



The Effect of Varied Fartlek Method Exercises on VO₂max and Specific Endurance in Young Football Players

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Abstract: The research question stems from the importance of oxygen uptake (VO₂max) and endurance performance for young football players and their impact on the skills and tactical performance of all players in the game. The researchers, who are experts in the field of sports training physiology, observed fluctuations in endurance performance levels and players' boredom due to a lack of variety in training methods, including a variable-speed play method. This is because the researchers observed the training programs of some coaches at the Karbala Youth Club and found that most coaches rely on a training method that is repetitive and causes players to get bored. Another reason that prompted the researchers to address this issue was the increase in the speed of modern football games. This requires young football players to improve their endurance performance, allowing players to always be in the best condition and delay fatigue, thereby achieving good results. Therefore, the researchers conducted various fartlek exercises on young football players at the Karbala Holy Land Club. The sample was randomly selected from the community. The sample was divided into two groups (control and experimental groups) with ten players in each group. The aim was to determine the effects of these exercises on the study group. The researchers hypothesized that diversified fartlek exercises would have a positive impact on the development of specific endurance skills in young football players. After conducting a pretest and applying these exercises to the study subjects three times a week for ten weeks, the researchers conducted a posttest and obtained the results. These carefully prepared exercises demonstrated their positive impact on the study group

Keywords: Varied Fartlek Method, Specific Endurance Capabilities

Introduction

Football training is a sport that is gaining importance at all levels. This has prompted experts and researchers to further develop the sport by introducing diverse training methods to improve the various physical qualities of football players. As football is a team sport, it places constant stress on various body systems and the performances vary during training and matches, so a high level of physical and physiological fitness is required. In recent years, we have observed a significant improvement in the physical fitness of athletes at world championships. This can only be achieved by exploring diverse training methods, applying modern methods, and using the huge technological potential to keep up with this development. Football is one of the most popular sports in the world and is widely studied in terms of assessing physical, game, physiological and psychological abilities. This ensures

that the training programs are based on sound scientific principles and are performed at the highest level. There are currently a variety of training methods aimed at developing physical and physiological aspects. These methods include the "variable speed fartlek training method", which is characterized by changes in intensity and speed, which is very suitable for football players because it simulates the real situation of the game and the constant fluctuations in physical fitness during the game. Fartlek running is an effective method to develop aerobic and anaerobic fitness. It also helps to improve the specific endurance required for the ever-changing game pace during the game. Therefore, speed-shifting fartlek running is one of the important ways to improve the efficiency of the circulatory and respiratory systems. It helps to improve the maximum oxygen uptake (VO₂ max) index and improves specific endurance (strength endurance, speed endurance and explosive endurance). This has a positive effect on improving the level of athletes and enabling them to show good technical and tactical performance throughout the game.

Research Problem

Endurance and VO₂max indices are important factors affecting physical and technical performance of football players, especially in the younger age groups, which are considered as a fundamental preparation for higher leagues. Despite the use of a variety of training methods, many coaches still rely on traditional methods that may not achieve the physiological responses required for optimal development of these skills. Therefore, it is necessary to study the effects of modern comprehensive training methods, such as Fartlek Variable Training, on improving VO₂max and specific endurance performance. This is because they are similar to real-life match conditions, with varying speeds and intensities. When observing the 2024/25 Youth League, we found that most players had a decrease in specific endurance performance. Therefore, researchers sought to address this issue and find a solution.

Research objective:

- To identify the effect of varied fartlek exercises on VO₂max and specific endurance in young football players.

Research hypothesis:

- There is an effect of varied fartlek exercises on VO₂max and specific endurance in young football players.

Research fields:

- Human field: Karbala youth club players for the 2024-2025 sports season
- Time field: (25/2/2025) to (30/5/2025)
- Spatial field: Karbala Secondary Stadium, Al-Jarrah Stadium, and Al-Khairat Club Stadium in Al-Hindiyah District.

