



Study of Cardiorespiratory Endurance and Muscle Strength in Volleyball Players in The Training to Win Phase

Viva Lenia Davina Permata¹, Arief Darmawan^{2*}

^{1,2} Faculty of Sports Science, Universitas Negeri Malang, Jl. Semarang No. 5 Malang, East Java, Indonesia

Abstract

Physical fitness is essential in volleyball as it directly contributes to an athlete's performance, especially during the training to win phase which demands peak competitive condition. This study aims to assess the physical fitness quality of volleyball athletes in Malang City as a basis for evaluating training programs. The study employed a descriptive quantitative survey design involving 33 selected athletes (13 males and 20 females). The physical fitness tests included push-ups, sit-ups, vertical jumps, and the beep test. Results showed the average scores were 31.25 for push-ups (SD = 11.37), 47.2 for sit-ups (SD = 6.13), 14.54 cm for vertical jumps (SD = 5.74), and 36.02 for the beep test (SD = 5.87). These findings indicate that the athletes' overall physical fitness falls within a moderate category, with noticeable performance gaps, particularly in upper-body strength and cardiovascular endurance. The results highlight the need for more targeted and structured physical conditioning programs. This study can serve as a reference for designing future training regimens and as a foundation for long-term physical development in volleyball athletes in Malang City.

Keywords: Endurance, Strenght, Volleyball.

PENDAHULUAN

Volleyball is a sport that demands complex physical abilities. According to Broto (2018), the physical components that volleyball players must possess include endurance, strength, speed, agility, and explosive power. Among these physical conditions, cardiorespiratory endurance and muscle strength are crucial elements that determine an athlete's performance in a match (Simanjuntak et al., 2024). Cardiorespiratory endurance is needed by players to stay energetic during intense matches (Nanda, 2015), while muscle strength contributes to performing explosive movements such as jumping, spiking, and blocking, which require maximum activation of the neuromuscular system to produce power in a short time (Bompa & Buzzichelli, 2019).

In the context of training periodization, the training to win phase is the final stage in the athlete development cycle, focusing primarily on developing tactics, techniques, and basic physical fitness, as well as enhancing maximum performance in competition. In this

phase, Pujowigoro (2019) stated that physical fitness is a fundamental aspect that needs to be improved to achieve athlete success. Purnamasari & Febriyanti (2020) echoed this sentiment, stating that physical fitness is a crucial component of any training program. Therefore, measuring and monitoring physical fitness, such as cardiorespiratory endurance and muscle strength, is crucial.

Furthermore, body composition cannot be ignored in assessing an athlete's physical condition. Body Mass Index (BMI) is an important indicator for evaluating an athlete's physical condition, as it reflects the proportion of weight and height that influences overall physical ability. One easy way to assess body composition is by measuring BMI (Ananda, 2022). According to research by Budi et al., (2023), a non-ideal BMI, whether too low or too high, can affect movement efficiency, lung capacity, and muscle workload during exercise. Therefore, in assessing an athlete's physical fitness, BMI measurement can be a supporting variable in assessing a player's physical readiness, especially during the training-to-win phase.

Although various studies have emphasized the importance of cardiorespiratory endurance, muscle strength, and body composition in supporting volleyball athlete performance, studies specifically integrating these three aspects are still limited. Most studies only focus on one physical condition variable separately (Rachmalia et al., 2022; Wismiarti & Hermanzoni, 2020), thus not providing a comprehensive picture of athletes' physical readiness, particularly during the training-to-win phase, which demands peak performance. Furthermore, contextual research on volleyball athletes in Indonesia is still relatively rare, resulting in a lack of empirical data on the physical condition profiles of local athletes. This creates a research gap that needs to be bridged through studies that simultaneously measure cardiorespiratory endurance, muscle strength, and body mass index to support the development of more targeted training programs tailored to athletes' needs.

Studies of cardiorespiratory endurance and muscle strength are essential foundations for developing a targeted, systematic, and scientifically based training program. Physical condition measurement data provides an objective picture of each athlete's abilities and weaknesses, allowing coaches to evaluate and adjust training portions, intensity, frequency, and type to best suit their needs. This approach ensures that training programs are not generic, but rather specific and individualized. This ensures optimal physical development for athletes, focused on their actual needs, and directly impacting performance during competition.

METHOD

This study used a quantitative descriptive research design with a survey method. The subjects in this study were all PORPROV volleyball athletes in Malang City who had passed the selection. To determine the characteristics of the respondents, height, weight, body mass index (BMI), and length of time as athletes were sought. The athletes consisted of 13 men and 20 women, resulting in a total of 33 subjects. To determine the physical condition of the athletes, the researcher used a physical condition test instrument consisting of four types of test components. These components consist of 1) arm muscle strength, 2) abdominal muscle strength, 3) leg muscle strength, and 4) cardiorespiratory endurance.

Data collection used a test method consisting of strength and cardiorespiratory endurance tests. Strength tests used the following tests: 1) Push Ups, 2) Sit Ups, and 3) Vertical Jumps. The Bleep Test was also used to determine cardiorespiratory endurance.

