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The Effect of Endurance Training with MAF Concept on VO_2Max Improvement in Male 1500-Meter Runners at Tiger Athletics Club, Bahorok

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ABSTRACT

This study aimed to determine the effect of endurance training using the Maximum Aerobic Function (MAF) concept on the VO_2Max improvement of male 1500-meter runners at the Tiger Athletics Club Bahorok. The research method used was an experimental one-group pretest-posttest design involving eight athletes selected through purposive sampling. The training consisted of endurance-based activities (uphill, downhill, and cross-country runs) over six weeks, with three sessions per week. VO_2Max was measured using the Bleep test before and after the training. The data analysis employed a paired t-test, with results showing a significant difference in VO_2Max values pre- and post-training ($t = 5.6568 > t_{0.05}(7) = 1.8946$), indicating that the training had a significant effect. Although the improvement percentages varied among athletes, all were classified within the "low" category according to the normalised gain score. The findings suggest that the MAF-based endurance training program can improve VO_2 Max in middle-distance runners and can be applied as an effective alternative for developing aerobic capacity in athletes.

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A. Conception and design of the study;
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INTRODUCTION

VO_2 max, the maximal oxygen uptake during incremental exercise, is a key indicator of cardiovascular endurance and aerobic capacity (VO_2 max, 2025). In middle-distance events like the 1,500 m, athletes rely on nearly equal contributions from aerobic and anaerobic systems; higher VO_2 max enables sustained pace, faster recovery between surges, and superior endurance (Determinants of performance..., 2011). Effective endurance training, therefore, can enhance VO_2 max and improve race performance (Heydari et al., 2013).

Endurance training modalities vary—from continuous long slow distance (LSD) running to high-intensity interval training (HIIT). Each stimulates physiological

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adaptations in the cardiovascular system but offers different trade-offs in performance gains and injury risk (Helgerud et al., 2007).

A promising method for improving aerobic endurance is the Maximum Aerobic Function (MAF) concept, as developed by Maffetone (Maffetone, 2016). This method zones heart rate into the low-to-moderate intensity range (approximately 180 minus age), focusing on fat oxidation and metabolic efficiency (MAF exercise HR..., 2020; Phil Maffetone, 2016). Observational and anecdotal evidence suggest that MAF training can improve VO_2 max gradually without overtraining or injury (Reddit user experience..., 2023; The Running Channel, 2022).

Meanwhile, HIIT protocols—such as repeated 4-minute intervals at 90–95% HR_max—have shown faster VO_2 max gains (5–7%) compared to continuous running at 70% HR_max (Helgerud et al., 2007). However, HIIT carries a higher risk of overuse injuries and may not suit all runners.

The MAF approach, which emphasizes low-heart-rate endurance, aims to optimize aerobic capacity and metabolic health. Yet, there is limited scientific assessment comparing MAF with traditional training in middle-distance runners.

Athletes from the Tiger Athletics Club Bahorok have shown performance stagnation in recent seasons, despite consistent participation in training. Initial observations identified several contributing factors, including monotonous training routines, irregular lifestyle habits, and inadequate recovery strategies. These issues can negatively affect aerobic capacity and long-term adaptation(Giriwijoyo et al., 2012).

To address these challenges, structured endurance training using heart-rate-based methods has been explored. The Maximum Aerobic Function (MAF) method, introduced by Maffetone, offers a low-intensity, individualized training approach based on maintaining heart rate within an aerobic threshold—calculated as "180 minus age," adjusted for fitness level and health conditions (Maffetone & Laursen, 2020). Research shows that training within this zone promotes fat metabolism, aerobic efficiency, and sustainable energy output.

At the Tiger Athletics Club in Bahorok, male 1,500 m runners demonstrate inconsistent performance and VO_2 max variability. Traditional mixed training methods are used without structured intensity control. Athletes sometimes face overtraining or performance plateaus without improvements in aerobic capacity.

Given that efficient aerobic systems underlie consistent pace and sprint ability in the 1,500 m, optimizing VO_2 max is a performance priority. A heart-rate guided MAF training model may offer a low-risk method to systematically enhance VO_2 max while minimizing overtraining.

Despite the popularity of MAF within endurance communities, there is a lack of empirical studies evaluating its effect on VO_2 max in competitive middle-distance runners. Most rigorous studies focus on HIIT vs LSD methods in cyclists and long-distance athletes (Helgerud et al., 2007), but few investigate the MAF system in 1,500 m runners or compare MAF against established regression-based baseline VO_2 max improvements.

