



Does TSR Training Programs Increase the Speed and VO₂max of MMA Athletes?

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ABSTRACT

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The purpose of this study is to examine the impact of an 8-week TUJA Shuttle Run (TSR) training program on enhancing speed and VO₂max in Mixed Martial Arts (MMA) athletes in Magetan Regency. This research employed a quasi-experimental approach using a one-group pretest-posttest design. The participants were eight actively competing MMA athletes selected through purposive sampling based on specific criteria, including consistent training attendance and absence of injury during the program. Data were collected using a 20-meter sprint test to assess speed and a multistage fitness test (commonly known as the beep test) to evaluate VO₂max levels. Both tests have been previously validated and are widely accepted as reliable tools for measuring biomotor performance and aerobic endurance. The collected data were analyzed using SPSS version 25 with a significance threshold set at $\alpha = 0.05$. Findings indicated a statistically significant improvement ($P < 0.05$) in both speed and VO₂max following the intervention. Participants demonstrated faster sprint times and elevated VO₂max values, indicating favorable adaptations within the cardiovascular and respiratory systems due to the training regimen. These outcomes suggest that the TSR program is an effective strategy for improving key physical fitness components essential to MMA performance. Based on these results, incorporating the TSR training model into foundational conditioning programs and competitive preparation phases is strongly recommended, particularly for athletes targeting regional and national tournaments.

1. INTRODUCTION

Mixed Martial Arts (MMA) has seen remarkable growth in popularity, emerging as one of the fastest-evolving combat sports both around the world and across the country (Bizarelo et al., 2024; I Lovell et al., 2013; Susanto et al., 2023; Yearby et al., 2024). This sport requires a highly diverse set of physical capabilities, integrating elements such as muscular strength, stamina, agility, quickness, flexibility, as well as both aerobic and anaerobic endurance (Bizarelo et al., 2024). MMA athletes must sustain peak physical output over extended periods, particularly during high-intensity and rapidly changing combat scenarios (Barbier, 2020; Gabrys et al., 2018). As a result, enhancing key physical attributes like speed and maximal oxygen uptake (VO₂max) plays a crucial role in boosting an athlete's performance during competition.

Speed is a vital biomotor skill for MMA athletes, as it influences their capacity to execute quick actions like evading strikes, launching attacks, initiating takedowns, and shifting between positions effectively (Tota et al., 2019). Speed contributes significantly to fluid and efficient movement within the ring or octagon, where fighters must continuously adjust their positioning to manage rhythm, distance, and momentum. Those with strong sprinting ability are better equipped to react swiftly to their opponents and influence the pace of the match (Simanjuntak et al., 2022).

Conversely, $VO_2\text{max}$ which reflects the body's capacity to take in and efficiently use oxygen during strenuous exercise is a key measure of an athlete's aerobic endurance. (Nery De Oliveira & Follmer, 2015). Mixed Martial Arts requires sustained muscular and cardiovascular exertion across several rounds with minimal recovery time. Athletes with lower $VO_2\text{max}$ levels are more likely to experience early fatigue, which can negatively affect their technical execution, judgment, and increase their vulnerability to injury. In contrast, those with higher $VO_2\text{max}$ levels are better equipped to preserve stamina and concentration throughout the duration of a match (Simanjuntak et al., 2022).

Enhancing both of these physical components requires a structured and purposeful training approach that can be systematically measured (Kostikiadis et al., 2018; Manolachi et al., 2023). An effective training method known to enhance speed is the TUJA Shuttle Run (TSR), which has shown positive results particularly among handball players (Jatmiko, Kusnanik, Nurhasan, et al., 2024), increasing speed and $VO_2\text{max}$ in rugby athletes (Jatmiko, Kusnanik, & Sidik, 2024), Increased speed and $VO_2\text{max}$ in volleyball athletes (Jatmiko et al., 2025), 8 weeks of TSR training increases $VO_2\text{max}$ (Jatmiko, Kusnanik, Nurhasan, et al., 2024). The TUJA Shuttle Run (TSR) represents a novel training approach that combines interval-based exercises with bursts of acceleration and frequent directional shifts to improve athletic performance (Jatmiko, Kusnanik, Nurhasan, et al., 2024). This exercise simulates the movement patterns typically encountered during MMA bouts, requiring athletes to navigate confined spaces with speed and precision while adapting to fast-changing conditions.

