

Enhancing VO₂Max: contrasting effects of fartlek training and small-sided games

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Abstract

Introduction: VO₂Max capacity is a key measure of performance indicator that is needed for soccer players to be in top physical shape using various training methods, both with and without the ball. **Objective:** This research aimed to discern the impact of fartlek training versus small-side game training to increase VO₂Max capacity of players. **Method:** This quasi-experimental research comprised of pre-test and post-test design with data collected from 20 players aged 15-17 years. Before the experiment, players were divided into groups based on a ranking system of ordinal matching pairing with the use of the Yo-Yo Intermittent Recovery Test (YO-YO IR Test). For data analysis, a statistical average difference test (T-test) was applied, which was initiated with a normality check using Lilliefors. **Results:** The result showed that $t_{count} (11.31) > t_{table} (1.833)$ illustrating a significant difference between the impacts of fartlek and small-sided games training on VO₂Max. In terms of increasing VO₂Max, fartlek training and small side games was able to raise players' average VO₂Max by 1.33, and 0.52, respectively. **Conclusions:** The results suggested that fartlek training was more effective than small-sided games training at increasing players' VO₂Max.

Keywords: Fartlek; Small Side Games; VO₂Max; Soccer

Introduction

Soccer, a phenomenal activity, is the most popular sport globally, enjoyed by millions (Putra & Sepriadi, 2022). According to preliminary studies, playing soccer effectively requires maintaining good physical, technical, tactical, and mental conditions. Therefore, physical fitness combined with tactical, technical, and mental aspects is needed for the competitive performance of players (Los Arcos et al., 2017; Arboleda-Serna et al., 2019; Bahtra et al., 2022). According to Atradin et al., (2023), soccer demands a mixture of technical, tactical, and physical skills. The sport comprised technical, tactical, physiological, psychological, and mental elements (Syafrianto et al., 2023), which are the main basis for improvement. This sport is a full-body contact activity, characterized by intermittent practices, including periods of low, medium, and high-intensity effort (Al Haddad et al., 2015; Joo, 2018; Michailidis et al., 2022). The sport fluctuates between low and high-intensity activities (Nyberg et al., 2016; Hulton et al., 2022), interspersed with long periods of running, as well as phases of low-intensity activity and walking (Penichet-Tomas et al., 2022).

The development of soccer has led to a faster-paced game, characterized by rapid transitions between attack and defense. Players are constantly on the move, both with and without the ball, executing actions such as passing, dribbling, shooting, kicking, jumping, and tackles (Bahtra, 2021). This dynamic style of play enables players to cover significant distances during a match, typically ranging from 8 to 14 km, with average distance falling between 10 to 12 km (Taylor, 2016; Emmonds et al., 2016; Bahtra, Tohidin, et al., 2023). During a soccer match, players commonly traverse distances of approximately 10 to 14 km (Theocharis et al., 2022), with some preliminary research reporting totals of 9 to 14 km (Aksoy et al., 2022), or 10 to 13 km in high-level games (Michailidis, 2022). Analyzing the breakdown of distances covered during a match shows various intensities of movement, such as 24% walking, 36% jogging, 20% running, 11% sprinting, 7% moving backward both quickly and slowly, and 2% dribbling (Scheunemann, 2013).

A high cruising range in sports, particularly in soccer, demands excellent endurance, one of the factors important for athletic achievement (Bahtra et al., 2022), defined as the ability of the body to perform activities for a long time without experiencing fatigue, alongside rapid recovery (Sidik et al., 2019; Gerber et al., 2021; S. S. Alexander et al., 2022). A major indicator for determining endurance is VO₂Max capacity, which represents the optimal oxygen consumption of the body during exercise (Taufik et al., 2021; Poon et al., 2021). This capacity is fundamental in training regimens (Coppola & Raiola, 2019), often regarded as the basis of athlete performance improvement (Budijanto & Kurniawan, 2020). In soccer, VO₂Max plays an important role, influencing the performance of players significantly (Ringgenberg et al., 2017; Thuc & Danh, 2019). It serves as

a crucial standard for evaluating aerobic fitness, with implications for soccer prowess (Aksoy et al., 2022). Papadopoulos et al., (2022) stated that players with higher VO2Max levels cover longer distances during matches.

Based on the relevance of VO2Max in soccer, the coach prioritizes increasing VO2Max levels of players, through systematic, structured, and continuous training. This requires the selection of appropriate training methods, varying between those requiring the ball and vice versa. Professional soccer teams adopt a diverse range of training methods to improve the physical condition of players, comprising both general drills, namely continuous running, circuits, intervals, repeated sprints, and specific ones such as small-sided games, technical exercises, and position specific drills with the ball (Strudwick, 2016). The choice of training method depends on the coach, with some preferring the ball-based exercises, while others focus on drills. However, the main objective is to optimize VO2Max of players to enhance performance on the field.