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Moreover, no research has been conducted within Indonesian middle-distance athletics clubs, particularly in rural or regional settings like Bahorok. This creates a gap in evidence-based training that could inform coaches and athletes in community club environments, balancing performance gains with volume and recovery.

This study is among the first to test: (1) the MAF training concept's effect on VO_2 max in male 1,500 m runners, (2) A locally relevant implementation within an Indonesian athletics club, and (3) A comparison of VO_2 max outcomes with established baseline data for similar athletes.

By employing a structured MAF program guided by the 180-age HR formula (Phil Maffetone, 2016) and pre-/post-intervention VO_2 max testing, this research contributes unique insights into heart-rate–based endurance conditioning for middle-distance athletes.

This study aims to evaluate whether MAF-based endurance training improves VO_2 max in male 1,500 m runners at the Tiger Athletics Club, Bahorok. Key research questions: (1) Does MAF training significantly increase VO_2 max over an 8-week program? (2) How do VO_2 max changes compare to existing data on traditional endurance training? And (3) Are runners able to adhere to MAF training (low HR) and avoid performance plateaus or injury?

We will assess VO_2 max via standardized field or lab tests at baseline and after 8 weeks of MAF training. Training adherence, pace, and heart-rate data will be logged.

Findings will inform coaches and athletes on the MAF method's effectiveness for building aerobic endurance in middle-distance runners, offering practical implications for training design, injury prevention, and athlete development in similar settings.

METHODS

This study employed a quantitative experimental approach with a one-group pretest-posttest design. The aim was to examine the effect of endurance training using the Maximum Aerobic Function (MAF) method on VO_2Max improvement among middle-distance runners.

Participants

The population in this study consisted of 12 male athletes aged 15–19 years who were active members of the Tiger Athletics Club Bahorok. Using purposive sampling based on inclusion criteria—regular attendance, absence of injury, and prior running experience—8 athletes were selected as research subjects.

Training Intervention

Participants underwent a six-week endurance training program guided by the MAF method. Training was conducted three times per week (Tuesday, Thursday, and Saturday), with each session lasting between 60 and 75 minutes. The training consisted of aerobic-based activities such as: Uphill/Downhill running and Cross-country or terrain running. Each athlete trained within their individual MAF heart rate zone, calculated using the formula: MAF HR = 180 – age ± adjustment factors(Maffetone & Laursen, 2020).

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Heart rates were monitored using Garmin Forerunner devices to ensure intensity remained within the aerobic zone.

Measurement Instrument

To assess VO_2Max, the multistage fitness test (beep test) was administered. This test is widely accepted as a valid indirect method for estimating VO_2Max and is suitable for field testing in sports settings (Watulingas, 2014).

The VO_2Max score was determined based on the last stage completed by the participant and calculated using the Leger equation integrated in standard beep test protocols.

Procedure

1. Pretest: Athletes performed the beep test to measure baseline VO_2Max.
2. Intervention: Athletes completed the MAF-based endurance training over six weeks.
3. Posttest: VO_2Max was reassessed using the same beep test protocol.

Throughout the intervention period, athletes were instructed to maintain hydration, nutrition, and recovery habits as guided by the coach.

Data Analysis

The collected data were analyzed using:

- Descriptive statistics to present the mean, minimum, and maximum VO_2Max scores.
- Paired sample t-test to determine the significance of the difference between pretest and posttest results.
- Normalized Gain Score (N-Gain) to classify the effectiveness of the intervention. The formula used was: $g=\frac{Sf-Si}{Smaks-Si}$

RESULTS AND DISCUSSION

Research Results

This study aims to determine the effect of endurance training with the MAF concept on increasing VO2max of male 1500-meter middle-distance runners at the Tiger Athletics Club Bahorok in 2025. The treatment given was endurance training in the form of uphill and cross-country endurance training. The treatment was carried out after collecting pre-test data in the form of a bleep test. After the treatment with the training program above, a post-test was carried out. The results of the tests and measurements carried out after carrying out the treatment for 6 weeks can show the truth of the hypothesis that has been proposed. The test and measurement results show the bar diagram of pre-test and post-test data as follows:

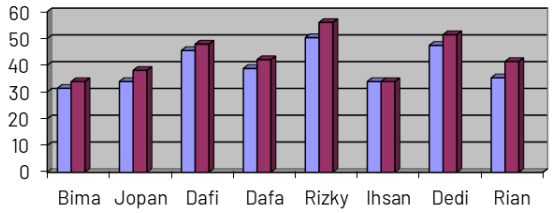

Figure 1.
Pretest And Posttest Data Results in Bar Graph Form

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From the data obtained from the test results with the bleep test instrument, the data obtained were Bima with a pre-test value of 31.4 and a post-test value of 33.9, Jopan with a pre-test value of 35.7 and a post-test value of 38.1, Dafi with a pre-test value of 45.5 and a post-test value of 47.9, Dafa with a pre-test value of 38.8 and a post-test value of 42.1, Rizky with a pre-test value of 50.3 and a post-test value of 56, Ihsan with a pre-test value of 33.9 and a post-test value of 33.9, Dedi with a pre-test value of 47.4 and a post-test value of 51.4, Rian with a pre-test value of 35.3 and a post-test value of 41.4.

