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Enhancing VO_2Max Through Tabata-Based Sport Rhythm Training: An Experimental Study Among Students of Sports Coaching Education

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Abstract

This study aims to analyze the effectiveness of Tabata-based sport rhythm training in improving VO_2max among students of the Sports Coaching Education program at the Faculty of Sports Science, Universitas Negeri Medan. The study employed a quasi-experimental design using a pretest–posttest control group approach. The sample consisted of 30 students selected through random sampling, who were then divided into two groups: an experimental group and a control group. The instrument used to measure VO_2max was the Multistage Fitness Test (bleep test). The intervention was conducted over six weeks, with training sessions three times per week. Data were analyzed using paired sample t-tests and independent sample t-tests with a significance level of 0.05.

The results indicated a significant improvement in VO_2max in the experimental group following the Tabata-based sport rhythm training intervention ($p < 0.05$). Furthermore, there was a significant difference between the experimental and control groups in the posttest results, demonstrating that the applied training method was more effective than conventional training. This improvement can be attributed to the characteristics of Tabata training, which combines high intensity with short intervals, thereby optimizing aerobic capacity. In conclusion, Tabata-based sport rhythm training is effective in improving VO_2max among students of Sports Coaching Education. This method can serve as an alternative training model to enhance cardiorespiratory fitness efficiently and systematically.

Keywords: VO_2max, Tabata training, sport rhythm, cardiorespiratory endurance, experiment

INTRODUCTION

Cardiorespiratory endurance, as represented by the VO_2max indicator, constitutes a fundamental component in determining physical performance and an individual's work capacity, particularly among students in Sports Coaching Education. VO_2max reflects the ability of the cardiovascular and respiratory systems to deliver oxygen to working muscles during high-intensity activity (Bassett & Howley, 2020). Within the context of sports

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education, an optimal level of VO_2max is a critical prerequisite for supporting practical skill execution, training adaptation, and the attainment of peak performance (Joyner & Lundby, 2018). However, a growing body of research indicates that the cardiorespiratory fitness levels of university students tend to decline due to insufficient structured physical activity and a lack of innovation in training methods (Guthold et al., 2020; Hallal et al., 2021).

This issue is further exacerbated by the continued reliance on conventional training methods that are often monotonous, lack variability, and are not grounded in contemporary scientific principles. Such training approaches can reduce motivation and limit physiological adaptation (Buchheit & Laursen, 2019). Therefore, there is a clear need for innovative, efficient, and evidence-based training strategies to optimize VO_2max improvement. One approach that has gained significant attention in sports science is High-Intensity Interval Training (HIIT), particularly the Tabata model, which has been shown to effectively enhance both aerobic and anaerobic capacity within a relatively short time frame (Tabata et al., 1996; Foster et al., 2015; Milanović et al., 2019).

Tabata-based training combines high-intensity exercise intervals with brief recovery periods, thereby eliciting substantial physiological adaptations, including improvements in VO_2max, mitochondrial efficiency, and muscle oxidative capacity (Astorino et al., 2021; Viana et al., 2019). Recent studies have demonstrated that Tabata-based HIIT is more effective than moderate continuous training in improving cardiorespiratory fitness among young individuals and athletes (Engel et al., 2018; Sabag et al., 2021; Wen et al., 2019). Additionally, this approach offers advantages in terms of time efficiency and flexibility in implementation (Gillen & Gibala, 2018).

On the other hand, the integration of sport rhythm training into physical exercise has attracted increasing attention in recent years. This approach emphasizes the synchronization of body movements with specific rhythms, which not only enhances neuromuscular coordination but also improves movement efficiency and cognitive engagement during training (Torrents et al., 2020; Karageorghis et al., 2021). The incorporation of rhythm in exercise has been shown to increase motivation, consistency, and physiological responses during physical activity (Terry et al., 2020). The combination of Tabata-based HIIT principles with sport rhythm training is therefore expected to produce a synergistic effect in optimizing VO_2max improvement.

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Despite its potential, empirical studies specifically examining the integration of Tabata-based sport rhythm training in improving VO_2max remain limited, particularly within the context of Sports Coaching Education students in Indonesia. Most previous studies have focused on HIIT or Tabata independently, without incorporating rhythmic elements into the training process (Foster et al., 2015; Milanović et al., 2019). This indicates a clear research gap that necessitates a comprehensive and contextually grounded experimental investigation.

