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Normative Standards Of Vo2max As A Measuring Tool For Athlete Selection In Badminton And Futsal Sports In Bojonegoro District

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Abstract

Background: Physical condition is a term that describes the degree of fitness and health of a person's body, which includes various components such as strength, agility, durability, speed, power, balance, flexibility, and reaction. One of the primary indicators for measuring aerobic endurance capacity is VO_2Max. A high VO_2Max level is essential in sports that require high intensity and prolonged gameplay, such as badminton and futsal. Bojonegoro district has significant athletic potential, but there are no established normative VO_2Max standards that can be used as a reference in the systematic selection and development of athletes.
Objectives: This study aims to develop normative VO_2Max standards as a benchmark for athlete selection in two sports, namely badminton and futsal, in Bojonegoro Regency. VO_2Max is a key indicator of aerobic capacity and cardiovascular system efficiency, which is very important in supporting athlete endurance and performance.
Methods: This study employed a quantitative approach using the Bleep Test instrument to measure VO_2Max in 73 active athletes affiliated with sports clubs in Bojonegoro.
Results: The study results showed that the average VO2Max for badminton athletes was 28.0 and for futsal athletes was 41.4, with standard deviations of 5.7 and 4.3, respectively. Based on category classification, most badminton athletes fell into the moderate category, while futsal athletes ranged from moderate to high categories.
Conclusion: These differences reflect the physiological characteristics required in each sport, with futsal demanding higher aerobic endurance due to its higher intensity and longer match duration. This study produced VO_2Max category norms for each sport, which can be used as a reference in the athlete selection process and in the development of targeted training programmes.

Keywords: VO_2Max, Endurance, Badminton, Futsal, Athletes, Bojonegoro, Normative Standards.

INTRODUCTION

Physical condition is a term that describes the degree of fitness and health of a person's body, which includes various components such as strength, agility, durability, speed, power, balance, flexibility, and reaction (Buanasita, 2022). Good physical condition not only contributes to optimal athletic performance but also plays a crucial role in maintaining long-term health and preventing various diseases (Berhimpong et al., 2020)

Endurance is a highly important physical ability, especially for athletes who need to perform at their best over extended periods. Endurance involves the ability of muscles and the cardiovascular system to work efficiently and continuously without excessive fatigue (Maizan & Umar, 2020). ndurance and maximum oxygen volume (VO_2Max) are closely related, with VO_2Max itself serving as the primary indicator of an individual's aerobic capacity and cardiovascular efficiency (Silvia, 2021).). The higher the VO_2Max value, the better the body's ability to transport and utilise oxygen during physical activity, resulting in higher endurance and optimal athletic performance (Arfanda, 2023).

Maximum Oxygen Volume (VO_2Max) is an important indicator of an athlete's aerobic capacity and serves as the primary parameter for assessing cardiovascular system efficiency (Rahmatulloh, 2025). In the context of sports, VO_2Max reflects the body's ability to absorb, transport, and utilise oxygen optimally during physical activity, which is crucial for athletic performance (Butar Butar, 2024). Recent research indicates that individuals with high VO_2Max levels often perform better in endurance-demanding sports such as badminton and futsal (Yanti et al., 2021).

The researcher selected badminton and futsal as the focus of this study because both sports are categorized as high-intensity activities that require excellent aerobic endurance (Liu et al., 2024). VO_2Max, as a key indicator of aerobic capacity, plays a crucial role in supporting athletes' ability to maintain optimal physical performance throughout matches of varying durations and intensities. In badminton, athletes with high VO_2Max can sustain their physical condition across 2–3 sets in a single match (Arnando et al., 2022), while in futsal, good VO_2Max enables players to endure the full 2 x 20 minutes of effective playing time (Fikri & Fahrizqi, 2021). The fast-paced nature and high intensity of both sports demand superior endurance levels, making VO_2Max a highly relevant and necessary metric for assessing and supporting athletic performance.

Sports that require high VO_2Max capacity include badminton and futsal. High VO_2Max capacity is crucial in these sports as it enhances endurance and athletic performance during matches. Each of these sports has a different game duration. Badminton athletes with good VO_2Max can maintain their physical condition throughout 2–3 sets in a single match (Arnando *et al.*, 2022). Futsal athletes with good VO_2Max can maintain optimal physical condition throughout a match lasting 2 x 20 minutes of effective playing time (Fikri & Fahrizqi, 2021). The high intensity and fast pace of futsal demand excellent aerobic endurance to enable athletes to perform at their best, both in defence and attack, throughout the entire match duration. The different match durations necessitate athletes to have optimal endurance to deliver their best performance throughout the match.