RESULTS AND DISCUSSION

Results

To understand the characteristics of the respondents in this study, a demographic analysis was conducted covering several key variables. This demographic data provides an overview of the participant profiles, which can help interpret the research results more conceptually. Details of the respondent characteristics are presented in the following table:

Table 1. Demographic Profile of Volleyball Athletes in Malang City, East Java PORPROV 2025

Demographic Characteristics	Statistical Analysis			
	Mean	Min	Max	Standard Deviation
Age (years)	19.06	17	21	1.14
Height (cm)	171.54	158	193	7.75
Body Weight (kg)	60.32	48.2	88.28	8.53
BMI (kg/m ²)	20.5	17.07	27.86	2.20
Length of Athlete Experience (years)	5.85	4	9	1.23

Table 1 shows a mean of 19.06, indicating that most athletes are in their late teens and early adulthood, with low age variation, indicating a relatively homogeneous age group still in optimal development in competitive sports. The height difference of 35 cm, although the average is quite ideal for volleyball athletes, is moderate. The moderate standard deviation indicates a diversity of body heights within the team. The average BMI indicates that the majority of athletes are in the normal weight category. Some are approaching the underweight category (17.07) and some are approaching the slightly overweight category (27.86), but most are still within healthy and functional limits for volleyball performance.

Meanwhile, most athletes have had almost 6 years of training and competition experience, indicating a fairly mature experience at the competitive level. The variation in experience is quite small, indicating uniformity in coaching backgrounds.

Table 2. Data Distribution

Description	Component			
	Push up	Vertical jump	Sit up	Beep test
Total value	1040	479.9	944	1188.8
Average	31.25	14.54	47.2	36.02
Median	33	14.9	48	37.5
Mode	35	12	48	31
Max	55	24.9	57	46.5
Min	8	4.8	35	20
Elementary School	11.37	5.74	1.63	5.87

Based on Table 2, the overall average arm-chest muscle strength is quite high at 31.25, but there is a small group of athletes whose performance is low and requires special attention in strengthening the upper body. The average leg muscle power is quite high at 14.54, as seen from the vertical jump value. The performance of the majority of athletes is at a good to excellent level. The sit-up component received an average score of 47.2, classified as moderate, and endurance received an average score of 36.2, classified as moderate. However, there is still quite large variation (high SD), indicating a quite striking difference in endurance between athletes.

Table 3. Physical Condition Test Results

Description	Component							
	Push up		Vertical jump		Sit up		Beep test	
	F		F		F		F	
	L	P	L	P	L	P	L	P
BS	0	0	2	10	0	12	0	7
B	0	1	10	7	2	5	1	3
S	1	10	1	3	11	3	6	8
K	6	9	0	0	0	0	4	2
KS	6	0	0	0	0	0	2	0
Amount	13	20	13	20	13	20	13	20

Based on table 3. In the push up component, no athletes were in the excellent category and only 1 woman was in the category, most athletes were in the moderate category (10 men and 10 women) but there were 15 athletes (6 men and 9 women) who were in the poor category and 6 athletes in the very poor category. Female athletes dominated the high category in the vertical jump with 12 athletes in the excellent category and 7 athletes in the good category showing quite good leg explosive power. In contrast, male athletes were still at the moderate level with a total of 10 athletes. The core strength of female athletes was very good as shown by 12 female athletes in the excellent category and 5 others in the good category, but male athletes showed a striking weakness with the

dominance of the low category as shown by the majority of men being in the moderate category (3 people) and very poor (6 people). The aerobic endurance of the majority of athletes was still classified as moderate to low. Only a few athletes were in the Very Good category (7 women), most were in the Moderate and Poor categories. A total of 10 athletes (4 Male, 6 Female) are in the Less category, and 5 others (2 Male, 3 Female) are in Very Less.

Discussion

Measurement of arm-chest muscle strength using a *push-up test* showed an average value of 31.25 with a fairly high standard deviation (11.37). These results indicate a performance gap between athletes, likely influenced by gender and individual strength levels. In the context of volleyball, arm-chest muscle strength is crucial, especially for smashes, overhead serves, and blocking (Maulana et al., 2021). Athletes with low arm strength will have difficulty creating powerful and accurate shots (Yolanda et al., 2023). Therefore, coaches need to pay special attention to this group of below-average athletes with progressive and structured upper body muscle strengthening exercises. These training programs can include variations of resistance training such as modified push-ups, bench presses, and resistance band exercises (Rohmah, 2018). Exercise should be performed gradually under close supervision to prevent injury and ensure effective muscle adaptation. Periodic evaluations are also necessary to objectively monitor muscle strength development and provide a basis for adjusting training loads.