TUJA Shuttle Run training involves high-intensity exercises that stimulate both the cardiovascular and neuromuscular systems at the same time. When implemented consistently over an eight-week period, this program can lead to notable physiological improvements, including enhanced heart and lung function, increased muscular power, and quicker neuromotor reactions factors that contribute to better speed and $VO_2\text{max}$. The training is structured based on the principles of progressive overload and periodization, ensuring athletes receive effective physical stimulus while minimizing the risk of overtraining or injury (Jatmiko, Kusnanik, & Sidik, 2024).

While prior research has highlighted the benefits of TUJA Shuttle Run (TSR) training in enhancing physical attributes like speed and aerobic capacity, most of these investigations have focused primarily on traditional competitive sports. There is a notable lack of studies exploring the impact of TSR on martial arts disciplines – especially within the context of Mixed Martial Arts (MMA). This gap is even more evident in specific regions such as Magetan Regency, where efforts to develop competitive sports are currently underway. Moreover, many existing studies still rely on conventional shuttle run protocols, with few exploring sport-specific modifications like TSR, which combines rapid acceleration, directional changes, and sustained endurance to replicate the demands of MMA. In addition, research that evaluates the effects of an 8-week targeted training program on both running speed and $VO_2\text{max}$ simultaneously in regional-level MMA athletes remains scarce, highlighting a critical area for further exploration.

Magetan Regency, located in East Java, has shown strong initiative in fostering martial arts, particularly Mixed Martial Arts (MMA), and holds considerable promise in cultivating elite-level athletes. However, the advancement of training programs in the

region still requires a scientific foundation grounded in empirical research and athlete-specific physiological responses. This study was conducted to examine the impact of an 8-week TUJA Shuttle Run regimen on the running speed and $VO_2\text{max}$ of MMA athletes in the region. The findings are anticipated to support the design of effective and practical physical training strategies, offering valuable insights for coaches, athletes, and sports organizations in their efforts to enhance athlete performance in a structured and evidence-based manner.

2. RESEARCH METHOD

This research employed a quantitative methodology with an experimental design, specifically utilizing a one-group pretest-posttest format. In this setup, participants underwent an 8-week TUJA Shuttle Run training program. Assessments were conducted both before (pretest) and after (posttest) the intervention to identify any changes in the variables of running speed and $VO_2\text{max}$. The study involved 8 male Mixed Martial Arts (MMA) athletes affiliated with a martial arts club in Magetan Regency. Participants were selected using purposive sampling with specific criteria: males aged 18 to 25 years, actively training in MMA for at least one year, in good physical condition, free from injury during the study, and willing to participate in the full 8-week training protocol. The independent variable was the TUJA Shuttle Run exercise, while the dependent variables included running speed (measured in seconds) and $VO_2\text{max}$ (measured in ml/kg/min). Running speed was assessed using a 20-meter sprint and recorded with a digital stopwatch, whereas $VO_2\text{max}$ was estimated through the Bleep Test and calculated using a standardized formula. The training program was administered three times per week over eight weeks, with a progressive load tailored to each athlete's initial fitness level. The research procedure included three phases: a pretest to collect baseline data, an 8-week training intervention, and a posttest to assess outcomes. The resulting data were analyzed using a paired sample t-test via SPSS version 25 to evaluate significant differences between pretest and posttest scores, with a significance threshold set at $\alpha = 0.05$.

3. RESULTS AND DISCUSSION

The results section of this study is organized in a structured manner. It begins with a presentation of the participants' demographic profiles, including key data such as age, height, weight, and Body Mass Index (BMI). Following this, descriptive statistics are outlined, highlighting the average (mean), standard deviation, as well as the minimum and maximum scores for the measured variables. To validate the suitability of the data for further analysis, a normality test is performed to assess whether the distribution meets statistical assumptions. Lastly, findings from the paired sample t-test are reported to identify whether there are significant changes between pre- and post-intervention measurements.