Methodology

The researchers used the experimental method with an equivalent experimental and control group design, as it is the appropriate method for solving the problem at hand.

Research Community and Sample

The subjects of the study in the 2024/25 season were set to be young football players from various clubs in Karbala (a total of six). Some clubs were excluded due to lack of holidays and other clubs not participating in the competition. Al-Khairat Club, which has 20 players, was randomly selected as the research sample. The sample was selected using a random sampling procedure. The sample was divided into two groups: a control group and an experimental group, with 10 players in each group, using simple random sampling and drawing of lots.

Methods, Devices, and Tools Used in the Research:

Data Collection Methods:

The researchers used interviews, observation, sources, references, testing, and measurement.

Devices and Tools Used in the Research:

- (2) American iPhone 6 Plus devices.
- (4) Korean-made PH computer.
- Medical scale.
- (50) plastic cones and cones of various sizes.
- (2) whistles.
- (8) colored shirts.
- (10) football balls.

Research Procedures

Homogeneity of the Research Sample

After determining the measures that influenced the study dependent variables (height, weight, chronological age, and training age) based on their relationship with the study variables, Levene's test was used to determine the homogeneity of the sample members on these measures. This was done to control for the study variables that influenced the experiment and attribute any differences to the independent variables.

Table 1. shows homogeneity

Variables	Unit of measurement	Sample homogeneity test			Type of significance
		Levene's test value	Degrees of freedom	Significance value	
Height	Cm	.178	18	.343	Non-sig
Training age	Month	.196	18	.699	Non-sig
Mass	Kg	2.325	18	.059	Non-sig
Chronological age	Month	.288	18	.421	Non-sig

As can be seen from Table (1), the significance values (sig) of all variables are greater than 0.05. Therefore, we accept the null hypothesis that the variances of the samples are homogeneous and there are no differences between the samples, that is, the data are homogeneous.

Defining the Research Variables:

The researchers defined the research variable based on a review of sources, references, and previous studies, and the relationship of the dependent variables to the independent variable.

Description of the Research Tests

Maximum Oxygen Consumption Test (VO₂max): (Amr Allah Ahmed Al-Basati. 2017)

Test Name: 12-minute running test (Cooper test)

Purpose of the test: Maximum Oxygen Consumption (VO₂MaX)

Equipment Used: Football field or athletics track, stopwatch, number of cones.

Test Description:

Athletes get into position behind the starting line. After the starting whistle blows, the athletes run continuously for 12 minutes on a known length of track or football field, trying to cover as much distance as possible. After the coach blows the whistle, the number of laps completed and the number of laps run by each athlete are recorded. Markers are set every 20 meters to record the distance.

Test Instructions:

- The coach announces the remaining time from time to time.
- The player has the right to walk whenever he feels the need to do so, and the coach must encourage him to continue running.

Score Calculation:

- Several referees (assistant referees) stand at the starting line, each holding a list with the names of several athletes (the athletes can be numbered). Each referee must record the number of laps completed by each athlete. At the end of the race, the number of laps completed by each athlete and the number of meters remaining in the lap that was not completed are recorded (the field or track is divided into sections of equal length, with a mark every 20 meters. A referee can be placed at each mark to facilitate recording. At the end of the race, the number of laps completed by each athlete and the number of meters in excess of the laps will be calculated).
- The total distance is calculated as follows:
Total Distance = (Number of Laps x Lap Distance) + Number of meters of the last lap not completed.
- Maximum oxygen consumption can be calculated as follows:
$$VO_2 \text{ Max} = (\text{Total Distance} - 505) \div 45$$

