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RESEARCH ARTICLE

The correlation of endurance and speed on the performance of Long-Distance Runners 2022 in East Java Province

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Abstract

The study aims to investigate the correlation between anaerobic speed and endurance in the performance of a marathon 5 km. Twenty-one athletes (15 males(aged 16.7 ± 1.6 years old) and six females (aged 17.8 ± 1.2 years old). The study relied on A cross-sectional design with a survey test used for a 300 m sprint test, a balke test (Vo2 Max), and the time performed at 5 km. The results of the study analysis data showed that significant relationship between endurance and performance as the result of speed in the 5 km running (p=0.002, r = -0.735) in males. The male anaerobic power and performance had a strong correlation (p=0.000, r=0.944). Female long-distance runners showed a significant relation between VO2 max and performance (p= 0.016, r = -0.894). On the other hand, the anaerobic test had a significant correlation with performance (p =0.048, r =0.814). The study concluded that the endurance (Vo2 max) and speed (anaerobic 300 m) contributed to the running time of long-distance runners 5 K.

Keywords

Endurance, Speed, Performance, Long-Distance

INTRODUCTION

Long-distance running is one of the most popular sports today, as evidenced by amateur participation in hundreds of marathons around the world (Ahmadyar, et al., 2015). Long-distance running is a sport that requires higher aerobic endurance compared to short-distance running. (Nikolaidis, et al., 2020). Long-distance running is characterized by a relatively long running duration, varying from 15 minutes to several hours, and different intensities depending on the sport and the athlete's abilities. (Boccia et al., 2017). Typically, 30-60° is the maximum oxygen consumption capacity (VO2max). This value may vary depending on the runner's endurance, distance covered, and environment. Although middle-distance running events are characterized by a high relative contribution from the aerobic energy system (Spencer et al., 2001) and performance in these events are highly correlated with the speed at which maximal oxygen uptake is achieved (VO2max), the high speeds at which depend on the Power stand runner, distance taken, And the environment. elite races are completed and demand high levels of biomechanical power output and a well-developed anaerobic capacity (Di Prampero et al., 1993).

Efforts to improve performance in sports must go through a training process with a scientific approach based on related knowledge such as coaching, physiology, biomechanics, pedagogy, sociology, psychology, and health sciences (Callary et al., 2023). The dominant scientific

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approach with natural sciences such as biology, physiology, and biomechanics has had a significant impact on the development of sports achievements (Hardman, A., & Jones, C, 2011). The sports scientific approach certainly makes a significant contribution to the development of science and technology (IPTEK) in the process of data collection, management, and decision-making processes (Luczak. T, 2021).

The aerobic demands of submaximal running have ̇2 been widely investigated, with VO2max receiving the most attention because it establishes the upper limit of an individual's ability to produce energy through oxidative pathways (Joyner, 1993). It is well accepted that the major metabolic pathway used in distance running events is oxidative and that a high VO2 max is a prerequisite for success in national and international competition. In a recent review paper (Joyner, 1993), distance running was hypothesized to be limited to physiologic variables: VO2 max, lactate threshold, and running economy (RE). In elite athletes, Saltin and Astrand Saltın and Astrand (1967) found that VO2 max is the dominant factor in achieving better performance in endurance events.

Little attention has been directed toward the anaerobic power component of distance running. Among runners whose VO2max and RE are similar, the contribution that anaerobic energy production makes to the order of finish in a close race may be significant. Consequently, anaerobic factors may contribute more to success in distance running than previously recognized (Tharp et al., 1997) found significant relationships between velocity at VO2max, (r = 520.752), 50-m sprint time (r = 50.62), and peak knee extension torque at 4008·sec21 (r = 520.554) to 10-km run time.

Athletes involved in long-distance running often seek to significantly reduce body mass, especially upper body fat mass, to improve physical condition and speed and body efficiency to improve race performance (Knechtleet al., 2011). A carefully planned reduction in body mass index can contribute to increasing speed, improving dynamics, and increasing oxygen consumption of working muscles (Hoffman, 2008). As concluded by a study (Manore, et al., 2012), training in athletes should be based on increasing muscle endurance without excessively developing muscle mass. Greater VO2 max, endurance, and performance in athletes are better for predicting performance in marathon runners (Alvero-Cruz, et al., 2022). It should be noted that individual training for long distances often focuses only on running moderate distances and strengthening the lower limbs, neglecting general training and building skeletal muscle mass. Tests related to VO2 max with training variables (training load and speed) and anthropometric variables affecting long-distance race times (Alvero-Cruz et al., 2020). Five-week interval training reduced body weight, body mass index, fat, basal heart rate, and increased VO2 max (Lubis et al., 2022).