This research focused on comparing two training methods aimed at improving VO2Max of players, namely fartlek training without the ball and small side games including the use of the ball. According to Sopyan et al., (2023), fartlek is a combination of slow running and short sprints, transitioning continuously from medium to fairly high distances, interspersed with alternating sprints, jogs and sprints. This endurance training system aims to build, restore or maintain the physical condition of an individual, particularly for sports requiring endurance (Pratama & Kushartanti, 2018). Fartlek training to improve VO2Max and physical condition typically includes walking, jogging and sprinting (Festiawan et al., 2020; Salgaonkar et al., 2020). It is simply defined as periods of fast running interspersed with slower running (Kumar, 2015; Gumantan & Fahrizq, 2020). The originators focused on the open nature, suggesting terrain variations such as hills, shrubs, ditches to jump over, sandy, yard, or soft soil, as it deviates from flat and monotonous scenery (Festiawan et al., 2021).

The ball-based training using small side games (SSG) method, is a form of exercise that simulate real gameplay, enabling players to master technical, tactical and physical skills simultaneously (Putra et al., 2022; Hammami et al., 2018). The coach commonly used small side games to improve endurance capacity and develop technical skills (Moran et al., 2019). According to Pa'lo et al. (2023), these games effectively improved the aerobic and anaerobic capacity of soccer players, providing adequate training for the sport. Small side games are beneficial for improving the physical performance of young players during seasonal preparation (Karahana, 2020). Furthermore, they are considered as valuable training tools for developing the physical, technical and tactical behaviours of players (Coutinho et al., 2018; Martínez-Benítez & Becerra-Patiño, 2023), making the game the basis of soccer coaching routines (Rabano-Muñoz et al., 2023).

The above listed training methods have significant difference, fartlek method is performed without using the ball, while small side games require the usage. Despite this dissimilarity, both methods are commonly used to enhance VO2Max capacity of players. While existing literature and research explored the results of fartlek training and small side games, none had specifically investigated the differences between the two methods. This research aims to examine the difference between fartlek training (exercise without using the ball) and small side games (exercise using the ball) in increasing VO2Max levels of players.

Material and Method

Participant

A quasi-experimental design with a two-group pre-test post-test method was adopted in this research. The samples comprised 20 male soccer players aged between 15 to 17 years. Prior to the experiment, participants were divided into two groups using ordinal matching pairing, as shown in Table 1. In addition, players were assigned to either fartlek or small-sided games group, which was determined randomly by drawing lots. The series of processes were carried out to ensure the formation of homogeneous and balanced groups for the analysis.

Table 1. Two-Group Post-Test Design

Pre-test	Grouping	Exercise Group	Post-test
T ₁	Ordinary Matched Pairing	Fartlek	T ₂
		Small Side Games	

Organization of Research

This research was conducted to find the difference between fartlek training and small side games. The training was carried out in 16 meetings occurring three times a week. It started with pre-test on the sample, followed by a 16-hour treatment phase, and concluded with post-test. The two training methods were designed to be the same in terms of training load, differing mainly in the training area. Training was conducted based on the principle of progressive load, in which the duration was increased weekly. Fartlek training was carried out in a 30x50 m area, including exercises such as walking, jogging and sprinting. However, small side games occurred in a 30x40 m area, featuring 5v5 matches without a goalkeeper, as shown in Table 2:

Table 2. Training Program

Sessions	Fartlek				Small Side Games			
	Area	Duration	Set	Recovery	Area	Duration	Set	Recovery
1-3	30x50 m	4 minutes	3	2 minutes/set	30x40 m	4 minutes	3	2 minutes/set
4-6	30x50 m	8 minutes	3	2 minutes/set	30x40 m	8 minutes	3	2 minutes/set
7-9	30x50 m	10 minutes	3	3 minutes/set	30x40 m	10 minutes	3	3 minutes/set
10-12	30x50 m	12 minutes	3	3 minutes/set	30x40 m	12 minutes	3	3 minutes/set
13-16	30x50 m	15 minutes	3	3 minutes/set	30x40 m	15 minutes	3	3 minutes/set

Instrument and Procedure

Players' VO2Max data were collected using the Yo-Yo Intermittent Recovery Test (Yoyo IR Test) level 1 (Bangsbo & Mohr, 2015). The test was carried out twice, namely before or pre-test and after the intervention or post-test. During the Yo-Yo test, players ran back and forth along a 25 m track, with 20 meters designated as the test track from point B to C, and the remaining 5 meters used to rest from A to B. Players started from point B and ran to C, on hearing a beep, and then returned to B. Following a brief 10-second recovery period in areas A and B, players initiated the next stage. This process continued until players reached the maximum capacity.