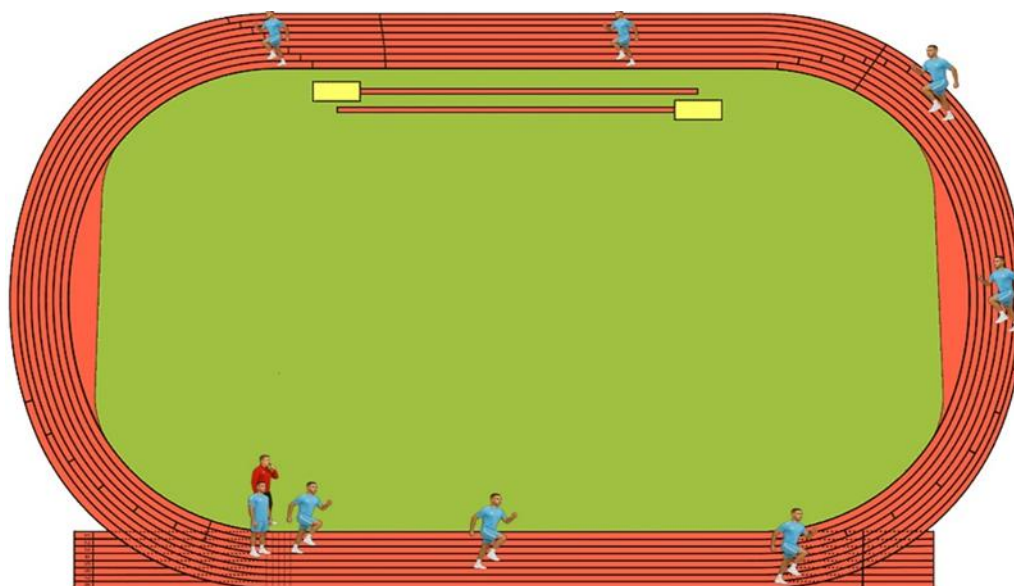


Figure 1. show Maximum Oxygen Consumption Test (VO₂max)

Speed Endurance Test (Faeq Abdul-Ilah Karim. 2024):

Test Name: Running with a Ball for a Distance of (5 x 30) m Without Stopping.

Objective of the Test: To Measure Speed Endurance in Football.

Equipment Used:

- Stopwatch - (2) Indicators
- Football - Measuring Tape - Whistle.

Performance Description:

From a high starting position, the player stands behind the starting line with the ball on the starting line. At the start signal, the player runs with the ball at maximum speed for a distance of (30) m to the finish line, circles around the finish line indicator, and returns with the ball, repeating the test (5) times continuously.

Test Instructions:

A distance of (30) m is determined, with the start and finish lines marked by two indicators, as shown in Figure (2). The player performs only one attempt.

Recording Method:

The time taken for the round trip is calculated five times and recorded to the nearest second.



Figure 2. show the speed endurance test.

Strength endurance test (Mushtaq Salal Abdul. 2023)

Test name: Vertical jump from a squat position (with fully bent knees) for (30) seconds.

Test objective: To measure the strength endurance of the leg muscles.

Equipment used:

- Stopwatch.
- Whistle.

Performance description:

When starting from a squat position, the tester stands tall, extending the knees and leaving the ground with each jump. The player continues jumping for (30) seconds, as shown in Figure (4) below.

Test instructions:

Jump upward with the arms extended at abdominal level, ensuring the knees are fully bent in the squat position. Each tester is given an attempt.

Recording method: The number of times the tester jumps within (30) seconds is recorded.



Figure 3. shows the strength endurance test

Image illustrating the strength endurance test

Performance endurance test (Faeq Abdul-Ilah Karim. 2024):

Test name: Zigzag running with the ball, ending with a goal (twice, from the left and right side of the field).

Test objective: To measure performance endurance.

Equipment used:

- Stopwatch - (19) markers.
- Measuring tape - Whistle.

Performance description:

As shown in Figure (5), two rows of markers are set up in the center of the football field. A number of distances (9) are marked within the rectangular rows. The player kicks the ball with his foot and passes through the markers at a distance of (5) meters.