Maximum aerobic power, low body mass, and daily training of long duration and distance contribute to good performance times in long-distance running (Methenitiset al., 2022). Body composition can influence female athletes' elite running times (Mitsuzonoal., 1994). In long-distance running, especially in the case of continuous low-intensity efforts, it is mainly the aerobic capacity that is activated that correlates with performance and body mass index (Sengeiset al., 2021). Aerobic capacity depends on the amount of blood circulation, maximum heart rate, and lung capacity (Stögglet al., 2021). An athlete's performance is influenced by the time of maximum oxygen intake in the body, known as VO2 max. (Scheer et al., 2021). High-intensity training and running down mountains affect increasing VO2 max (Lemireet al., 2023). Physical performance is influenced by well-planned training (taking into account its duration and intensity), genetic and psychological factors (motivation), and the external environment (temperature, altitude, air humidity) (Belinchon et al., 2023). From a physiological point of view, physical activity is influenced by the activity of the cardiovascular and social systems. Strength training for leg muscles and abdominal muscles in adolescents is related to cardiorespiratory endurance (Moseset al., 2023). The two variables can also predict marathon performance, body fat percentage, and recovery heart rate (Kenneallyet al., 2021).lean the body forward running produces consistent acceleration performance (Nagahara et al., 2019)

MATERIALS AND METHODS

Study Design and Participants

The cross-sectional design with a survey test was used in the study. Twenty-six of the population in this study were all male and female athletes in long-distance running in the 5000m, who participated in the East Java Province Sports Games (PORPOV) in 2022. Based on the inclusion criteria, the athletes who signed informed consent and volunteered to be participants in the study were 21 athletes (15 male, and six female), and finished the long-distance running 5000 m championship. All participants completed a medical history and an informed consent form before testing. The Institute of Research and Community Service Center approved the study (Project no. 26/LPPM/STOK BINA GUNA/I/2022). All the data test procedures were conducted following the Declaration of Helsinki.

Data Collection

Research Instrument

This study measured endurance by the Balke test. The Balke test was to get data on VO2 max by running for 15 minutes.

The speed variable data was tested by 300-meterrunning, and data obtained from the results was tested by the Athletic coach from each city in East Java, which was carried out four months before the 7th East Jave Province Games (POPROV) on June 29th – July 2nd,2022.

The performance of long-distance running was measured by the achieved time in running 5000 meters.

Maximal Oxygen Consumption (MaXVO2) Measurement

Before testing, subjects warmed up by jogging at an easy, comfortable pace for 5–10 minutes and then performed various stretches to reduce the risk of injury.

To estimate maximal oxygen power, an indirect method, the 12-minute run-walk test (Cooper), was performed. The results were determined by multiplying the number of laps run by the distance of each lap (400m) and adding the completed lap distance (in meters). MaXVO2 values were determined by Balke's formula (Balke, 1961).

MaxVO2 ml/kg-min. = 33.3+(X-150)x 0.178 ml/kg-min.

X= distance run in 1 minute

300 Meter Run Test

This test aimed to complete 300 meters in the quickest possible time. Ensure that a good warm-upwas conducted before the test, including a jog, stretches, and some short sprints.The 300-m sprint was performed after all other tests had been completed because of the high level of fatigue reached during this test. Subjects were paired with a person of the same gender and a similar 5-km performance time to help elicit optimal performance. The 5-km race and the 300-m sprint data represented a competitive effort that allowed a more valid examination of the relationships between variables (Foster et al., 1993). From a standing start, the subjects were asked to run one 300-m race at maximum effort. Digital stopwatches (Accusplit, San Jose, CA) were used to record the total elapsed time for each runner.

Data analysis

The data analysis technique used in this study was Pearson product-moment correlation coefficient analysis. All data were reported as descriptive statistics and correlation between physical condition and 5000m performance. The relationship between cardiovascular endurance (VO2Max), 300-meter running speed, and 5000m running performance was analyzed using the Pearson product-moment correlation coefficient with a significance level of $p = 0.05$. Statistical analysis using SPSS Statistics 26 software was used.