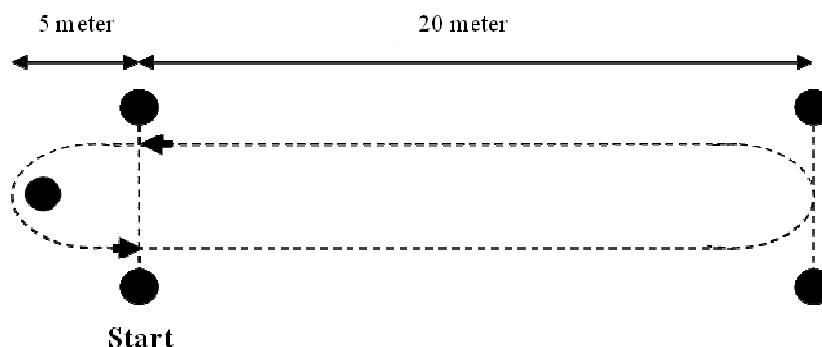


Figure 1. Yo-Yo Track in Intermittent Recovery Test

Statistical Analysis

The analysis was conducted based on the following steps 1) a normality test performed using Lilliefors method to assess the distribution of the data, 2) the effectiveness of the training methods was evaluated using the T-test.

Result

The data description aims to describe the characteristics and measurement of the test and each variable, enabling the classification of the sample. The research process was conducted in 18 meetings, with details of one for the initial or pre-test, 16 for the treatment and the remaining one for the final or post-test. Table 3 shows the data description for the 10 players who engaged in fartlek training and small side games groups. For fartlek training group, the average VO2Max at pre-test and post-test were 41.57, and 42.88, with the highest recorded value of 44.13 and 45.47, respectively. Similarly, for small side games group, average VO2Max at pre-test and post-test were 41.76 and 42.28, with the highest scores observed at 43.79 and 44.13, respectively.

Table 3. Data Description

Group	Pre-test				Post-test			
	Average	STDV	Max	Min	Average	STDV	Max	Min
Fartlek	41.57	1.61	44.13	38.42	42.88	1.56	45.47	40.77
SSG	41.76	1.25	43.79	40.10	42.28	1.29	44.13	40.77

Table 4 and Figure 2 show the differences in VO2Max of players from the two training groups. Among the 10 players in fartlek group, 1 was in the good category in the range of 45 to 50, while the remaining 9 were in the moderate category of 38 to 44. However, all 10 players in small side games group, were classified in the moderate category based on VO2Max range. These results showed that those in fartlek group were slightly better than small side games.

Table 4. VO2Max Classification of Small side Games and Fartlek Groups

Classification	VO2Max	Small Side Games		Fartlek	
		Absolute	Relative	Absolute	Relative
Excellent	>55				
Very Good	51 – 55				
Good	45 – 50			1	10%
Moderate	38 – 44	10	100%	9	90%
Low	35 – 37				
Poor	< 35				
Total		10	100%	10	100%

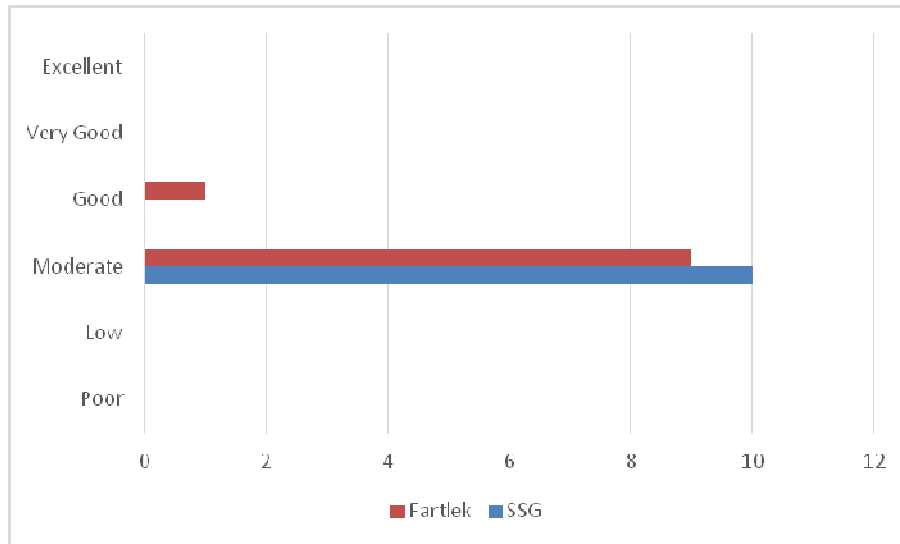


Figure 2. The Comparison of Fartlek and Small Side Games Groups

The results of hypothesis testing comparing fartlek and small side games groups are shown in Table 5. The test showed that $t_{\text{count}} (11.31) > t_{\text{table}} (1.833)$, depicting a significant difference in the effectiveness of fartlek training and small side games. The results showed that fartlek training was more effective than small side games with average increase of 1.33 and 0.52, respectively.