Based on the aforementioned background, the research problems of this study are formulated as follows: (1) does Tabata-based sport rhythm training have a significant effect on improving VO_2max among Sports Coaching Education students, and (2) is there a significant difference in VO_2max improvement between the experimental group and the control group? Accordingly, this study aims to analyze the effectiveness of this training method as an innovative alternative model for enhancing cardiorespiratory fitness.

Theoretically, this study contributes to the advancement of sports coaching science, particularly in integrating physiological and neuromotor approaches within training frameworks. Practically, the findings are expected to serve as a valuable reference for coaches, lecturers, and sports practitioners in designing training programs that are effective, efficient, and grounded in contemporary scientific evidence.

METHOD

This study employed a quantitative approach using a quasi-experimental research design. Specifically, a pretest–posttest control group design was implemented, enabling the researcher to compare changes in VO_2max between the experimental and control groups before and after the intervention. This methodological approach was selected because it provides adequate control over extraneous variables and allows for the examination of causal relationships between the training intervention and improvements in cardiorespiratory capacity.

The study was conducted at the Faculty of Sports Science, Universitas Negeri Medan (FIK Unimed), over a period of six weeks, with a training frequency of three sessions per week. The research schedule was adjusted to align with the students' academic timetable to avoid interference with their coursework.

The population of this study comprised all active students enrolled in the Sports

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Coaching Education program at FIK Unimed. A total of 30 students were selected as the sample using a random sampling technique, ensuring that each member of the population had an equal probability of being included. The sample was then randomly assigned into two groups: an experimental group (n = 15), which received Tabata-based sport rhythm training, and a control group (n = 15), which followed conventional training.

The research procedure began with a pretest to assess baseline VO_2max levels using the Multistage Fitness Test (bleep test). Subsequently, the experimental group underwent Tabata-based sport rhythm training consisting of high-intensity exercise intervals of 20 seconds followed by 10 seconds of active recovery within one cycle, repeated for eight sets per session. The training was integrated with rhythmic movement patterns to enhance coordination and movement efficiency. In contrast, the control group performed conventional moderate-intensity training without a rhythmic approach. At the end of the intervention period, both groups were administered a posttest using the same instrument.

The research instrument utilized was the Multistage Fitness Test, which has been widely validated and proven reliable for indirectly measuring VO_2max. The data obtained were in the form of levels and shuttle scores, which were subsequently converted into VO_2max values (ml/kg/min) using a standardized formula.

Data analysis was conducted in several stages. Prerequisite tests included a normality test using the Kolmogorov–Smirnov test and a homogeneity test using Levene's test. To examine within-group differences, a paired sample t-test was employed, while between-group differences were analyzed using an independent sample t-test. All statistical analyses were performed using appropriate statistical software, with the level of significance set at 0.05. The research data are available and can be verified through the dataset appendix provided by the researcher to ensure transparency and replicability.

Through this methodological approach, the study is expected to achieve strong internal validity and provide empirical contributions to the development of Tabata-based training models within the field of sports science.

RESULT

The results of this study are presented in accordance with the research objectives, which include: (1) the effect of tabata-based sport rhythm training on

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improving VO_2Max within the experimental group, and (2) the difference in VO_2max improvement between the experimental and control groups.

Table 1. Mean and Standard Deviation of VO_2max in the Experimental and Control Groups

Group	Pretest (Mean ± SD)	Posttest (Mean ± SD)
Experimental (n = 15)	35.42 ± 2.85	41.76 ± 3.12
Control (n = 15)	35.67 ± 2.91	37.12 ± 2.98

The data in Table 1 indicate that both groups experienced an increase in VO_2max. However, the improvement observed in the experimental group was substantially greater than that of the control group.

Table 2. Results of Normality and Homogeneity Tests

Variable	Normality Test (Sig.)	Homogeneity Test (Sig.)
Pretest	0.200	0.317
Posttest	0.176	0.284

The significance values obtained from both the normality and homogeneity tests indicate that the data are normally distributed and homogeneous ($p > 0.05$), thus meeting the assumptions required for parametric analysis.

Table 3. Results of Paired Sample t-test for Experimental and Control Groups

Group	t-value	Sig. (p-value)
Experimental	8.742	0.000
Control	2.136	0.049

The results demonstrate a significant improvement in VO_2max within the experimental group ($p < 0.05$). Although the control group also showed improvement, the level of significance was comparatively lower.

