



The Utilization of VO₂Max Data as Archery Athlete Selection and Monitoring Instrument

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Keywords

Sport Management;
Archery; VO₂Max

Abstract

In sports management in schools, objectivity in the athlete selection process is often compromised due to the lack of use of measurable and scientific-based physical data. In archery, aerobic capacity, especially VO₂max, plays an important role in maintaining physical stability, concentration, and heart rate stability during matches. This study aims to implement VO₂max audit as a strategic instrument in the selection, evaluation, and monitoring of archery athletes at SMK Negeri Bali Mandara. A descriptive quantitative approach was used with 21 archery athletes. VO₂max was measured using the Multistage Fitness Test (MFT). The results showed that athletes' aerobic capacity ranged from 22.93 to 38.84 ml/kg/min, with the majority (52.4%) in the "Adequate" category. These findings indicate that most athletes still need to improve their physical condition. The data from this fitness audit can be used as a basis for grouping more effective and directed training programs. In addition, the VO₂max audit provides a scientific foundation for more transparent, objective, and accountable managerial decision-making in the school sports environment.

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INTRODUCTION

Self-development is a way for teachers to see the existing potential of students so that they can be explored more deeply for the advancement of sports achievements one day and indirectly make students fresh and physically fit. The purpose of self-development is to provide opportunities for students to develop and express themselves according to their talents and interests by paying attention to the state of the school. Efforts to develop movement skills and spur growth and physical development are one of which is archery sports activities. Self-development in archery aims to see the potential and talent of students for this sport (ARISMAN & Okilanda, 2020). Archery is a social sport that is able to relax the body and can be used as a sport to achieve achievements, so that basic techniques, movement mechanisms, physical conditions and mentality become a unit that must be owned by beginner or professional archers (Bramantha & Setiawan, 2022). The development of science and technology has resulted in changes in the human lifestyle itself. This development can improve the benefits of using traditional equipment to be more modern, this can be seen from the use of bows and arrows used by archers. Where equipment was initially only used as a weapon for self-defense, attack and hunting, now bows and arrows are popular among the public as tools for sports and recreation. Archery is a sport that has its own characteristics in its class, although in its development it is not in demand by certain groupsof, but this sport is quite capable of making an impact and also being taken into account by other countries in the world so that this is able to raise the name of the Indonesian nation in general on the world stage.

Archery is often considered a sport that relies solely on eye sharpness, technical precision, and mental composure. However, physiologically, the stability of the shot is also greatly affected by the cardiorespiratory capacity or VO2Max of the athlete. Recent research shows that although archery is a closed skill sport, physical condition remains an important foundation in maintaining concentration, controlling breathing, stabilizing heart rate, and strengthening athletes' mental endurance during the game. Therefore, good physical ability cannot be separated from the achievement of optimal performance in the sport of archery. One way to measure the physical condition of athletes objectively is through the Multistage Fitness Test (MFT). This test is important because the results of MFT are able to describe the level of aerobic capacity or VO2Max of athletes which is directly related to the ability to maintain focus and stability of performance while archery. Thus, archery athletes need not only good technical skills, but also an adequate level of fitness to be able to maintain the consistency of shots in long training and competitions. At SMK Negeri Bali Mandara itself, the main challenge in managing archery extracurriculars is to choose the athletes who are most prepared to compete objectively. By conducting physical condition tests, especially the Multistage Fitness Test (MFT), coaches can more easily map athletes' potential, physical readiness, and achievement opportunities from an early age. This article discusses how fitness audits can be a managerial instrument for coaches in athlete selection and monitoring systems so that every decision made is based on accurate, measurable, and scientific physical data.