- The second distance is (15) meters. The player runs with the ball, passing through the markers in a zigzag pattern, and the running distance is (20) meters. After passing the

last marker, the player guides the ball to the center circle with the inside of his foot. If he fails, he must guide the ball again. If the second pass fails, the test must be repeated. After the ball reaches the center circle, the player starts running with the ball. He rushes from the center of the center circle to the seven goal posts lined up in a row and passes between the goal posts in a zigzag pattern.

- The player passes the last goal post on the right side of the penalty area line and aims at the goal. He then runs straight to the ball in the right corner of the penalty area, rolls the ball back to the nearest goal post, and shoots with his left foot after the ball passes the goal post. He then runs to the other left corner of the penalty area, rolls the ball back in the same way, and shoots with his right foot. After the shot, he runs to the last ball on the penalty spot and scores. Once the ball crosses the goal line, the player signals the end of the test. At this point, a stopwatch is used to time the run..

Test Instructions:

- All shots must pass through the goal, and touching the crossbar or post does not count as a goal.
- If a player fails, the ball on the side must be used.
- Consecutive failures require each test to be repeated on the designated obstacle course.
- The test is conducted sequentially on the first and second rows, and the time for both tests is calculated.

Scoring Method:

- The time is calculated to the nearest (1/100) of a second from the start until the ball crosses the goal.
- The test is conducted sequentially on the first and second rows, and the time for both tests is calculated.
- Each player is given one attempt.

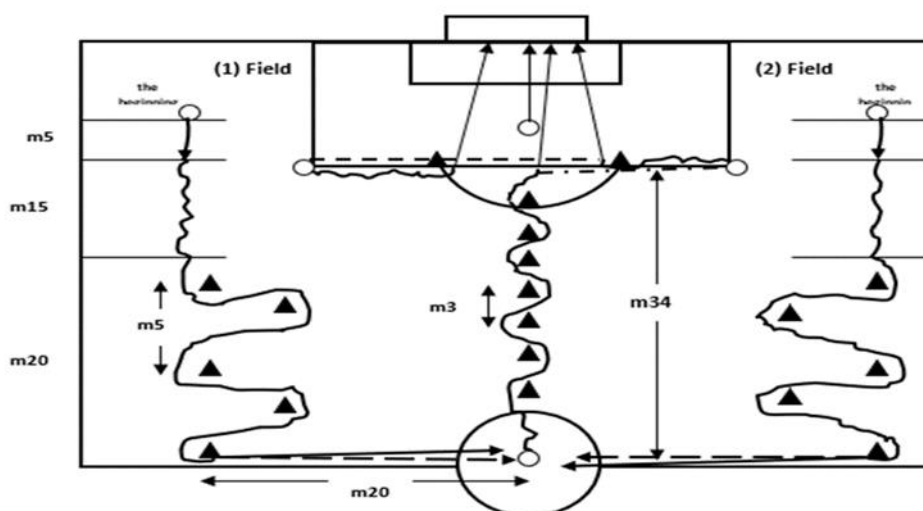


Figure 4. shows the performance endurance test

Pre-tests:

The researchers conducted the pretest for the research sample on Friday, February 28, 2025, at 5:00 PM, at the Karbala International Secondary Club Stadium.

Equivalence of the two research groups:

To establish a single starting point for the two research groups, the researchers worked to establish equivalence in the studied variables, using the results of the pretests and applying the statistical law (t-test) for independent samples, as shown in Table (2).

Table 2. shows the equivalence of the control and experimental groups for all research variables

No	Search variables	Unit of measurement	Control group		Experimental group		T value calculated	Level Sig	Type Sig
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
1	Vo2max	Millimeter	40.59	0.63	40.72	0.65	0.44	0.66	Non sig
2	Speed endurance	Second	46.67	4.27	45.60	5.27	0.49	0.62	Non sig
3	Power endurance	Second	24.30	0.94	24.60	1.07	0.66	0.51	Non sig
4	Performance endurance	Second	1.43	0.07	1.41	0.06	0.60	0.55	Non sig

From Table 2, we can see that the significance value (sig) for all research variables is greater than (0.05). Therefore, we are about to accept the null hypothesis, which states that there is no difference between the scores of the control and experimental groups, and that the differences are not significant, indicating the equivalence of the two research groups.