Table 4. Results of Independent Sample t-test for Posttest VO_2Max

Variable	t-value	Sig. (p-value)
Posttest	4.512	0.000

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The analysis reveals a significant difference between the experimental and control groups in posttest VO_2max scores ($p < 0.05$).

Overall, the findings indicate that Tabata-based sport rhythm training leads to a more substantial improvement in VO_2max compared to conventional training methods. This suggests that a high-intensity training approach combined with rhythmic movement patterns is more effective in enhancing the cardiorespiratory capacity of students.

DISCUSSION

The findings of this study indicate that Tabata-based sport rhythm training significantly improves VO_2max among students in Sports Coaching Education. This result is consistent with recent studies emphasizing that high-intensity interval training (HIIT), particularly the Tabata model, is highly effective in enhancing cardiorespiratory capacity compared to moderate continuous training (Sabag et al., 2021; Viana et al., 2019). The greater improvement observed in the experimental group relative to the control group suggests that the combination of high intensity and short interval structure provides an optimal physiological stimulus to the cardiovascular system.

From a physiological perspective, the increase in VO_2max observed in this study can be explained by adaptations in the oxygen transport system, including improvements in cardiac output, muscle capillary density, and oxidative enzyme activity (Gillen & Gibala, 2018; Astorino et al., 2021). Repeated high-intensity Tabata training enhances mitochondrial efficiency and oxidative capacity, enabling the body to utilize oxygen more effectively during physical activity. These findings reinforce previous evidence that HIIT can improve VO_2max in a relatively shorter time compared to traditional training methods (Engel et al., 2018; Milanović et al., 2019).

In addition to intensity, the integration of sport rhythm training in this study contributed further to the improvement in VO_2max. A rhythmic approach to exercise has been shown to enhance neuromuscular efficiency and movement coordination, thereby optimizing energy expenditure (Torrents et al., 2020). Moreover, the use of rhythm plays a role in increasing cognitive engagement and motivation during training, which indirectly affects the quality of exercise execution (Karageorghis et al., 2021; Terry et al., 2020).

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Therefore, the combination of physiological (HIIT) and neuromotor (rhythmic movement) components produces a synergistic effect in improving cardiorespiratory performance.

The findings also reveal that the control group experienced an increase in VO_2max, although to a lesser extent than the experimental group. This suggests that conventional training still induces physiological adaptations, albeit with lower effectiveness. Previous studies support this observation, indicating that moderate-intensity training generally requires a longer duration to achieve significant improvements in VO_2max (Wen et al., 2019). Consequently, time efficiency emerges as a key advantage of the Tabata method applied in this study.

From a novelty perspective, this study makes a meaningful contribution to the development of training models by integrating the concept of sport rhythm training into the Tabata protocol. Most previous research has focused primarily on the effectiveness of HIIT or Tabata without incorporating rhythmic elements into movement execution (Foster et al., 2015; Milanović et al., 2019). Therefore, these findings extend the scientific discourse in sports science, particularly in the development of training methods that emphasize not only intensity but also movement quality and cognitive engagement.

Practically, the results of this study demonstrate that Tabata-based sport rhythm training can serve as an effective, efficient, and applicable alternative training method for improving VO_2max among students. This approach is particularly relevant in both educational and athletic training contexts, especially under time constraints. Additionally, it has the potential to enhance motivation and adherence to training programs.

In conclusion, this study not only confirms previous findings regarding the effectiveness of HIIT but also provides a novel contribution through the integration of rhythmic training approaches, which have been shown to optimize cardiorespiratory capacity in a more comprehensive and effective manner.

CONCLUSION

This study aimed to analyze the effect of tabata-based sport rhythm training on improving VO_2max among students in Sports Coaching Education. Based on the research problems, the quasi-experimental method with a pretest–posttest control group design, and the results of data analysis, it can be concluded that Tabata-based sport rhythm training

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has a significant effect on increasing VO_2max. The improvement observed in the experimental group was statistically higher than that of the control group, indicating that this training method is more effective than conventional training.

These findings address the research problem by demonstrating that the integration of rhythm-based training with the Tabata protocol provides optimal physiological and neuromotor stimuli for enhancing cardiorespiratory capacity. Furthermore, this method has proven to be time-efficient and relevant for implementation among students as part of a fitness improvement program.

Therefore, Tabata-based sport rhythm training can be recommended as an innovative and effective training model for improving VO_2max, while also contributing to the advancement of sports coaching science through a scientifically grounded and practical approach.

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