The novelty of this research lies in the application of VO2Max audit as a managerial instrument in the selection and monitoring system of archery athletes in the school environment. Previous research has generally focused only on the relationship between physical condition and athletic performance or improved athletic technique, while this study places VO2Max not only as an indicator of fitness, but also as a basis for objective decision-making in educational sports management. In addition, this study is unique because it integrates the results of the Multistage Fitness Test (MFT) into the process of evaluating and mapping the potential of archery athletes systematically. In archery, research on aerobic data-based fitness audits is still relatively limited, especially at the high school level and extracurricular activities. Most of the previous research was conducted more on sports or sports with high physical activity. Therefore, this study provides a new perspective that archery also requires good aerobic capacity to maintain postural stability, concentration, heart rate control, and performance consistency during matches. Another novelty is the use of fitness audit results as a basis for transparency in the process of promoting athletes to a higher level of competition. Thus, this research not only contributes to the aspect of sports science, but also to the development of a school sports management system that is more objective, measurable, and based on scientific data.

METHODS

This study uses a quantitative descriptive method. The subjects in this study were 21 archery extracurricular students of SMK Negeri Bali Mandara, where the researcher measured their aerobic capacity using the Multistage Fitness Test (MFT) instrument. Data collection was carried out in the school field at a predetermined time. The data obtained were then converted into ml/kg/min units to map the physical profile of all members in depth using descriptive statistics in the form of average values, standard deviations, maximum values, minimum values, and percentage categories of VO₂max levels (excellent, good, moderate, poor, and very poor). The results of this audit are classified to assist extracurricular coaches in conducting ongoing athlete data archiving or longitudinal monitoring. The data obtained is then converted into ml/kg/min units to map the physical profile of all members in depth. The raw data from the measurement results of 21 extracurricular athletes are as follows:

Table 1. Descriptive Statistics of VO₂max (n = 21)

Parameter	Value
Mean	27.84
SD	4.45
Minimum	22.93
Maximum	38.84

RESULTS AND DISCUSSION

Extracurricular activities are activities that are carried out outside of active hours that are carried out at school or outside school with the aim of expanding students' horizons and knowledge. In other words, extracurricular activities are challenging and complementary activities for students in addition to compulsory learning hours (Amirzan, 2020). Extracurricular activities are also in line with the Independent Curriculum policy which emphasizes the importance of character formation and overall development of students' potential, including through extracurricular activities that support project-based learning. In order for students to develop their full potential, proper management and service are needed, so that school can be an optimal environment for their development (Khoiriyah et al., 2025). Extracurricular activities are activities carried out in developing certain aspects of what is found in the curriculum that is being run, including those related to how to apply the science learned by students in accordance with the demands of their life needs and the surrounding environment (Sari et al., 2020). In archery, athletes must be able to concentrate on every step of archery and must be innovative and appropriate when determining the decision to aim and release arrows (Yachsie et al., 2021). To be able to concentrate in archery requires good physical condition.

The physical condition of something is always inherent and needed in a person's daily process starting from opening their eyes to life not being conceived physically (Prasetyo, 2018). High achievements are achieved through a planned training process, having goals, and evaluation. The training aims to help athletes improve their skills and achieve peak achievements. To achieve achievement, it must go through a process of 4 training components that must be observed, trained, and realized by athletes (1) physical condition (2) Technique (3) Mental (4) Tactics. Every physical condition must be developed as a whole gradually and continuously because the physical condition is excellent as an athlete is not able to undergo training properly and with quality. The main goal is to improve the quality of Faal potential and increase biomotor potential to the peak of achievement. Some of the biomotor aspects that must be observed are cardiovascular endurance, strength, flexibility, speed, and muscle endurance. Biotomotor components/physical conditions are a must and a priority for athletes to develop. The importance of physical aspects needs to be developed, the stages of which must be known, namely: (1) Physical preparation stage in general, (2) Physical Preparation Stage in Particular, (3) Preparation Stage very specifically according to the needs of Sports Branches (Citra et al., 2021). Physical in sports is a biomotor ability or fitness component needed by athletes according to the needs of the sport they are involved in. Good physique is the basic foundation for building an achievement, because techniques, tactics and psychics can be developed well if athletes have good physical

qualities. The dominant physical exercise performed in archery athletes is arm muscle strength training. Because the archery equipment is quite heavy, in order for the archer to do good technique, the archer must have good arm strength as well. The training provided is not always only directed at the development of technical skills, but the development of physical training is very necessary (Ratu Perwiranegara Paksi B & Sukendro, 2021).