Application of the Varied Fartlek Exercises to the Research Sample:

- The time period for implementing the research exercises is (10) weeks.
- The number of units per week is (3) units.
- The total number of units is (30) training units.
- The exercise time in each unit is (28-40) minutes.
- The number of exercises in each training unit is (2-3) exercises.
- The exercises were implemented on Sunday, March 2, 2025, at the beginning of the main section of the training units, halfway through the general preparation period and until the end of the special preparation period.

Post-tests

After completing the exercises, the researchers conducted the post-tests on the research sample on Friday, May 9, 2025, at 5:00 PM, at the Karbala International Secondary Stadium. The study followed the same conditions and procedures as the pre-tests, as much as possible. The researchers used the same procedures as the pre-tests.

Statistical Methods:

The researchers used the SPSS statistical program and utilized the following statistical methods:

- Arithmetic mean
- Standard deviation
- Levene's test
- Independent samples t-test
- Correlated samples t-test

Result and Discussion

Presentation and Analysis of the Research Test Results (Pre- and Post-test) for the Experimental Group

To identify the differences between the pre- and post-tests of the research variables for the experimental group, the researchers used the t-test for matched samples, as shown in Table (3).

Table 3. the differences between the pre- and post-tests of the research variables for the experimental group

No	Search variables	Unit of measurement	Pre-test		Post-test		T value calculated	Level Sig	Type Sig
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
1	Vo2max	ml/kg/d	40.72	0.65	42.68	0.75	9.93	0.01	Sig
2	Speed endurance	Secondly	45.60	5.27	40.99	2.64	5.03	0.00	Sig
3	Power endurance	Secondly	24.60	1.07	26.40	0.69	6.19	0.00	Sig
4	Performance endurance	Secondly	1.41	0.06	1.21	0.11	5.51	0.00	Sig

From Table (3), we can observe that the statistical indicators for the pre- and post-test results for the studied research variables and for the experimental group indicated significant differences between the pre- and post-tests, in favor of the post-test for the experimental group. This is confirmed by the significance value (sig) shown in Table (3), which was less than the significance level of (0.05). Therefore, we accept the alternative hypothesis, which states that there are significant differences between the pre- and post-test scores, in favor of the post-test.

Presentation and Analysis of the Research Test Results (Pre-Post) for the Control Group

To verify the research hypothesis, the researcher analyzed the pre- and post-test data using the t-test for correlated samples. Table (4) shows the significance of the differences between the pre- and post-tests for the control group on the two studied research variables.

Table 4. the significance of the differences between the pre- and post-tests for the control group on the two studied research variables

No	Search variables	Unit of measurement	Pre-test		Post-test		T value calculated	Level Sig	Type Sig
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
1	Vo2max	Millimeter	40.59	0.63	41.00	0.71	3.50	0.07	Sig
2	Speed endurance	Secondly	46.67	4.27	46.48	4.37	1.50	0.16	Non sig
3	Power endurance	Secondly	24.30	0.94	25.20	0.91	2.86	0.01	Sig
4	Performance endurance	Secondly	1.43	0.07	1.42	0.17	0.23	0.81	Non.sig

From Table (4), we can observe that the statistical indicators for the pre- and post-test results, the research variables, and the control group indicated significant differences between the pre- and post-tests, in favor of the post-test for the control group. This is confirmed by the significance value (sig) shown in Table (4), which was less than the significance level of (0.05). Therefore, we accept the alternative hypothesis, which states that there is a difference between the scores of the pre- and post-tests, in favor of the post-test.