Table 1. Sample Characteristics

No	Sampel	Age (year)	Height (cm)	Weight (kg)	BMI (Score)	BMI Category
1	AB	21	168	55,1	19,77	Ideal
2	DE	17	174	55,1	18,73	Ideal
3	FL	20	160	59,9	22,70	Ideal
4	KGF	18	167	59,2	20,33	Ideal
5	BNM	23	167	63,0	21,76	Ideal
6	TGK	17	166	58,5	20,47	Ideal
7	TPB	18	170	56,6	19,48	Ideal
8	TYC	18	173	66,7	21,95	Ideal

The participants involved in this study all demonstrated Body Mass Index (BMI) values falling within the "Ideal" range, specifically between 18.5 and 24.9, as defined by WHO guidelines. BMI was calculated by dividing each athlete's body weight (in kilograms) by the square of their height (in meters). The average age of the athletes was 19.75 years, placing them in the developmental stage between late adolescence and early adulthood a critical period for achieving peak physical condition. The sample included individuals with heights ranging from 160 cm to 174 cm and body weights between 55.1 kg and 66.7 kg. Among them, respondent FL had the highest BMI at 22.70, while respondent DE had the lowest at 18.73, with both still within the optimal range. These figures suggest that all participants maintained healthy nutritional status and well-balanced physiques, which are essential for excelling in physically demanding sports like MMA, where strength, agility, and endurance are key. Therefore, the overall BMI data reflect that the athletes were physically prepared and capable of engaging in structured training programs such as the TUJA Shuttle Run without facing issues related to undernutrition or excess body weight.

Table 2. Descriptive Statistics

Variables	Mean	SD	Min	Max
Speed Before	5.650	0.160	5.4	5.9
Speed After	5.225	0.104	5.1	5.4
VO ₂ max Before	42.338	1.278	40.1	44.2
VO ₂ max After	47.188	0.858	46.0	48.5

The descriptive analysis results demonstrated improvements in physical performance, specifically in speed and VO₂max, following an 8-week TUJA Shuttle Run training program. Prior to the intervention, the participants' average speed was recorded at 5.650 seconds (SD = 0.160), with times ranging from 5.4 to 5.9 seconds. After completing the training, the average speed time improved to 5.225 seconds (SD = 0.104), with a range of 5.1 to 5.4 seconds, indicating enhanced speed as evidenced by shorter sprint durations. Regarding aerobic capacity, the pre-training VO₂max averaged 42.338 ml/kg/min (SD = 1.278), with individual values between 40.1 and 44.2. Post-training, this increased to an average of 47.188 ml/kg/min (SD = 0.858), with a range of 46.0 to 48.5. These outcomes suggest that the TUJA Shuttle Run program effectively boosted both the speed and aerobic fitness levels of MMA athletes in Magetan Regency.

Table 3. Shapiro-Wilk Normality Test

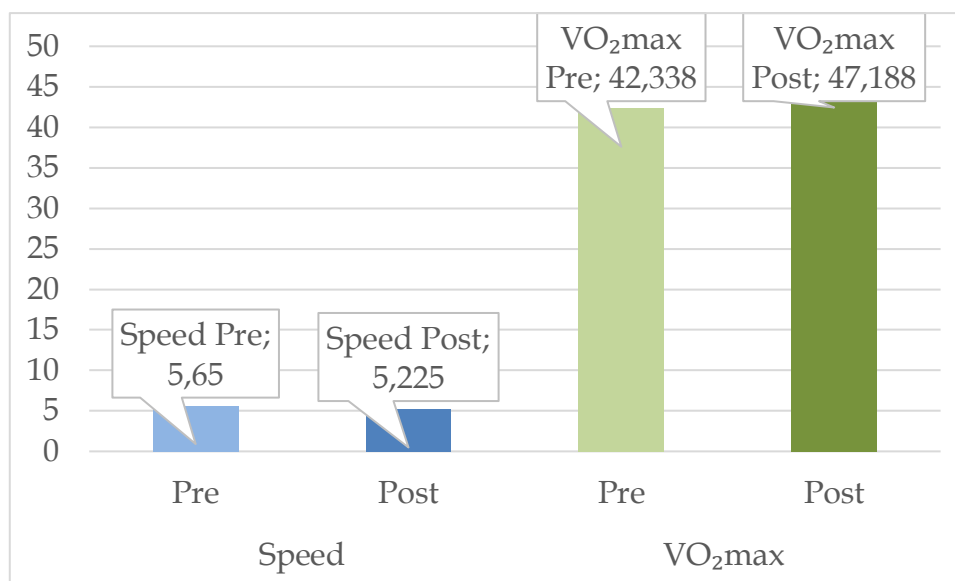
Variables	p-value	Distribution
Speed Before	0.975	Normal
Speed After	0.408	Normal
VO ₂ max Before	0.924	Normal
VO ₂ max After	0.833	Normal

The normality test was conducted using the Shapiro-Wilk method, and the results indicated that all data related to speed and VO₂max, both prior to and following the intervention, had p-values exceeding 0.05. Specifically, the p-value for pre-training speed was 0.975, post-training speed was 0.408, pre-training VO₂max was 0.924, and post-training VO₂max was 0.833. Because all p-values were equal to or greater than 0.05, it can be inferred that the data for each variable followed a normal distribution. This confirms that the assumption of normality was fulfilled, allowing for the use of parametric statistical procedures, such as the paired sample t-test, in subsequent analyses.