Table 1.
Description of Pre-test and Post-test Result Data with Bleep Test Instrument (t-Test)

Variabel	n	Average	Range	Standard Deviation	t_{count}	t_{table}
Endurance with the MAF concept	8	3,3	26,4	1,6578	5,6568	1,8946

Referring to the calculation results carried out in the hypothesis testing using the t-test, the t_{count} was obtained as 5.65. Furthermore, this figure was compared with the t-table figure with degrees of freedom (dk) = n-1 (8-1 = 7) at a significance level of $\alpha = 0.05$, which was 1.8946. Thus, $t_{count} > t_{table}$ (5.6568> 1.8946), which indicates that Ha is accepted and Ho is rejected. Therefore, it can be concluded that there is a significant effect of endurance training with the MAF concept on increasing VO2Max of male 1500-meter runners at the Tiger Athletics Club Bahorok in 2025.

Table 2.
The criteria for increasing each individual's VO2max using the N-gain formula

No	Name	Pre-test Result	Pre-test Result	Difference	$g=\frac{Sf-Si}{Smaks-Si}$	Criteria
1	Bima	31.4	33.9	2.5	0.044	Low
2	Ihsan	33.4	33.9	0	0	Low
3	Rian	35.3	41.4	6.1	0.115	Low
4	Jopan	35.7	38.1	2.4	0.045	Low
5	Dafa	38.8	42.1	3.3	0.066	Low
6	Dafi	45.5	47.9	2.4	0.052	Low
7	Dedi	47.4	51.4	4	0.098	Low
8	Rizky	50.3	56.0	5.7	0.150	Low

Based on the above criteria, it can be described that the sample has differences in the increase of each individual. However, based on the N-gain criteria, the sample that falls into the low criteria is 100%, which is 8 people; the sample that falls into the medium and high criteria is 0%.

Discussion

This study demonstrated that endurance training based on the Maximum Aerobic Function (MAF) concept had a significant effect on improving VO_2Max among male 1500-meter middle-distance runners. This is evidenced by the paired sample t-test result, where the t-value (5.6568) exceeded the critical t-table value (1.8946) at the 5% significance level, indicating that the intervention significantly enhanced the athletes' aerobic capacity.

The training program was implemented over a six-week period with a frequency of three sessions per week. The training modalities included uphill/downhill runs and cross-

country workouts. These utilized the natural hilly terrain, which required athletes to engage major muscle groups with greater intensity. Uphill running helped improve leg strength and the capacity of the cardiovascular and respiratory systems, while downhill running contributed to neuromuscular adaptation and movement control.

Cross-country running, as a form of long-distance aerobic training, also proved effective in enhancing running efficiency and physiological adaptation to fatigue. This training composition aligns with the principles of the MAF method, which emphasizes working at the maximum aerobic level without exceeding the anaerobic threshold. Such training encourages long-term aerobic adaptations, particularly improvements in VO_2Max(Maffetone & Laursen, 2020).

However, based on the normalised gain score, the VO_2Max improvements observed among participants were categorized as low. This may have been influenced by external factors such as inconsistent attendance, lack of adequate rest, and unmonitored nutrition during the training period. These findings are consistent with those of (Busyairi & Ray, 2018), who reported that consistent moderate-intensity, high-volume training improves VO_2Max in middle- and long-distance runners. MAF-based training is especially suitable for endurance athletes, as it minimizes injury risk while focusing on developing a strong aerobic energy system.

CONCLUSION

This study concludes that a six-week endurance training program based on the Maximum Aerobic Function (MAF) concept significantly improves VO_2Max in male 1500-meter runners at the Tiger Athletics Club Bahorok. The statistical analysis confirmed that the training had a meaningful impact on aerobic capacity, as evidenced by the improvement in VO_2Max scores across all participants. While the N-gain scores indicated a low category of effectiveness, the consistent upward trend highlights the potential of the MAF method as a viable alternative in endurance training, particularly for adolescent athletes in grassroots settings.

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