Presentation and Analysis of the Results of the (Post-) Tests between the Experimental and Control Groups

Table 5. shows the arithmetic means, standard deviations, calculated t-value, and significance level between the post-test for the control and experimental groups

No	Search Variables	Unit of measurement	control group		experimental group		T value calculated	Level Sig	Type Sig
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
1	Vo2max	Millimeter	41.00	0.71	42.68	0.75	5.12	0.00	Sig
2	Speed Endurance	Secondly	46.48	4.37	40.99	2.64	3.39	0.00	Sig
3	Power Endurance	Secondly	25.20	0.91	26.40	0.69	3.28	0.00	Sig
4	Performance Endurance	Secondly	1.42	0.17	1.21	0.11	3.07	0.00	Sig

From Table (5), we note that the statistical indicators for the post-test results for the research variables and for both the experimental and control groups indicated significant differences between the post-tests in favor of the experimental group. This is confirmed by the (sig) value shown in Table (5), which was less than the significance level (0.05).

Therefore, we accept the alternative hypothesis, which states that there are significant differences between the post-test scores in favor of the experimental group. To determine the true nature of the differences, we must refer to the values of the arithmetic means for the experimental group for the studied research variable, as the values of the arithmetic means for the experimental group were better than the post-measurement means for the control group. As for the speed variable, the results indicated that there were no differences between the two groups. This is confirmed by the (sig) value shown in Table (5), which was greater than the significance level (0.05). Therefore, we accept the null hypothesis, which states that there are no differences between the two groups.

Discussion of the Results

The results of Table (3) reveal statistically significant differences between the pre- and post-measurements, in favor of the post-measurement. This supports the hypothesis adopted by the study regarding the effectiveness of varied fartlek exercises. The results showed that these exercises had a positive and direct impact on developing the physiological variables under study, particularly those related to the $VO_2\text{max}$ index and specific endurance capabilities. These improvements were clearly reflected in the experimental group compared to the control group, enhancing the credibility of the training program used. According to data analysis using a paired-samples t-test, and adopting a significance level of ($\text{Sig} \leq 0.05$), varied fartlek exercises contributed effectively to creating significant differences indicating a noticeable improvement in the physical abilities studied among young football players. $VO_2\text{max}$ (ml/kg/min):

Table (3) shows that the arithmetic mean for the pre-test was 40.72, with a standard deviation of 0.65, while it increased to 42.68 for the post-test, with a standard deviation of 0.75. The calculated t-value was 9.93, with a significant significance ($\text{Sig} = 0.01$), which is statistically significant.

This improvement in the $VO_2\text{max}$ confirms the effectiveness of varied fartlek exercises in developing the efficiency of the cardiovascular system and increasing the maximum aerobic capacity of the players. This is consistent with what many researchers have indicated (Midgley et al., 2020; Buchheit & Laursen, 2019), which states that varied interval training improves oxygen consumption by stimulating the heart muscle and increasing the ability to extract oxygen from the working muscles. This development is positively reflected in overall performance in football, which requires continuous and variable-intensity effort.

Speed Endurance (seconds):

The average performance decreased from 45.60 seconds in the pre-test to 40.99 seconds in the post-test, with a t-value of 5.03 and a significant significance ($\text{Sig} = 0.00$), indicating a significant difference in favor of the post-test. This improvement is attributed to the physiological effect of the varied fartlek technique, which combines high and low effort, stimulating the anaerobic and aerobic systems simultaneously and increasing the player's ability to maintain performance speed for longer periods. This is consistent with

what (Iaia & Bangsbo ,2017) stated about the importance of variable intensity exercises in improving speed endurance in team sports players.

Strength Endurance (seconds):

This variable showed an increase in the arithmetic mean from 24.60 to 26.40, and a calculated t-value of 6.19 at a significance level (Sig = 0.00), indicating a significant difference in favor of the post-test.

This improvement indicates the positive effect of the fartlek method in developing the ability to perform muscular effort for extended periods, especially in repetitive movements such as sprinting, physical contact, and lunges, which require the simultaneous integration of endurance and strength. The research results support Reilly et al.'s (2018) suggestion that fartlek exercises help develop strength endurance due to their gradual and variable nature.

