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Comparison of Circuit Training and Fartlek Methods on Cardiovascular Fitness in Relation to Motivation at SMAN 4 Tanjungpinang

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Abstract

This study was prompted by initial observations revealing suboptimal maximal oxygen consumption (VO₂max) levels in futsal athletes at SMA Negeri 4 Tanjungpinang. This diminished aerobic capacity is hypothesized to be influenced by multifactorial elements, notably the training methodologies employed and the athletes' levels of intrinsic and extrinsic motivation. Consequently, this research utilized a quasi-experimental, pretest-posttest control group design with a sample of 36 purposively selected students to empirically investigate the impact of these variables on VO₂max enhancement. VO₂max was assessed via the Yo-yo Intermittent Recovery Test Level 1 (Yo-yo IR1), while motivation data were gathered through a validated and reliable questionnaire. Two-way ANOVA with a 2x2 factorial design was employed for data analysis. Findings indicated a significant difference in VO₂max between circuit training and fartlek training groups (Sig. = 0.028 < 0.05), and a significant interaction between training methods and motivation on VO₂max (Sig. = 0.000 < 0.05). Furthermore, differences in VO₂max were observed between circuit and fartlek training at both high (Q_{count} = 22.23 > Q_{table} 3.85) and low (Q_{count} = -8.83 < Q_{table} 3.85) motivation levels.

INTRODUCTION

Extracurricular activities are vital for holistic student development, complementing academic curricula. Supervised by educators, these activities foster positive attitudes and allow students to cultivate talents in areas like futsal, basketball, or scouting. They are intentionally designed to help students pursue interests and achieve success, ultimately contributing to their overall well-being. Futsal's widespread appeal across demographics has led to numerous regional, national, and international competitions, notably Indonesia's National Futsal League, aiming to elevate

performance standards. Crucially, achieving high-level futsal performance hinges on technical mastery, forms the fundamental bedrock for optimal athletic achievement, complementing physical and tactical training.

Futsal, a 5-a-side football variant, shares soccer's objective: scoring goals (Travassos et al., 2018). Its name, derived from Spanish/Portuguese ("fut" for football, "sal" for indoor), highlights its origin. Beyond recreation, futsal is crucial for talent development, as exemplified by Brazilian legends like Ronaldinho and Kaká, who honed their exceptional VO₂ max, speed, and ball control through early futsal play. Optimal physical condition is vital for players to maximize their technical abilities.

Optimal physical condition is a prerequisite for athletic success in futsal, as players' attributes must align with sport-specific demands (Albalad-Aiguabella et al., 2025; Oliveira et al., 2025). Endurance, particularly VO₂ max, is crucial; professional Indonesian male futsal athletes typically exhibit VO₂ max levels of 50-53.7 ml/kg BW/minute. Without superior physical conditioning, achieving peak performance is unattainable (Adirahma et al., 2021).

Futsal inherently demands high speed and VO₂ max for continuous movement, rapid decision-making, and dynamic plays (Sekulic et al., 2021). Stable physical conditioning ensures players sustain high performance throughout the 2x20 minute match. VO₂ max, or maximal oxygen uptake, signifies the peak rate of oxygen consumption during exhaustive aerobic metabolism, crucial for ATP production and muscular function.

During observations of a futsal tournament involving athletes from SMA Negeri 4 Tanjungpinang, a significant deficiency in player endurance was noted, which ultimately hindered their ability to sustain performance throughout the match. This was evidenced by players prematurely attempting aggressive attacks but often committing unforced errors. While performance and stability were adequate in the first half, noticeable fatigue set in towards the end of the second half, leading to diminished concentration and focus. This decline allowed opponents to easily gain control of the game.

To address these observed challenges, this research proposes investigating the efficacy of two distinct training methodologies: circuit training and fartlek training. Circuit training is a structured exercise approach utilizing a series of stations, each featuring a different exercise. Participants move sequentially from one station to the next with brief rest periods between stations and longer rests between sets. This method is highly effective for enhancing motor skills and fundamental techniques.

Fartlek training, meaning "speed play," as a method developed by Scandinavian and German runners in the 1920s-1930s. This technique focuses on varying running speeds within a single training session, engaging both muscular and cardiovascular endurance. Athletes actively contribute to determining the pace changes during continuous, high-intensity short-distance intervals. Sprints are executed spontaneously, based on the player's subjective feel and assessment. While specialized, fartlek is often implemented during the preparatory phase of training, offering a dynamic alternative to monotonous continuous training methods. Stating that fartlek allows for individual-specific adjustments in running speed, empowering players to dictate their own pace.

Given the complex issues pertaining to the futsal athletes at SMA Negeri 4 Tanjungpinang, this research aims to empirically investigate the influence of circuit training, fartlek training, and

training motivation on the VO2 max of these athletes. The findings from this study are expected to provide valuable insights and practical solutions to enhance the performance of these young athletes.