RESULTS

Based on the result showed that from the total of 26 participants long distance running in the East Java Province Games, only 88.8% fulfilled the inclusion criteria. The characteristics of data participants are shown in Table 1.

Table 1. Descriptive data of participants

Parameters	Female (N=6) M±SD	Male (N=15) M±SD
Weight (kg)	50.89 ± 4.73	54.64 ± 4.72
Height (cm)	163.17± 4.22	165.2 ± 3.89
Age (year)	17.83 ± 1.17	16.66 ± 1.58
Anaerobic	1.65 ± 0.04	1.63 ± 0.04
Vo2max	54.64 ± 4.72	50.88 ± 4.73
5k performance	19.99± 1.16	19.11 ± 1.53
BMI (kg/m^2)	19.11 ± 1.53	19.99 ± 1.16

BMI= Body Mass Index

The normality test on male athletes showed (p = 200, p> 0.05), which means the distribution data is normal. While, for the female athlete's distribution data (p = 200, p> 0.05). The hypothesis is shown in Table 2.

Table 2. Hypothesis test for male athlete's long-distance running

		VO2 Max (ml/kg/min)	Speed (s)	Performance(s)
VO2 Max (ml/kg/min)	Pearson Correlation	1	-.721 **	-.735 **
	Sig. (2-tailed)		002	002
	N	15	15	15
Speed (s)	Pearson Correlation	-.721 **	1	.944 **
	Sig. (2-tailed)	002		.000
	N	15	15	15
Performance(s)	Pearson Correlation	-.735 **	.944 **	1
	Sig. (2-tailed)	002	.000	
	N	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

The normality test data of performance, VO2 max, and Speed for female athletes showed (p = 0.200, p > 0.05), so the distribution data was normal. Based on the distribution data, the data analysis for the hypothesis used parametric there is the person for product-moment because of more than 2 variables. The hypothesis test is shown in Table 3.

Table 3. Hypothesis test for female athletes of long-distance running

		VO2 Max (ml/kg/min)	Speed (s)	Performance(s)
VO2 Max (ml/kg/min)	Pearson Correlation	1	-.951 **	-.894 *
	Sig. (2-tailed)		.004	.016
	N	6	6	6
Speed (s)	Pearson Correlation	-.951 **	1	.814 *
	Sig. (2-tailed)	.004		048
	N	6	6	6
Performance(s)	Pearson Correlation	-.894 *	.814 *	1
	Sig. (2-tailed)	.016	048	
	N	6	6	6

**. Correlation is significant at the 0.01 level (2-tailed) ; *. Correlation is significant at the 0.05 level (2-tailed).

Table 3 presented that the female athletes the correlation between VO2 max and performance is – 0.894, its mean strongest correlation. The degree of relation between speed and performance is 0.814 is a strong correlation.

DISCUSSION

Metabolic effectiveness refers to the utilization of available energy to provide optimal performance, while cardiopulmonary efficiency refers to the smallest work output for processes related to oxygen transport and utilization (Peyre.

T. and Coertjens, 2018). Therefore, RE is an important physiological determinant of endurance performance (Kipp et al., 2019). Increased RE allows athletes to run at faster speeds for the same oxygen uptake (VO 2) and thus achieve superior performance (Hoogkamer et al., 2016).

According to McLaughlin et al. (2010), VO 2MAX explained 81% of the total variance, and RE accounted for an additional 11% of 16 km endurance running performance. These results complement what has been found in the literature as a predictor of maximal endurance running performance. These results are from previous research, which showed VO2Max and RE, as two main predictors of running endurance performance (Bassett and Howley, 2000).

The data showed the strongest negative correlation between VO2max, and speed, when the value of VO2 Max is more significant, and the speed is the shortest time for both male and female athletes in long-distance running. During training, the physical condition has improved even though not significant, because the physical condition is an effect of intensity, training session, body composition, and anthropometrics (Kagawa et al., 2023). This finding differs from a study that involved Body Mass Index and mass as good indicators compared to height (Sedeaud et al., 2023). The other study found that long-distance running training is practical in adapting endurance, body composition, and flexibility (Nikolaidis et al., 2021). Aerobic interval training for five weeks, two times a week, per session was a maximum of 77 minutes improved the physical condition of athletes (Lubis, et al., 2023).