Bojonegoro Regency has significant and continuously developing athletic potential across various sports disciplines, as evidenced by the active participation of sports clubs and consistent involvement in regional and provincial competitions (Fithroni & Rusdiawan, 2023). However, data on physical fitness, particularly VO_2Max values as a primary indicator of aerobic endurance, remains limited and has not been systematically or scientifically measured. The absence of standardized fitness data makes the athlete selection and development process still subjective and less data-driven, which may hinder the identification of athletes with truly superior physical capacities (Exel & Dabnichki, 2024). Therefore, this study aims to address that gap by developing a standardized VO_2Max benchmark applicable to athletes in Bojonegoro. This standardization is expected to provide clear and objective insights into athletes' fitness levels and physical potential, allowing coaches to design more targeted and effective training programs. Furthermore, the data generated through this research can serve as a scientific foundation for the future development and advancement of athletes in Bojonegoro Regency (Baidhowi & SEI, 2022).

With standardised norms, coaches can more easily compare the abilities of one athlete with another, both within the same team and across different teams, thereby identifying athletes with high potential who require more attention in training programmes (Dwitama & Wibowo, 2022). Objective To establish normative VO_2Max standards as a benchmark for athlete selection in sports disciplines in Bojonegoro District, focusing on determining the endurance levels of badminton and futsal athletes.

METHODS

This study uses a descriptive quantitative design with the aim of establishing VO_2Max standard norms based on numerical data from athletes. The sampling technique employed is

total sampling, where all 73 active athletes participating in badminton and futsal sports clubs in Bojonegoro Regency were included as research samples. Cardiovascular endurance capacity was measured using the Bleep Test instrument, ensuring that all equipment was ready and that athletes were in optimal condition and had performed sufficient warm-up to minimize the risk of injury during testing. The collected data were then analyzed descriptively to determine normative VO_2Max categories that can be used as benchmarks in the athlete selection and development processes in the region.

RESULTS

This study aims to develop normative standards as a benchmark for athlete selection in Bojonegoro Regency in two sports, namely badminton and futsal. The instrument used is the bleep test. Descriptive results are shown in Table 1. Based on Table 1, the average VO_2Max of badminton athletes is 28.0 out of 49 athletes with a standard deviation of 5.7, indicating moderate aerobic capacity. Meanwhile, futsal athletes have a higher average VO_2Max of 24 athletes with a standard deviation of 4.3, indicating more optimal aerobic endurance in line with the demands of the intense game.

Table 1. VO_2Max Measurement Result

Branch of Sport	N	Average VO_2Max	Standard Deviation (SD)
Badminton	49	28,0	**5,7**
Futsal	24	41,4	**4,3**

Table 2. Badminton and Futsal Intervals

Category	Badminton	Futsal
Very High	>36,5	>47,9
High	30,9 – 36,5	43,6 – 47,9
Medium	25,2 – 30,9	39,3 – 43,6
Low	19,5 – 25,2	35,0 – 39,3
Very Low	< 19,5	< 35,0

The VO_2Max category in badminton indicates that values above 36.5 are very high, and values below 19.5 are very low. The other categories are high (30.9–36.5), moderate (25.2–30.9), and low (19.5–25.2). In futsal, VO_2Max values above 47.9 are classified as very high, and values below 35.0 are classified as very low. The other categories are high (43.6–47.9), moderate (39.3–43.6), and low (35.0–39.3). The range of values in futsal tends to be higher, reflecting the greater need for aerobic endurance compared to badminton.

DISCUSSION

Research findings indicate that VO_2Max plays a crucial role in assessing an athlete's physical capacity in endurance-based sports such as badminton and futsal (Pratiwi et al., 2024). Athletes with higher VO_2Max levels generally demonstrate better performance as they can sustain training intensity for longer periods (Permana & Praetyo, 2021). The average VO_2Max in each sport aligns with the physical characteristics of that sport. Basketball has the highest average due to its high-intensity and prolonged duration nature.