METHODS

This study employs a quasi-experimental design to investigate the influence of circuit training, fartlek training, and training motivation on the VO2 max of high school futsal athletes at SMA Negeri 4 Tanjungpinang. The research design utilizes a treatment by design approach with a 2x2 factorial design. The study will span approximately eight weeks (April – June 2024), involving 24 training sessions conducted three times a week at the SMA Negeri 4 Tanjungpinang futsal court. The population consists of 36 male futsal athletes from SMA Negeri 4 Tanjungpinang, all of whom will be included as samples using a total sampling technique. Prior to intervention, all 36 participants will undergo a pre-test to assess their initial VO2 max. Based on these pre-test scores, participants will be ranked and then paired using an ordinal pairing technique (A-B-B-A pattern) to form two matched groups of 18 participants each. VO2 max will be measured using the Yo-Yo Intermittent Recovery Test Level 1 (Male), while training motivation will be assessed via a questionnaire. Data analysis and hypothesis testing will be performed using a Two-Way Analysis of Variance (ANOVA). Before conducting the ANOVA, preliminary analyses, including normality and test for homogeneity of variance, will be performed to ensure statistical assumptions are met.

RESULT AND DISCUSSION

Based on the researcher's calculations, the output from Levene's Test of Equality of Error Variances showed a homogeneous distribution with a significance value of 0.721 (> 0.05). Additionally, normality was assessed using the Shapiro-Wilk test in SPSS version 26, where all groups demonstrated a normal distribution with significance values greater than 0.05, as presented in the table below.

Table 1. Summary of Normality Test Results

Group	Sig	α	Description
High motivation	0.136	0.05	Normal
Low motivation	0.145	0.05	Normal
Circuit training method	0.084	0.05	Normal
Fartlek method	0.111	0.05	Normal

Furthermore, the results of the researchers' hypothesis testing are presented as follows

- a. A significant difference in VO2Max was observed between futsal athletes at SMA Negeri 4 Tanjungpinang who engaged in circuit training and those who undertook fartlek training
 Our recent research on VO2Max differences in futsal athletes from SMA Negeri 4 Tanjungpinang revealed that the circuit training group achieved better VO2Max scores than the fartlek training group. This finding is consistent with our initial hypothesis. SPSS output further confirmed this, showing a significance value of 0.028 ($p < 0.05$).
- b. The present study investigated the interaction effect of training methods and motivation on the VO2 Max of futsal athletes at SMA Negeri 4 Tanjungpinang.
 To evaluate the second hypothesis, statistical analysis confirmed a significant interaction between training methods and VO2 Max among SMA Negeri 4 Tanjungpinang futsal athletes

(Sig. = 0.000, $p < 0.05$). The null hypothesis was thus rejected, with this interaction visualized in a diagram.

- c. Among highly motivated futsal athletes at SMA Negeri 4 Tanjungpinang, a significant difference in VO₂Max was found between those exposed to circuit training and fartlek training. Specifically, the mean VO₂Max for high-motivation athletes undergoing circuit training (A1B1) was 53.93, while those on fartlek training (A2B1) recorded 44.22. The observed difference (A1B1 > A2B1) is statistically significant ($Q_{\text{calculated}} = 22.23 > Q_{\text{critical}} = 3.89$), thereby substantiating the hypothesis that circuit training is more effective than fartlek training in improving VO₂Max among futsal athletes with high training motivation.
- d. A significant difference in VO₂Max was observed among futsal athletes from SMA Negeri 4 Tanjungpinang with low training motivation, specifically between those who underwent circuit training and those who underwent fartlek training. The results revealed that futsal athletes with low training motivation who engaged in circuit training (A2B2) had an average VO₂Max of 44, while those undertaking fartlek training (A2B2) achieved an average VO₂Max of 49.46. The observed relationship (A1B2 < A2B2) and a calculated Q-value of -8.83, which is less than the critical Q-table value of 3.89, provide compelling evidence for our hypothesis. This indicates that among futsal athletes with low training motivation, the fartlek training method leads to a significantly higher VO₂Max compared to the circuit training method.