One of the metabolic systems used in exercise is the aerobic metabolic system which will be directly proportional to aerobic exercise. The characteristics of aerobic exercise include low-medium intensity, lasting for a relatively long time. Aerobic exercise has an effect on lactic transport in the muscles. The higher the lactate value per mmol, the higher the intensity of the exercise charged. Talking about the intensity of exercise will be directly related to the cardiovascular ability of the athlete to perform physical activity. The way to find out how much cardiovascular capacity to support physical activity will be obtained through the VO2Max test (Syafriani et al., 2017). VO2Max is a fitness factor needed by athletes, non-athletes, including students. For athletes to support brilliant achievements, while the needs of non-athletes are useful for health welfare, there needs to be an increase in VO2Max and intensively (Purnomo et al., 2024). Maximum oxygen volume (VO2Max) is a measure of the cardiovascular system's capacity to deliver oxygen through the blood to the muscle masses involved in dynamic work for one minute. The higher the VO2max, the higher the cardiopulmonary endurance so that athletes do not get tired quickly and can perform well when competing or doing physical exercise (Is & Hariansyah, 2020).

VO2max is the maximum level of oxygen your body can use during exercise. VO2max is measured in milliliters (ml) of oxygen consumed in one minute, per kilogram of your body weight (ml/kg/minute). Oxygen is the most important part of the respiratory process. When oxygen is inhaled, your lungs absorb it and convert it into energy called adenosine triphosphate (ATP). ATP activates the body's cells and helps release carbon dioxide (CO2) created during the breathing process. VO2Max is usually used to measure an athlete's endurance in doing a sport. Endurance is one of the elements of physical condition that is indispensable in archery. This endurance is referred to as aerobic endurance (Sukmawati et al., 2025). VO2max is an important measure of a person's aerobic capacity and is often used as an indicator of physical performance. Archers with high VO2max are usually able to race longer and more efficiently compared to archers with lower VO2max. VO2max is measured in milliliters per kilogram of body weight per minute (ml/kg/minute). A high VO2max value indicates good aerobic ability, which allows archers to race longer and more intensely without fatigue (Al Ma et al., 2024). In the training process where the coach plays an important role in physical fitness in the athlete, with many forms of physical training to be interesting so that physical exercise is liked by athletes so that the physical fitness of athletes becomes better, personal factors also greatly affect where each athlete has different physical conditions that each individual has. In addition, environmental factors that include adequate facilities and infrastructure used will make it easier for coaches and athletes to improve optimal physical condition (Hidayat & Munandar, 2023).

By using the reference to the standard norms of 15-17 years old, the fitness profile of each archery extracurricular athlete of SMK Negeri Bali Mandara can be objectively mapped as follows:

Table 2. Age Norm Standards 15-17

Category	Male	Female
Excellent	>36	>32
Good	32-35.9	28-31.9
Enough	28-31.9	24-27.9
Less	<28	<24

Table 3. Category Classification Results

Category	Frequency (n)	Percentage (%)	Gender Distribution
Excellent	1	4.8	1 M, 0 F
Good	3	14.3	3 M, 0 F
Adequate	11	52.4	5 M, 6 F
Poor	6	28.6	3 M, 3 F
Total	21	100.0	12 M, 9 F

Based on the data in **Table 3**, the audit results showed that most of the students (11 people) were in the "Sufficient" fitness category. Comparatively, there is a significant difference in aerobic capacity between genders, where the average VO₂Max of men (29.9 ml/kg/minute) is higher than that of women (25.1 ml/kg/minute). Managerially, these findings show that only one student (Dalem Bali) has a "Very Good" capacity, while there are six students in the "Less" category. This emphasizes that extracurricular management strategies must begin to integrate cardiovascular fitness improvement programs in a focused manner for athletes in the low category in order to be able to compete optimally and avoid premature fatigue during competitions.