Based on the research findings, the average VO_2Max of badminton athletes is 28.0 with a standard deviation of 5.7. Meanwhile, the average VO_2Max of futsal athletes is significantly higher at 41.4 ml/kg/minute with a standard deviation of 4.3. This difference indicates variations in physiological needs and physical demands between the two sports. When compared to the established VO_2Max classification categories, most badminton athletes fall into the moderate category (25.2–30.9). This indicates that the aerobic endurance of badminton athletes is generally sufficient to meet the demands of interval-based matches that span multiple sets (Setyawan, 2022). However, there is still room for improvement in aerobic capacity to achieve the high or very high categories, which would positively impact the ability to maintain game intensity over longer match durations.

Meanwhile, in futsal, the average VO_2Max of athletes is 41.4, falling into the moderate to high category (range 39.3–47.9). This value indicates that most futsal athletes have good aerobic endurance capacity, which aligns with the characteristics of futsal, which demands high speed, dynamic movement, and rapid game transitions during the two halves of the match (Latif et al., 2022). This high VO_2Max is an important indicator in supporting athletes' performance during matches. Overall, the data shows that futsal athletes have a higher average VO_2Max compared to badminton athletes (Boeng, 2024). This difference is reasonable considering that the intensity of futsal is generally higher and more continuous compared to badminton, which is interval-based. Therefore, VO_2Max improvement training programmes remain important to implement in both sports to achieve peak performance in line with the physical and technical characteristics of each sport (Setijono et al., 2025).

The differences in average values and VO_2Max categories between badminton and futsal reflect the differing physiological characteristics required in each sport (Ruqayyah & Rahadianti, 2022). Badminton athletes generally possess adequate aerobic capacity for interval-based play and require rapid reaction times, although they remain in the moderate category. This indicates that further improvement in VO_2Max capacity is still needed to optimise performance, especially in

matches spanning multiple sets (Wiriawan, 2022). Conversely, futsal athletes exhibit significantly higher average VO_2Max values, reflecting the demands of high-intensity play with prolonged effective duration. Futsal requires athletes to move quickly, continuously transitioning between attack and defence, making high aerobic endurance a key factor in maintaining performance throughout the match (de Oliveira Castro *et al.*, 2022).

Overall, the frequency distribution of VO_2Max across the two sports indicates that most athletes fall into the moderate category, reflecting the average performance of the studied athlete group. This can serve as a basis for determining the cut-off or minimum VO_2Max threshold suitable for athlete selection processes in each sport in Bojonegoro District. However, these results also highlight the need for more focused training and physical capacity enhancement programmes, particularly for athletes in the low category.

This study can serve as an initial reference for developing normative VO_2Max standards that can be used by coaches in Bojonegoro District. However, this study has several limitations that need to be considered. First, the sample size used in this study is still limited, so the results obtained may not fully represent the entire population of athletes in Bojonegoro District. Additionally, this study has not categorised age, gender, and performance.

Researchers hope that in the future, more extensive data collection and further analysis will be required, taking into account factors such as age, gender, and training level, to produce more comprehensive standards. Thus, further research is expected to provide a more accurate and in-depth picture of the aerobic capacity of athletes in various sports.

CONCLUSION

This study establishes normative VO_2Max standards as a benchmark in the selection process for badminton and futsal athletes in Bojonegoro Regency. The results show that the average VO_2Max of badminton athletes is 28.0, which falls into the moderate category, while futsal athletes have an average VO_2Max of 41.4, which falls into the moderate to very high category. This difference reflects the physiological characteristics and physical demands of each sport, where futsal requires higher aerobic capacity due to its greater intensity and duration compared to badminton. The norms established in this study can serve as a reference for identifying athletes' endurance levels and form the basis for planning more effective and targeted training programmes. Additionally, the results of this study can be used as an initial guide in the process of selecting potential athletes in Bojonegoro District. However, this study has limitations

in terms of sample size and does not consider factors such as age, gender, and performance level. Therefore, further research with a broader scope is needed to develop more comprehensive and applicable VO_2Max standards.

CONFLICT OF INTEREST

The author hereby declares that this research is free from conflicts of interest with any party

AUTHOR'S CONTRIBUTION

Aprilia contributed to conducting of research and writing of the article. Putri contributed to the preparation of ideas and supervision during data collection. Priadana contributed to the supervision of the writing. Saputri contributed to the proofreading of the article.

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