Discussion

Circuit training is a well-established and highly effective method for enhancing aerobic capacity in athletes, particularly in sports demanding high endurance like futsal (Dolci et al., 2020; Mahalingam et al., 2024; Spyrou et al., 2020). This method, characterized by a series of exercises performed with brief recovery periods, stimulates physiological adaptations through varied stimuli, proving more effective than monotonous training (Gruet et al., 2022; Haugen et al., 2019). A primary benefit of circuit training is the significant improvement in maximal oxygen uptake (VO₂ max), a crucial indicator of aerobic fitness reflecting the body's efficiency in oxygen utilization during physical activity (Bafirman et al., 2023; Menz et al., 2021; Sperlich et al., 2017). High-intensity circuit training specifically enhances VO₂max by inducing greater cardiorespiratory adaptations compared to conventional aerobic methods, thereby improving players' ability to sustain high intensity and mitigate fatigue (Ballesta-García et al., 2020; Marín-Pagán et al., 2020; Taufik et al., 2021). Mechanistically, this training boosts cardiac capacity, blood volume, capillary density, and mitochondrial efficiency, optimizing oxygen transport and aerobic energy production (Pang et al., 2021). While fartlek training offers flexibility and endurance benefits through varied intensities that mimic game demands, potentially enhancing recovery (Pratama & Kushartanti, 2018), circuit training is often preferred by coaches for VO₂max enhancement due to its structured nature, precise control over intensity and duration, and comprehensive benefits for cardiorespiratory fitness, muscular strength, and endurance (Ikenna et al., 2020; Mahalingam et al., 2024).

Optimizing VO₂max enhancement in futsal players necessitates a personalized approach to training, heavily influenced by individual motivation. High intrinsic and extrinsic motivation correlates with better adherence to structured, intensive methods like circuit training, leading to optimal physiological adaptations such as improved cardiac capacity and capillary density (Sperlich et al., 2017; Wahl et al., 2022). Conversely, for less motivated players, flexible and enjoyable

methods like fartlek training may be more effective, fostering sustained engagement and aerobic endurance (Marcos-Pardo et al., 2019). Aligning training methods with individual preferences further boosts motivation, ultimately impacting VO₂max gains. Therefore, effective VO₂max programs should integrate initial motivational assessments, diverse training options, and a supportive environment to maximize both physiological improvements and player satisfaction.

For futsal players aiming to enhance performance, circuit training offers a structured and effective approach to improve maximal oxygen uptake (VO₂max) (Feito et al., 2018). Sport coaching experts suggest that its distinct interval structure and diverse exercises promote optimal physiological adaptation, stimulating muscle growth, and increasing strength through varied intensities (Burgos-Jara et al., 2023). This contrasts with the less structured nature of fartlek training, which can hinder precise VO₂max measurement and maximization. High motivation in futsal athletes allows them to engage in intense circuit training, fostering adaptations like increased capillary density and mitochondrial biogenesis, thereby enhancing oxygen transport and utilization (S. Franco et al., 2024). While fartlek may yield smaller VO₂max gains than structured intervals, it significantly boosts aerobic endurance and recovery, making it valuable for maintaining high intensity and accelerating post-exercise recovery in futsal players.

Fartlek training, characterized by its unstructured and adaptable nature, offers high flexibility for enhancing aerobic endurance in futsal players. Its natural intensity variations (fast, slow, alternating) simulate game-specific physical demands, forcing rapid cardiovascular adaptation and improved oxygen delivery to working muscles. This flexibility makes fartlek appealing, preventing monotony often associated with rigid routines. For low-motivation players, fartlek can be more effective than circuit training for improving VO₂max, as its adjustable intensity and duration cater to individual comfort and ability. This gradual progression fosters sustained engagement and motivation, incrementally boosting fitness. While perhaps slower than circuit training for VO₂max gains, fartlek's adaptive demands still efficiently improve aerobic endurance, providing an accessible entry point for less motivated players to gradually increase their VO₂max.

CONCLUSIONS

The findings of this study conclusively demonstrate that the choice of training methodology significantly influences the VO₂max levels of futsal athletes at SMA Negeri 4 Tanjungpinang. Specifically, a notable distinction was observed in aerobic capacity between athletes engaged in circuit training compared to those undergoing fartlek training. Furthermore, the research unveiled a compelling interaction effect between training methods and athlete motivation, indicating that the effectiveness of a particular training regimen on VO₂max is intricately linked to the individual's motivational state. While differences in VO₂max were present across both training modalities, the impact of motivation on these outcomes was evident, highlighting its crucial role in athletic development. Therefore, it is strongly recommended that sports educators and coaches at SMA Negeri 4 Tanjungpinang, and similar institutions, consider the synergistic relationship between tailored training programs and athlete motivation when designing interventions aimed at enhancing cardiorespiratory fitness in young futsal players. Future strategies should prioritize not only the implementation of effective physical conditioning protocols but also foster an environment that cultivates and sustains high levels of intrinsic and extrinsic motivation among athletes.

CONFLICTS OF INTEREST STATEMENT

Regarding this study, the author declares that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Study concept and design: Irfan Dwi Prasetyo. Acquisition of data: Bafirman Bafirman. Analysis and interpretation of data: Arsil Arsil. Drafting the manuscript: Irfan Dwi Prasetyo. Critical revision of the manuscript for important intellectual content: Padli Padli. Statistical analysis: Irfan Dwi Prasetyo.

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