Performance Endurance (seconds):

The mean performance endurance decreased from 1.41 seconds to 1.21 seconds, with a t-value of 5.51 and significant significance (Sig = 0.00). Despite the apparent small numerical difference, the statistical significance indicates an improvement in player efficiency when performing under physical pressure and fatigue.

This indicator is one of the most important indicators of specific endurance associated with the effectiveness of skill and tactical performance under match conditions, as it demonstrates a player's ability to maintain motor performance efficiency despite fatigue. This supports (Bishop et al. ,2021) assertion that fartlek training improves skill endurance in team sports players by improving energy efficiency and performance recovery.

The researchers concluded that varied fartlek exercises had a significant and positive effect on developing VO₂max, speed endurance, strength endurance, and performance endurance in young football players. These improvements are attributed to the variety in intensity, duration, and rest within the training sessions, which helped stimulate multiple physiological systems and enhance the efficiency of physical and skill performance. Table (4) shows the results of the analysis of the differences between the pre- and post-measurements of the control group sample, which was not exposed to a training intervention using various fartlek exercises, which clearly shows the nature of the development or stability of performance as a result of the traditional program followed.

Vo₂max (ml/kg/min):

The control group recorded a slight improvement in mean Vo₂max, increasing from 40.59 to 41.00 ml/kg/min, with a small standard deviation. However, the calculated t-value was 3.50 at a significance level of 0.07, and was not statistically significant at a Sig ≤ 0.05, indicating that this improvement is not attributable to the training program, but may be the result of random or natural factors such as limited body adaptation. This highlights the importance of using modern training methods such as the varied fartlek method to

stimulate real improvements in VO₂max efficiency, as indicated by (Buchheit, M., & Laursen, P. B., 2019).

Speed Endurance (seconds):

The results showed convergence in performance between the pre- and post-test measurements, with the mean time decreasing from 46.67 to 46.48 seconds. However, the t-value (1.50) at a significance level of 0.16 was not statistically significant, confirming the lack of a real effect of the traditional program on developing this variable. This is consistent with (Iaia, F. M., & Bangsbo, J. 2017). stating that speed endurance requires complex training components based on irregular intervals and variable intensity, which is lacking in classical training.

Strength Endurance (seconds):

This is the only variable that showed statistically significant differences in the performance of the control group, with the mean increasing from 24.30 to 25.20 seconds, with a t-value (2.86) at a significance level of 0.01. This improvement is likely due to muscle habituation to the training pattern. However, despite its statistical significance, its effect remains limited compared to what can be achieved through more varied and intense methods, such as those provided by the varied fartlek method (Reilly, T., Morris, T., & Whyte, G., 2018).

Performance Endurance (seconds):

The results for this variable did not show any significant differences, as the average remained approximately constant (1.43 to 1.42 seconds), with a t-value (0.23) and a high significance level (0.81), reflecting the lack of qualitative improvement in the overall performance efficiency of the group. This indicates the need to employ training modules that simulate real-world match situations in terms of changes in tempo and physical pressure, which are essential characteristics of fartlek exercises (Midgley, A. W., McNaughton, L. R., & Wilkinson, M. 2020).

The researchers concluded that the traditional program used with the control group was insufficient to produce significant changes in most of the physiological variables under investigation, with the exception of strength endurance. This enhances the effectiveness of applying modern training methods such as varied fartlek exercises, which rely on diversity in intensity, distance, and time, achieving greater stimulation of the circulatory and respiratory systems and developing general and specific physical endurance capabilities more effectively, as indicated by both (Bishop et al. 2021) and (Laursen & Buchheit, 2019)

The results of Table (5) show that there are statistically significant differences at the level of (Sig ≤ 0.05) in all studied variables: VO₂max, speed endurance, strength endurance, and performance endurance. These differences favored the experimental group that underwent a fartlek-style training program, compared to the control group that continued with traditional training.