Table 4. Paired t-Test Results

Variable	p-value	Conclusion
Speed	0.000	Significant Difference
VO ₂ max	0.000	Significant Difference

The results of the paired sample t-test revealed a p-value of 0.000 for both the speed and VO₂max variables. Since these values are below the 0.05 threshold, it indicates a statistically significant difference between the pre- and post-training data. Therefore, it can be concluded that the 8-week implementation of TUJA Shuttle Run training had a meaningful impact on improving both speed and VO₂max among MMA athletes in Magetan Regency.

**Figure 1.** Differences Before and After 8 Weeks of TSR Training in Speed and VO₂max.

The findings of this study demonstrated a notable improvement in both speed and VO₂max performance among the athletes following the intervention. The average sprint

time improved from 5.65 seconds during the pretest to 5.225 seconds in the posttest, indicating enhanced speed through reduced completion time. Similarly, the $VO_2\text{max}$ levels rose from an average of 42.338 ml/kg/min to 47.188 ml/kg/min, signaling better aerobic endurance and more efficient cardiovascular function. These outcomes suggest that the implemented training regimen successfully elevated the athletes' physical capabilities in terms of speed and aerobic fitness.

The findings indicated that an 8-week TUJA Shuttle Run training program had a meaningful impact on improving both speed and $VO_2\text{max}$ among Mixed Martial Arts (MMA) athletes in Magetan Regency. This training approach incorporates sprint activities with frequent directional changes, targeting the activation of both aerobic and anaerobic energy systems. Such a method aligns well with the physical demands of MMA competitions, which require athletes to perform with high intensity, combining stamina, explosive power, and quick bursts of speed within short durations (Davidenko et al., 2024).

A reduction in sprint time reflects an improvement in speed, which suggests enhanced neuromuscular coordination and muscular adaptation for quick and powerful movements (Jatmiko et al., 2025; Jatmiko, Kusnanik, & Sidik, 2024). This skill plays a crucial role in MMA, where athletes must quickly execute offensive and defensive maneuvers and rapidly shift positions within the combat zone (Tota et al., 2014).

Moreover, the notable improvement in $VO_2\text{max}$ indicates beneficial changes in the athlete's heart and lung function, enhancing overall aerobic capacity (Alm, 2013). $VO_2\text{max}$ serves as a key measure of the body's aerobic fitness, reflecting how effectively oxygen is taken in, delivered to the muscles, and utilized during strenuous exercise (Jatmiko, Kusnanik, Nurhasan, et al., 2024). The improvement in $VO_2\text{max}$ enables MMA athletes to perform at higher intensities for extended durations with reduced fatigue, thereby enhancing their effectiveness during competition (Peacock et al., 2019; Tota et al., 2019).

The TUJA Shuttle Run training incorporates diverse dynamic motions such as speeding up, slowing down, and rapid directional shifts (Jatmiko, Kusnanik, Nurhasan, et al., 2024). The movement patterns developed through this training closely mirror the demands of actual MMA competition, such as evading attacks, delivering tactical combinations, or gaining advantageous positions. As a result, the program not only enhances general fitness but also develops sport-specific functional skills needed during combat. From a physiological standpoint, shuttle run exercises are known to enhance cardiovascular, respiratory, and muscular system performance simultaneously. Recent findings also highlight that this form of training improves the body's ability to delay fatigue by raising the lactate threshold, enabling athletes to perform more effectively in high-stress situations during bouts (Jatmiko, Kusnanik, & Sidik, 2024b; Jatmiko, Kusnanik, Nurhasan, et al., 2024).

4. CONCLUSION

In conclusion, the TUJA Shuttle Run has demonstrated effectiveness as a practical approach for enhancing essential biomotor attributes in MMA athletes, notably speed and aerobic endurance ($VO_2\text{max}$). Incorporating this training method into regular conditioning routines is highly advisable, especially during foundational physical

preparation phases and periods aimed at maximizing performance readiness. Coaches and conditioning experts should also carefully regulate the training load intensity, duration, and frequency to ensure athletes experience the most beneficial physiological adaptations

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