Meanwhile, *the vertical jump results* reflect the explosive ability of the leg muscles, with an average of only 14.54 cm. This value is relatively low for volleyball athletes, especially in the *training to win phase*, which demands maximum jumping ability to perform spikes and blocks effectively. Explosive leg muscle power is a key indicator in volleyball, so improving this component should be a priority in training programs. Plyometric training, functional strengthening, and landing techniques should be integrated into physical training sessions to increase jumping effectiveness (Permana et al., 2024), reduce the risk of injury, and improve performance on the field.

Sit-up test, used to measure core muscle strength and endurance, yielded an average score of 47.2 with minimal variation between athletes. Strong core muscles play a role in maintaining body stability, particularly during landing from a jump, rotating the body during a smash, and transitioning from a defensive to an offensive position (Fuchs et al., 2019). In the *training to win phase*, core strength must be developed not only statically but also dynamically, to support the athlete's explosive and complex movements during the

match. Training programs can include exercises such as dynamic planks, side planks, and the use of a medicine ball for body rotation.

Finally, in the *beep test*, which measures cardiovascular endurance, the average score was 36.02, with a standard deviation of 5.87. Although considered moderate, this endurance does not yet reflect the optimal capacity required in volleyball matches, which often last up to five sets. Maulana et al., (2024) stated that good aerobic and anaerobic endurance are needed to maintain consistent performance, reduce mental and physical fatigue, and accelerate recovery between rallies. Athletes with low scores on this test should be given a game-based interval training program or *game-based conditioning*, so that endurance development is carried out specifically and relevant to the pattern of volleyball play (Riski Septa Jatmikanto, 2016).

Based on the analysis of physical condition measurements and profile analysis covering several main variables of Malang City volleyball athletes who will participate in the 2025 East Java PORPROV championship, demographic characteristics in terms of age, the age of Malang City volleyball athletes shows an average of 19 years with a minimum of 17 years and a maximum of 21 years, for the average profile position is the middle blocker and spike position. According to Balyi (1999) the framework of the Long-Term Athlete Development (LTAD) book, this age group is generally in the " *Training to Compete* " phase—a transition period between the development of advanced techniques and increasing physical performance towards the "Training to Win" phase, which is more oriented towards high-level and professional competitions.

According to Arsil (Rachmalia & Lengkana, 2022), an ideal volleyball athlete should possess five key physical components: strength, speed, endurance, explosive power, agility, and good coordination. All of these components play a crucial role in supporting technical skills such as jumping, blocking, and smashing. In particular, optimal vertical jump height significantly determines the effectiveness of smashes and the ability to defend through efficient blocking. Therefore, physical training should focus on improving the quality of the vertical jump, enabling athletes to perform optimally in dynamic and competitive game situations.

In addition to physical strength and endurance, body composition, such as Body Mass Index (BMI), also plays a significant role in volleyball athletes' performance. The average BMI of 20.5 indicates that the majority of athletes are within the normal range. However, some athletes are approaching the underweight or slightly overweight categories. This is important to consider because a suboptimal BMI can impact movement efficiency, lung capacity, and agility and mobility on the field (Budi et al., 2023). Regular BMI

evaluation and monitoring can be used as a supporting indicator in developing an integrated nutrition and physical training program, particularly during the training-to-win phase, which requires maximum performance (Ananda N. A., 2022).

Furthermore, the average athlete's experience of nearly six years provides a solid foundation for more intensive and specific coaching. Athletes with sufficient experience should already have a good understanding of playing techniques and strategies. However, without optimal physical condition, maximum performance potential will still not be achieved. Therefore, coaches need to take a more individualized approach, taking into account the athlete's experience in designing training loads and the frequency of strength and endurance training that suit each athlete's needs (Bompa & Buzzichelli, 2019; Pujowigoro, 2019).

Finally, performance variations between genders also need to be taken into consideration when developing training programs. Data shows that female athletes excel in several components, such as the vertical jump and sit-ups, while male athletes show weaknesses, particularly in core and upper body strength. This difference may be caused by previously unbalanced training patterns or a lack of an individual-specific needs-based training approach. Therefore, a gender-based approach and individual needs analysis are crucial for more effective and equitable physical development for all athletes in achieving their best performance (Rachmalia & Lengkana, 2022).

CONCLUSION

Based on the results and discussion presented, it can be concluded that the majority of volleyball athletes in Malang City who will participate in the Provincial Sports Week (PORPROV) showed that the leg muscle strength aspect was classified as good, as indicated by the average vertical jump value of 14.54 cm (SD = 5.74), although this value can still be improved for competitive performance. The abdominal muscle strength aspect was in the moderate category with an average sit-up value of 47.2 (SD = 6.13), indicating a fairly even core stability ability among athletes. Meanwhile, the arm muscle strength aspect was considered still less than optimal with an average push-up of 31.25 (SD = 11.37), and there were significant differences in performance between individuals. In addition, cardiovascular endurance as measured by the beep test was also in the moderate category, with an average value of 36.02 (SD = 5.87). These findings indicate that the upper body strength and endurance aspects need to be the main focus in physical development programs, so that athlete performance is more optimal and ready to compete in competitions such as PORPROV.

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