

# Lifestyle and aerobic fitness in young volleyball athletes

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**Abstract.** Background: The performance of volleyball athletes is influenced by aerobic fitness. Objective: This study aims to analyze factors related to aerobic fitness in volleyball athletes. Method: The research design used was a cross-sectional study. The sample consisted of 41 volleyball athletes from the Sidoarjo Indonesian Volleyball Development Club aged 14-18 years. Smoking habits and rest adequacy were measured using questionnaires, physical activity was evaluated using the Global Physical Activity Questionnaire (GPAQ), and aerobic fitness was assessed using the Multistage Fitness Test (MFT). Results: There is a significant relationship between aerobic fitness with physical activity ( $r=0.39$ ,  $p=0.01$ ), gender ( $r=-0.76$ ,  $p=0.00$ ), and smoking habits ( $r=-0.35$ ,  $p=0.03$ ) in volleyball athletes. Conclusions: These findings highlight the importance of these factors in maintaining and improving aerobic fitness levels in volleyball athletes.

## 1 Introduction

Physical fitness is the key to success in all sports, [1] which supports the achievement of optimal athlete physical performance. One of the physical fitness related to health is aerobic fitness and body composition [2]. Increasing physical fitness will affect the performance of athletes [3].

The definition of aerobic fitness is the body's ability to use oxygen to produce energy for daily activities. Factors influencing it include the frequency, intensity, and duration of exercise [4]. Components of physical fitness such as cardiorespiratory endurance are crucial for overall physical and mental fitness. Cardiorespiratory fitness is characterized by good endurance, where the body can supply oxygen needed by the muscles over an extended period. The degree of cardiorespiratory endurance reflects how the heart and lungs respond to physical activity.

Volleyball is a sport that requires an optimal level of physical fitness to achieve high performance when competing. Technical performance is influenced by physical

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characteristics, physical fitness, ability in speed, and vertical jump. Volleyball is a sport that involves training periods interspersed with rest, combining aerobics with high-intensity anaerobic activity [5].

Achieving high performance in athletes is not only influenced by training on the field, but also by lifestyle factors. Important components in an athlete's daily life significantly affect the athlete's training and performance. Athletes prepare themselves to achieve optimal performance. Regular training, healthy food consumption, availability of time for rest, recovery, and sleep are needed in the athlete's daily life. If either of these activities is not performed, it will reduce performance. This healthy lifestyle will improve overall health and prevent disease [6]. This study aims to analyze factors related to aerobic fitness.

## 2 Materials and methods

This study employed cross-sectional study, with a sample consisting of 41 volleyball athletes from the Sidoarjo Indonesian Volleyball Development Club, aged 14-18 years, including both genders. Aerobic fitness was assessed using the Multistage Fitness Test (MFT), where participants ran back and forth continuously between two points 20 meters apart, following a beep signal with progressively shorter time intervals until they reached their maximum test level. Nutritional status was evaluated using BMI.

Physical activity was measured using the GPAQ instrument. The GPAQ (Global Physical Activity Questionnaire) instrument is a tool for describing activity patterns developed by WHO based on weekly activity calculations. The GPAQ instrument consists of 16 questions covering four parts of physical activity: workday physical activity, inter-location activities, recreational activities, and sedentary or non-moving activities. Based on the MET (Metabolic Equivalent) classification of physical activity in the GPAQ instrument, there are three levels of activity (high, moderate, and low physical activity). Collected information on smoking habits, rest, and gender were evaluated using a questionnaire. Rest in this study refers to the need for sleep in adolescents aged 13-18 years. According to the American Academy of Pediatrics Childhood Sleep Guidelines, adolescents aged 13-18 years should receive 8-10 hours of sleep every night to support optimal health.

The relationship between aerobic fitness and BMI, smoking habits, adequate rest, smoking, and gender was analyzed using the Spearman Rank Correlation test at a confidence level of 95% ( $\rho=0.05$ ).

## 3 Results and discussion

The results of the study showed that the sample consisted of 41 athletes aged 14-18 years, with 48.78% male and 51.22% female. Most of the subjects had a normal nutritional status (BMI) at 78.05%, while 87.81% did not have a smoking habit. However, 58.54% reported inadequate rest, 58.54% engaged in vigorous activity levels, and aerobic fitness was categorized as average at 24.39% and above average at 21.95% (Table 1).

