States which finds a correlation between VO<sub>2</sub> max and performance times of recreational triathletes. The total performance times were correlated to VO<sub>2</sub> max values. This indicates the important role a moderately trained individual's aerobic power has in determining performances in endurance events.<sup>14</sup>

A study in India shows there's no significant positive correlation between BMI and VO<sub>2</sub> max (mL/kg/min) of physical education students, which suggests possible effect body mass index on cardiorespiratory function. Nevertheless, in the field of sport, higher BMI is helpful for storing more energy, applying more force and power, and increase stability.<sup>15</sup> This result is slightly contraindicated with this study which reported that there's a slight effect of BMI towards VO<sub>2</sub> max which might be caused by the background of the participants recruited. The other study used a physical education student which already has a high baseline of VO<sub>2</sub> max (mean VO<sub>2</sub> max 48.96) while this study recruited participants with varieties of backgrounds which caused high varieties of baseline VO<sub>2</sub> max.

There are some limitations in this study. This study only included one gym in Bandung while there was another numerous gym in Bandung, therefore, this study might not strongly represent the

population. Further study is still needed to confirm the causal relationship of duration spent in the fitness center and  $VO_2$  max level in adult i.e. using a prospective study. Other contributing factors such as BMI, diet, training intensity, and fatigue rate could also be considered. Including more gyms in Bandung is also important to represent a larger population. Finally, a standardized tool is also needed to calculate the duration spent in the gym from each participant to increase the precision.

## CONCLUSION

There is a significant positive correlation between duration spent in the fitness center and  $VO_2$ max in adults.

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