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The Relationship Between Anaerobic Endurance and the Performance of 400 Meter Runners in Ambon City

Marson Arens Biloro[1*], Emma Rumahlewang[2], John Melvin tahapary[3]

Penjaskerek, fakultas KIP, Universitas pattimura

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Abstract

This study aims to analyze the relationship between anaerobic endurance and the performance of 400-meter sprinters in Ambon City. The research background highlights the crucial role of anaerobic capacity in sustaining high-speed performance throughout the track, where the lactic energy system predominates. A quantitative correlational design was employed, involving 32 male and female athletes aged 18–25 years who participated in the 400-meter event. Anaerobic endurance was assessed using a 300-meter sprint test, while running performance was measured by the best completion time from two trials. Data were analyzed using the Pearson correlation test. Results revealed a moderate positive correlation between anaerobic endurance and 400-meter running performance (r = 0.50; tcount = 0.4205 > ttable = 0.3494, df = 30), indicating that higher anaerobic capacity corresponds to better athletic performance. These findings emphasize the importance of anaerobic training methods, such as high-intensity interval training (HIIT), to enhance sprint endurance and speed. This study contributes empirical evidence to the development of athletic training programs at the regional level.

Keywords: *anaerobic endurance, athletic performance, 400-meter sprint, exercise physiology*

(*) Corresponding Author: Arensmarson@gmail.com

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INTRODUCTION

Sports have a strategic role in shaping healthy, resilient, and characterful Indonesian people, as well as supporting the development of superior and competitive human resources (Giriwijoyo, 2005). Based on Law of the Republic of Indonesia Number 11 of 2022 concerning Sports, sports are an important means to develop physical and spiritual potential through the fields of education, society, and achievements. One of the priority branches in the National Sports Grand Design (DBON) is athletics, which includes the number of running, jumping, throwing, and walking (Munasifah, 2008). Among these numbers, the 400-meter run occupies a privileged position because it demands a combination of high speed, strength and endurance.

Physiologically, the performance of running 400 meters is influenced by the ability of the anaerobic energy system, which is the body's mechanism to produce energy without oxygen at short-duration high-intensity activities (Bowers & Mole, 2000). This system relies on muscle glycogen to form energy, but the process also produces lactic acid that builds up and causes fatigue (Wilmore & Costill, 2004). Athletes with high anaerobic capacity are able to delay muscle fatigue and maintain speed to the finish line. Therefore, resistance to lactate accumulation is the main determinant in the success of the 400 meter running performance.

Previous research has shown a significant correlation between anaerobic capacity and medium-distance sprint outcomes. Supriyono (2018) found a strong negative correlation between anaerobic endurance and 400-meter running time (r = –0.64), while Marlina and Hartati (2020) reported a 12.4% increase after the implementation of high-intensity interval training. Latuheru's research (2021) also confirms the positive influence of anaerobic power on race results. The focus of this study on athletes in Ambon City highlights the weak local anaerobic capacity which has an impact on the decrease in speed after 200–300 meters. The results of this study are expected to strengthen the study of sports physiology and become a scientific basis in the application of HIIT-based exercises to improve the performance of regional athletes.

METHODS

This study uses a quantitative approach with a correlational design that aims to determine the relationship between anaerobic endurance (variable X) and the performance of 400-meter runners (variable Y). This design was chosen because it is suitable for analyzing the degree of interdependence between variables without providing experimental treatment and describing physiological phenomena objectively. The research was carried out on August 30, 2025 at the Mandala Karpan Stadium, Faculty of Teacher Training and Education, Pattimura University, Ambon City, which is a regional athletic activity center with physical test facilities according to standards. The research subjects consisted of 32 male and female athletes aged 18–25 years old who were members of the Ambon City athletic club, with a population of 125 athletes in the 400 meters, taken using a random sampling technique so that each athlete had the same opportunity to become a sample. The selection criteria include athletes who have been actively competing in the past year as well as in good physical condition at the time of data collection. The research procedure was carried out through two stages, namely an anaerobic endurance test with a 300-meter sprint run in one full track to measure the average speed using the formula (v = s/t), and a 400-meter run performance test with the best time of two attempts. Measurements are made using a digital stopwatch, with results recorded on an observation form. The research instrument was adjusted to the standards recommended by Fenanattachir and Faruq (2015) for the measurement of anaerobic endurance and Sunarno (2007) for the performance norm of the 400 meter run. The data obtained was analyzed using Pearson's Product Moment correlation to test the strength of the relationship between the two variables after going through normality and linearity tests as a statistical prerequisite. The results of the analysis showed r = 0.50 with t calculated (0.4205) > t table (0.3494) at a significance level of 5% (α = 0.05), so it was concluded that there was a significant positive relationship between anaerobic endurance and the performance of 400-meter runners. These findings reinforce empirical evidence that anaerobic capacity plays an important role in sprint performance and can be used as a scientific basis for coaches to develop exercise programs based on sports physiology, such as High-Intensity Interval Training (HIIT), to improve athletes' performance in Ambon City in a measurable and sustainable manner.