Table 2 has two main findings, 15 male athletes of long-distance running 5000m revealed that the indicator of endurance (VO2 max) had a negative significant correlation with performance (finished time) (p = 0.002, r = -0.74). It means that when the VO2 max is higher the finished time gets shorter. The speed variable has a positive significant correlation to performance (p = 0.00, r = 0.94). It means that the correlation was inline, when the speed is quick, the finished time also fast. This finding has supported the study that VO2 max affected the time finished in the performance of trail runs (Ehrström, et al ., 2018). High maximal aerobic power (VO2 max) and running economy had a positive relationship in trained long-distance athletes (Shaw, et al., 2015).

In this study, the female athletes revealed the same result correlation as male athletes in long-distance running between VO2 max and speed on performance ((VO2 max, p = 0.016, r = -0.89), (speed p = 0.048, r = 0.94)). The previous study found that Speed and interval training increased the VO2 max of middle and long-distance running athletes (Wajib, M., & Sukma, 2022). The neuromuscular and muscle power characteristics were essential determinants of five km running performance. Run time and VO2 max correlated with maximal anaerobic power (p = 0.01, r = 50.68, p = 0.05, r = 50.54, respectively Paavolainen et al. (1991).

A cause-and-effect relationship between endurance performance and anaerobic training was demonstrated by Hickson et al. (1980). They determined that heavy resistance training increased endurance performance. The training program was designed to strengthen the quadriceps, with resistance placed at 80% of 1 repetition maximum. After the 10-week program, no change in VO2 max was found, but endurance time to exhaustion significantly increased by 8% when subjects exercised at 100% of their pretraining VO2 max.
In the present study, the results of the 5 anaerobic power tests were significantly intercorrelated (p<0.05). For example, the 50-m sprint was found to be significantly related to the plyometric leap test (r = 520.656), dynamic vertical jump (CMJ) power (r = 520.622), static vertical jump (SJ) power (r = 520.621), SJ height (r = 520.603), 300-m sprint time (r = 50.599), and CMJ height (r = 520.596). It is interesting to note that power was so well related to endurance performance, especially since so many of the subjects were training for a marathon. Marathon training typically reduces the size and power of fast-twitch fibers. The correlations of 50- and 300-m sprint times with 10-km run time indicate that as sprint time increased, so did 10-km runtime (r = 50.44,p<0.05 and r = 50.79,p< 0.05, respectively). Thus, individuals with faster 10-km run times tended to generate a greater degree of power on the anaerobic field tests and were able to sprint faster than their counterparts. Increased rate of force development and reduced time on the ground may be characteristic of the faster performers.

In the present study, both the 10-km race and the 300-m sprint were performed within a competitive environment. Consequently, the relationships between the 300-m sprint time with the 10-km race performance can perhaps be viewed as a more valid measure than data from laboratory assessment. All of the relationships assessed in the present study were made with the 10-km run time that was performed in the competition. Thus, we avoided in part this limitation. In conclusion, the results of the present study showed a significant relationship between the plyometric leap distance, the results of both vertical jump tests, and both sprint times with 10-km run time (all $p < 0.05$). Multiple regression indicated that the plyometric leap distance and the 300-m sprint time were the best predictors of run performance, explaining 78% of the variance in 10-km run time (SEE, 2.92 minutes). Through the use of simple field tests of anaerobic power, one can predict success in 10-km run performance with a reasonable degree of accuracy in runners that are heterogeneous in ability (Sinnett et al., 2001).

Conclusions

The study concludes that endurance (VO2Max) has a negative relationship with performance and speed (an aerobic test 300-meter run) has a positive relationship with performance in both male and female athletes long-distance runners 5 km of the East Java Province Games in 2022.

The study recommends that coaches of long-distance running focus on increasing VO2 max and aerobic power to improve the performance of athletes.

Conflict of Interest:

There is no personal or financial conflict of interest within the scope of the study.

Information on Ethics Committee Permission

The study was approved and supervised by the departmental research committee, The Institute of Research and Community Service Center approved the study (Project no. 26/LPPM/STOK BINA GUNA/I/2022), dated 15 August 2022).

Researchers' Contribution Statement

Study conception and design: MW, SR, MEW and SS; Data Collection: MW, SR, MEW and SS; Analysis and Interpretation of results: MW, SR, MEW and SS; Draft manuscript preparation: MW, SR, MEW and SS; All authors reviewed the results and approved the final version of the manuscript.

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