Table 5. Hypothesis Test Result

Group	Average	SD	A	t_{count}	t_{table}	Description
Fartlek	42.884	1.56	0.05	11.31	1.833	Significant
Small Side Games	42.281	1.29				

Discussion

The results showed that both methods effectively increased VO2Max of players, despite the distinct characteristics. Fartlek training, conducted without using the ball, enabled players to solely focus on exercises such as jogging, sprinting, walking, etc. It includes a continuous blend of slow running and short sprints, transitioning from medium to fairly high distances and alternating between sprints, and jogging (Harsono, 2017). These activities progressively increased the workload on the heart and lungs, optimizing the increase in VO2Max. The optimization is further enhanced through consistent, structured, and systematic fartlek training, along with progressively increased routines.

The results also showed that practicing small side games effectively increased VO2Max of players with small side games conducted to motivate players to maintain continuous movement in pursuit of the ball. This uninterrupted activity enhanced lung capacity by promoting optimal oxygen consumption. However, small side games training increases VO2Max and also improves technical skills, due to the ball-based nature of the exercises (Bekris et al., 2012). Incorporating small side games into weekly training routines contributed to improved physical fitness and soccer specific skills (Radziminski et al., 2013; Paprancová et al., 2024). In addition, training with the ball has several advantages, including 1) it simultaneously improves endurance and helps players to develop basic technical skills through increased contact with the ball, 2) eliminates boredom

during endurance training, 3) facilitates easier organization and control of exercises by the coach, and 4) increases the motivation of players during endurance training (Bahtra et al., 2022).

Soccer, being a sport that demands endurance over extended periods, requires a good VO2Max (Bahtra, Putra, et al., 2023). Several theories and literature reported various insights concerning VO2Max requirement of players. For example, average oxygen uptake for an international soccer team ranges from 55 to 68 ml/kg/minute (Slimani et al., 2019) and 48 to 62 ml/kg/minute (Modric et al., 2021). Professional players, and amateurs (Helgerud et al., 2001) showed VO2Max of 56.5 ml/kg/min and 55.7 ml/kg/min, respectively. The best players can achieve VO2Max levels of 65 to 70 ml/kg/min, influenced by factors such as age, individual performance level, and field position. VO2Max of 60 to 62 ml/kg/min was considered a reasonable reserve for players, particularly for those aged 16 to 17 years old (Taylor, 2016). However, different playing position requires varying VO2Max levels. On the average, wing, center backs, midfielder, striker and goalkeeper had VO2Max values of 62 ml/kg/min, 56 ml/kg/min, 62 ml/kg/min, 60 ml/kg/min, and 51 ml/kg/min, respectively. For semi-professional (active) players, wing, center backs, midfielder and striker, the values were 55 ml/kg/min, 55 ml/kg/min, 58 ml/kg/min, and 54 ml/kg/min, respectively (Scheunemann, 2013).

A good VO2Max is essential for players to sustain optimal performance in the game. Soccer is characterized by high-intensity intermittent exercise that requires players to possess excellent physical fitness. This comprised a combination of high-intensity activities, such as sprinting, accelerating, jumping and changing direction, with low-intensity phases namely jogging or walking (Sannicandro & Cofano, 2023). Increased endurance ability significantly improved players' performance in matches such as distance travelled, intensity, number of sprints, and the ball involvement (RUSSELL et al., 2016; Bahtra, Crisari, et al., 2023). Endurance training augments maximal oxygen uptake (VO2Max) and fosters positive enzymatic and metabolic adaptations, thereby increasing resistance to fatigue (Costa et al., 2016).

Fartlek and small side games methods offered effective means of increasing VO2Max of players, despite the distinct characteristics. The coach usually considered various factors, including the condition of players, available training facilities, and scheduling constraints, when deciding which method best suits the team. In addition, the phases of training periodization play a significant role in the decision-making process. During the general preparation phase, fartlek training was preferred, which focused on the overall physical conditioning. However, in the special preparation phase, small side games were more advantageous, because it improved the physical condition of the players, and focused on developing technique skills. By practicing small side games, the coach simultaneously addressed both aspects and made it a valuable choice for the training stage.

Conclusion

In conclusion, the results showed that the two methods increased VO2Max of players. Statistically, fartlek training led to a greater average VO2Max increase of 1.33, compared to the 0.52 for small side games. The result showed that fartlek training was more effective in enhancing VO2Max than small side games, due to the distinct treatment methods. Furthermore, Fartlek training focused only on running, while small side games required playing with the ball, which might have diverted the attention of players from maximizing VO2Max. The outcome provided valuable insights for the coach, when selecting training methods to increase VO2Max capacity of players.

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