**Table 1.** Respondent characteristics

Variables	n	%
<b>Gender</b>		
- Female	21	51.22
- Male	20	48.78
<b>BMI</b>		
- Severe level of underweight	2	4.88
- Mild level of underweight	5	12.19
- Normal	32	78.05
- Normal	1	2.44

Variables	n	%
- Overweight	1	2.44
- Obesitas		
<b>Smoking habit</b>		
- Smoke	5	12.19
- No	36	87.81
<b>Adequate of rest</b>		
- Adequate ( $\geq 8$ hours)	17	41.46
- Inadequate ( $< 8$ hours)	24	58.54
<b>Physical Activity</b>		
- Low	3	7.31
- Moderate	14	34.15
- Vigorous	24	58.54
<b>Aerobic Fitness</b>		
- Poor	9	21.95
- Below Avarage	7	17.08
- Avarage	10	24.39
- Above Avarage	9	21.95
- Excellent	5	12.19
- Superior	1	2.44

Table 2 shows that physical activity, smoking habits, and gender are significantly related to aerobic fitness. The correlation coefficient (r) value of physical activity is positive ( $r = 0.39$ ), indicating that the higher the physical activity of volleyball athletes leads to the higher aerobic fitness. Negative r values were found in gender ( $r = -0.76$ ) and smoking habits ( $r = -0.35$ ). In terms of gender, female athletes have lower aerobic fitness than male athletes. Likewise, in the smoking habit variable, where athletes who smoke will experience a decrease in aerobic fitness compared to non-smokers.

**Table 2.** Analysis results related to aerobic fitness<sup>1</sup>

Variables	p-value	Correlation Coefficient (r)
Physical Activity	0.01	0.39
Smoking Habit	0.03	-0.35
Adequacy of rest (Sleep)	0.41	-0.13
Gender	0.00	-0.76
Body Mass Index (BMI)	0.89	-0.02

<sup>1</sup>Rank Spearman Test, p value  $< 0.05$

### 3.1. Physical activity

WHO defines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity refers to all movement including during leisure time, transportation to and from places, and work or household tasks. Moderate and vigorous-intensity physical activity can improve health. Physical activity is beneficial for health and well-being, while physical inactivity increases the risk of non-communicable diseases (NCDs) and other adverse health outcomes. Physical inactivity and sedentary behavior contribute to the increase in NCDs and burden the health care system.

Various studies have shown that increasing physical activity will positively influence cardiovascular fitness [7]. The findings prove that aerobic fitness is influenced by physical exercise.

### 3.2. Smoking habits

Study by Jeon et.al (2021) showed that the non-smoking group had greater muscle endurance than the smoking group in elderly men. This finding proves that smoking is not beneficial for fitness and health [8]. The positive effects of not smoking include the improvement of the circulatory system, lung, and cardiovascular function [9]. More specifically, forced expiratory volume in 1 second improves within 1 to 5 years in those who quit smoking [10,11]. Smoking disrupts oxygen delivery, where adenosine triphosphate production decreases, resulting in a lack of energy for muscle contraction [12].

The negative effects of smoking on the circulatory system can damage the vascular endothelium and affect the blood supply to the respiratory muscles [12,13]. The study by Su et al. [14] found a relationship between smoking and aerobic and anaerobic fitness levels in Asian male soldiers. Smoking affects muscle and cardiovascular endurance, as evidenced by push-ups, sit-ups, and long-distance running performance. Another study found that anaerobic endurance of the quadriceps muscles was lower in the group of smokers than in non-smokers [15].

Another negative impact of smoking is a decrease in instantaneous explosive performance including repetition of movements and their speed. Smoking can also cause loss of muscle mass, where there is increased proteolysis and inhibits protein synthesis. Smoking can interfere with the oxygen delivery system to the mitochondria and the production of adenosine triphosphate in the mitochondria, which can impair muscle contraction and anaerobic fitness [16]. Moslemi-Haghighi et al. [17] also showed that the running speed of smokers was significantly slower than those who had never smoked.

Study by Degens et al. (2015) showed that exposure to cigarette smoke increases proteolysis and inhibits protein synthesis, resulting in muscle loss [19]. In animals exposed to cigarette smoke, muscle contraction strength (forelimb grip strength) was found to be reduced, leading to muscle mass loss. In addition to muscle mass loss, loss of muscle oxidative phenotype or mitochondrial dysregulation can also contribute to muscle weakness.

Smoking is detrimental to health, including physical fitness. According to research by Su et al., smoking is associated with reduced physical fitness. Smoking leads to a decline in physical abilities, as it results in increased levels of carbon monoxide, which diminishes the amount of oxygen carried by hemoglobin [14].

### 3.3. Gender

Gender influences athletic performance due to various morphological and physiological differences, with aerobic capacity and physical work capacity are greater in men [20]. A difference in average aerobic capacity, as measured by VO<sub>2</sub> max (maximal oxygen uptake) exists in male and female athletes [21, 22]. In women, the average VO<sub>2</sub> max value is approximately 70-75% of the VO<sub>2</sub> max value in men after puberty [23].

Physiologically, there are differences between men and women. Research by Jacinto et al. (2024) showed that there were significant differences in anthropometry and body composition in men and women, with women having lower anthropometric and body composition measurements than men [24]. Other studies also show significant differences in functional capacity [25, 26, 27]. For example, in the time-limited sit-stand test, female athletes showed lower performance compared to men [28]. In a cross-sectional study, higher values were identified in men compared to women for the 30-second chair test, the time-limited get-up-and-walk test, and the 6-minute walk test [29].

## 4 Conclusion

Lifestyle factors, particularly physical activity and smoking habits, significantly influence the aerobic fitness of volleyball athletes. Future research should include a broader and more diverse population, employing various testing tools and methodologies to validate and expand upon these findings.

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