VO₂ max (maximum oxygen consumption index):

The results of the experimental group showed a clear improvement in the average VO₂ max (42.68 ml/kg/min) compared to the control group (41.00 ml/kg/min), with a value of ($t = 5.12$, $Sig = 0.00$), indicating the effectiveness of fartlek-style training in developing the cardiorespiratory efficiency and aerobic capacity of the players. This result is consistent with what (Buchheit, M., & Laursen, P. B. 2019). indicated, that programs with varying intensity and content, such as fartleks, significantly stimulate the cardiorespiratory system and effectively improve VO₂ max.

Speed Endurance:

The experimental group's performance improved significantly in the speed endurance test (40.99 seconds) compared to the control group (46.48 seconds), with a value of ($t = 3.39$, $Sig = 0.00$). This effect reflects the ability of fartlek exercises, which combine high effort and active rest, to effectively improve performance recovery after intense exertion. This is supported by (Iaia, F. M., & Bangsbo, J. 2017) in their study on the effect of repeated speed and endurance training on enhancing physical performance related to offensive and defensive situations in football. Strength Endurance: The experimental group recorded higher strength endurance (26.40 seconds) compared to the control group (25.20 seconds), with a t-value of 3.28, $Sig = 0.00$, indicating that the applied exercises not only enhanced the aerobic aspect but also developed the ability to resist muscular fatigue for longer periods. This is consistent with the findings of (Iaia, F. M., & Bangsbo, J. ,2017). who emphasized the importance of varying high-intensity exercises to stimulate muscular and neural adaptations associated with endurance.

Strength Endurance:

The experimental group recorded higher strength endurance (26.40 seconds) compared to the control group (25.20 seconds), with a $t = 3.28$, $Sig = 0.00$, indicating that the applied exercises not only enhanced aerobic performance but also developed the ability to resist muscular fatigue for longer periods. This is consistent with the findings of (Bishop, D. J., Girard, O., & Mendez-Villanueva, A. 2021). who emphasized the importance of varying high-intensity exercises to stimulate muscular and neural adaptations associated with endurance.

Performance Endurance:

The average performance endurance was in favor of the experimental group (1.21 seconds) compared to the control group (1.42 seconds), with a $t = 3.07$, $Sig = 0.00$. This reflects the development of the ability to maintain a constant level of physical performance over long periods of the match without deterioration in efficiency, a key goal in developing specific fitness in young football players, as highlighted by (Bishop, D. J., Girard, O., & Mendez-Villanueva, A. 2021). in their review of the importance of training individualization based on the real-world demands of the game. The researchers concluded that all statistical values in the table indicate a clear superiority for the experimental group that received

variable fartlek training. This confirms the research hypothesis that this training method has a positive and effective impact on improving the physiological variables and endurance capabilities associated with the performance of young football players. This effect is due to the aerobic and anaerobic adaptations brought about by varying the intensity, time load, and movement within fartlek training, which mimics the nature of variable performance in football matches.

Conclusion

- Varied fartlek training has clearly proven effective in improving the VO_2 max index in young football players, indicating increased cardiorespiratory efficiency and aerobic capacity as a result of the gradual and varied intensity.
- The applied exercises led to a significant improvement in specific endurance capabilities (speed endurance, strength, and performance), reflecting the compatibility of the training program with the motor performance requirements of football matches. 3. The experimental group outperformed the control group in all physical and physiological variables studied, supporting the adoption of fartlek exercises as a scientific training approach for developing age-group football players.

Recommendations:

- Incorporate varied fartlek exercises into the core training modules for preparing young football players, given their demonstrated positive effect in improving aerobic indicators and specific physical abilities.
- Design training programs that include a variety of intensity and movement rhythm (such as the fartlek method), in line with the requirements of real-world game situations and providing the necessary physiological stimulation for development.
- Conduct future research that utilizes varied fartlek exercises to develop other abilities, such as agility, balance, or mental abilities during play, to further comprehensively evaluate the impact of this training method.

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