RESULTS AND DISCUSSION

RESULTS

This study was conducted to analyze the relationship between anaerobic endurance (X) and the performance of 400-meter (Y) runners in athletes in Ambon City. A total of 32 male and female athletes with an age range of 18–25 years participated as a research sample, which was selected through a random sampling technique from a population of 125 athletes in the 400-meter run.

Data were obtained through two test instruments: a 300-meter sprint test to measure anaerobic endurance and a 400-meter running test to measure athlete performance. The best time of the two experiments was recorded using a high-precision digital stopwatch. The analysis was carried out using Pearson's descriptive statistical and Product Moment correlation approach.

Table.1 Field raw flat results

THEY RESPOND	**anaerobic endurance(X)**	**400 m (Y) Athlete Performance**
Michael	36,68	53,77
Well, yes	40,59	58,61
Hendro Supahelu	40,08	56,27
Roy Kudubun	36,21	54,2
Viona Papilaya	39,4	63,5
Aurelin J, Mateheru	49,78	60,04
Eda Tumuli	46,1	67,5
Alya Bat; Ayeri	49,11	69,2
Yunus Latuperissa	39,55	55,01
Joseb Abaulu	43,96	57,77
Stelo Y, Lapulalan	51,96	60,04
Amos Spirits	35,7	54,21
Joan Pattipeilohy	51,24	60,12
Sela Paais	49,21	60,23
Febilian Pasurnay	48,28	66,21
Gis Saimima	41,2	67,5
Gio Matulesy	39,61	59,73
Moris Relebulan	38,17	54,28
Usman Renwarin	39,2	58,3
Samir Laturua	39,45	54,21
Mey Latupeirissa	45,7	65,89
Lidia Tanamal	45,09	65,37
Mikhail Makatite	45,08	65,41
Gween Patalala	44,06	63,52
Julio A, Lewier	40,12	74,18
Revelation ,E Syaranamual	39,25	54,3
Zanski M, Warusuk	39,12	64,29
Nadine Mahubesy	51,46	60,75
Sailen Salampesy	43,68	64,29
Viktor Tuhuhena	39,9	55,43
Edwin P, Syaranamual	39,12	56,29
Buce F, Linansera	39,57	56,36

The results in Table 1 show that the average value of athletes' anaerobic endurance (X) = 42.73 seconds and the average performance time of 400 meters (Y) = 60.52 seconds. This value indicates the medium category according to the classification of Fenanattachir and Faruq (2015) for anaerobic endurance and Sunarno (2007) for 400-meter sprint performance.

Table. 2 Descriptive analysis

Variabel	**N**	**Minimum**	**Maximum**	**Average**	**DV**
Anaerobic Endurance (X)	2	35,7	51,96	42,73	4,8
400 m (Y) Running Performance	2	53,77	74,18	60,52	5,3

Correlation analysis using Pearson Product Moment yielded a value of r = 0.50, with t calculated = 0.4205 > t table = 0.3494 (df = 30, α = 0.05). These values showed a moderate and significant positive relationship between anaerobic endurance and 400-meter running performance.