Table 4. Summary of Statistics/Parameters

Parameters	Results (ml/kg/minutes)
Average Score (Mean)	27.84
Standard Deviation	4.45
Maximum Value	38.84
Minimum Value	22.93

The data above shows that there is a significant gap between the athletes with the highest fitness (38.84) and the lowest (22.93). In the context of team management, this difference requires differentiation of training programs so that workloads can be adjusted to individual capacity. Furthermore, the results of the categorization based on the percentage standard show the following distribution: Excellent: 9.5% (2 students) Good: 14.3% (3 students) Adequate: 52.4% (11 students) Less: 23.8% (5 students) In managing extracurriculars, resource efficiency and also the right placement of athletes are key. Fitness audits through VO₂Max data function as an instrument in conducting objective selection to achieve optimal achievement from students. Based on risk management principles, sending athletes with low VO₂Max levels to high-intensity tournaments will be at risk of failure due to fatigue experienced by the athlete. Selection based solely on technical scores without considering physical fitness often results in a decline in performance in the final elimination round. Therefore, coaches need to conduct physical data-based selection as the new standard in school sports organizations.

Evaluation is an effort to objectively measure and source value from the achievement of previously planned results, where the results of the evaluation are intended to be feedback for planning that will be carried out in the future. Evaluation is one of the functions or elements of management, for the improvement of functions or other social management, namely planning (Vanagosi & Dewi, 2019). As a monitoring instrument, VO₂Max data functions as a periodic "Physical Report Card" for students. Regular monitoring of the physical profile of the athlete assists the team coach in making strategic decisions, such as determining the right rest time before the tournament starts. If the results of the audit show a decrease in fitness trends in an athlete, the coach can take mitigation measures to maintain accuracy stability. This aims to ensure that athletes' physical performance remains at an optimal level during the competition period without experiencing early fatigue. Good aerobic endurance has been shown to play an important role in managing match stress in archery athletes.

The use of scientific data increases stakeholder trust, especially the school and students' parents. This audit process ensures that coaches have concrete and transparent evidence of promoting athletes to the core team. This transparency is very much in line with the values of professionalism upheld at SMK Negeri Bali Mandara, where every managerial decision is taken

responsibly and evidence-based. With an organized physical database system, extracurricular management can account for achievements in a more professional manner.

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CONCLUSION

This study concludes that $VO_2\text{max}$ -based fitness audits through the Multistage Fitness Test (MFT) can serve as an effective managerial instrument in the selection, evaluation, and monitoring of archery athletes in school extracurricular programs. The findings showed that the average $VO_2\text{max}$ of archery extracurricular students at SMK Negeri Bali Mandara was 27.84 ml/kg/minute, with most students (52.4%) categorized as having "adequate" aerobic capacity, while several students were still in the "less" category. These results indicate that the overall physical condition of the athletes still requires systematic improvement, particularly in cardiovascular endurance to support concentration, stability, and consistency during competitions. The study also demonstrates that aerobic capacity plays an important role in archery performance, even though archery is commonly viewed as a sport dominated by technical precision and mental focus. Athletes with better $VO_2\text{max}$ levels tend to have greater endurance, improved heart rate control, and reduced fatigue, which contribute to maintaining performance quality during training and tournaments. Therefore, physical conditioning should be integrated with technical, tactical, and mental training in archery coaching programs.

Managerially, the implementation of fitness audits provides objective and scientific data that can assist coaches in making transparent decisions regarding athlete selection, training load adjustments, and tournament preparation. The use of $VO_2\text{max}$ data as a "physical report card" also supports continuous monitoring of athlete development and enables coaches to apply more individualized training programs based on the athlete's fitness profile. In addition, this study highlights the novelty of integrating $VO_2\text{max}$ audits into school sports management systems, particularly in archery extracurricular activities, where research on aerobic fitness management is still limited. The findings contribute not only to sports science but also to the development of evidence-based extracurricular management practices that promote professionalism, transparency, and accountability in athlete development. Therefore, it is recommended that schools and coaches conduct regular physical fitness evaluations and incorporate structured cardiovascular training programs to improve athletes' aerobic capacity and overall competitive readiness.

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