Table 3 Results of the persone correlation test

Statistics	**Value**
Correlation Coefficient (r)	0,5
Calculated t-value	0,4205
Table t-value (α = 0.05; df = 30)	0,3494
Interpretasi	There was a significant positive association

DISCUSSION

The results showed a positive and significant relationship between anaerobic endurance and the performance of 400-meter runners with a correlation value of r = 0.50 and t calculated (0.4205) > t table (0.3494) at a significance level of 5%. This means that the higher the anaerobic endurance ability of an athlete, the better the performance achieved in the 400-meter run. This relationship can be explained by the body's physiological mechanisms in producing energy without oxygen at high-intensity activities lasting 45–60 seconds, where the anaerobic glycolytic system is the main source of energy (Wilmore & Costill, 2004; Bowers & Mole, 2000). Athletes with high anaerobic capacity are able to tolerate lactic acid accumulation for longer, delay muscle fatigue, and maintain high speed until the finish line (Giriwijoyo & Sidik, 2012; Bompa & Haff, 2009).

These findings reinforce the results of previous studies that showed that anaerobic endurance contributes significantly to medium sprint performance. Supriyono (2018) found a strong negative correlation (r = –0.64) between anaerobic capacity and 400-meter running time, while Latuheru (2021) reported that anaerobic power had a significant effect on running speed (r = –0.58). In addition, Marlina and Hartati (2020) stated that high-intensity interval training can increase anaerobic endurance by 12.4% and sprint speed by 6.7%, while Yusran and Syahputra (2022) emphasized that anaerobic capacity has a strong correlation (r = –0.71) to sprint performance. The consistency of these results shows that the anaerobic energy system plays a crucial role in maintaining optimal speed in the 400-meter run.

Theoretically, the results of this study are in line with the Energy System Contribution Theory put forward by Duffield et al. (2004) and Haugen et al. (2020), which states that 400-meter sprint activities utilize 60–70% of the energy from the glycolytic anaerobic system (lactate) and 30–40% from the aerobic system. Athletes with high anaerobic endurance have better metabolic efficiency in producing energy (ATP) and resisting fatigue due to increased lactate levels. According to Laursen and Jenkins (2002), High-Intensity Interval Training (HIIT) training can increase glycolytic enzyme activity and glycogen utilization efficiency, thereby increasing the body's anaerobic capacity. Field conditions that show a decrease in speed in the first 250–300 meters of the track indicate that some athletes still have limitations in the anaerobic system, so a more focused training program is needed on developing non-oxidative energy capabilities.

From a practical point of view, this research makes an important contribution to sports coaching in Ambon City. These results confirm the need for energy physiology-based exercise programs, such as repeated sprint training and anaerobic threshold training, to improve anaerobic capacity and running performance (Hadiono, 2023). Theoretically, this study reinforces the concept put forward by Fox et al. (1993) that a combination of anaerobic endurance, muscle speed, and biomechanical techniques determines the success of sprint performance. Thus, this study not only answers the formulation of the problem but also provides a scientific basis for coaches and sports institutions to develop evidence-based training programs that are oriented towards increasing anaerobic capacity as the main performance factor of 400-meter runners.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that there is a positive and significant relationship between anaerobic endurance and the performance of 400-meter runners in Ambon City, with a correlation value of r = 0.50 at a significance level of 5%. These findings show that the higher the anaerobic endurance capacity of an athlete, the more optimal the performance produced in the 400-meter running number. Physiologically, anaerobic endurance plays an important role in maintaining high speed, delaying muscle fatigue, and maintaining performance stability to the finish line. This study strengthens the theory of sports physiology that the glycolytic anaerobic energy system (lactate) is the main determinant of success in the athletic branch of the medium-distance sprint.

Practically, the results of this study are the scientific basis for coaches and sports coaches to implement exercise programs that emphasize increasing anaerobic capacity, such as High-Intensity Interval Training (HIIT), repeated sprint training, and anaerobic threshold training. This research is also expected to be a reference for athletic coaching institutions at the regional level in designing training strategies based on energy physiology. For further research, it is recommended that a broader study be conducted by involving a larger number of samples, differentiating gender categories, and adding other variables such as body composition, muscle strength, and running technique in order to obtain a more comprehensive picture of the factors that affect the performance of 400-meter runners.

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