

The effectiveness of modern training styles (Tabata, Fartlek, & Slopes) in developing some physical variables and physiological indicators among young football players"

فاعلية الأساليب التدريبية الحديثة (التاباتا، الفارتلك، والمنحدرات) في تطوير بعض المتغيرات البدنية والمؤشرات الفسيولوجية لدى ناشئي كرة القدم

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Abstract: This study aimed to examine the effectiveness of modern training methods (Tabata, Fartlek, and Slopes training) in developing selected physical and physiological variables among youth soccer players. The researcher employed an experimental approach using pre- and post-tests on a purposive sample of (24) players, divided into three groups according to the training method, over eight weeks with three sessions per week. Tests included assessments of speed, agility, muscular power, endurance, vital capacity, and maximal oxygen consumption ($VO_2 \text{ max}$). Results revealed statistically significant improvements ($\alpha \leq 0.05$) in most physical and physiological variables across all groups, with the Tabata method showing superiority in developing muscular strength and explosive power, Fartlek training demonstrating greater effectiveness in improving cardiorespiratory endurance, and Slopes training excelling in enhancing speed and speed endurance. The study recommends that coaches diversify training methods and integrate them into training programs to achieve comprehensive physical and physiological development in youth soccer players.

Keywords: Effectiveness of Tabata ; Fartlek ; Slopes Training ; Physical Variables ; Physiological Indicators, Youth Soccer Players.

المخلص : هدفت الدراسة التعرف إلى فاعلية الأساليب التدريبية الحديثة (التاباتا، الفارتلك، والمنحدرات) في تطوير بعض المتغيرات البدنية والمؤشرات الفسيولوجية لدى ناشئي كرة القدم ، اعتمد الباحث المنهج التجريبي باستخدام القياسين القبلي والبعدي على عينة قصدية مكونة من (24) لاعباً، جرى تقسيمهم إلى ثلاث مجموعات وفقاً لأسلوب التدريب المستخدم، واستمر البرنامج لمدة ثمانية أسابيع بواقع ثلاث وحدات تدريبية أسبوعياً. تضمنت الاختبارات قياس

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السرعة، والرشاقة، والقوة العضلية، والتحمل، والسعة الحيوية، واستهلاك الأكسجين الأقصى ($VO_2 \max$). أظهرت النتائج وجود فروق دالة إحصائية ($\alpha \leq 0.05$) في معظم المتغيرات البدنية والفسيولوجية بين القياسين القبلي والبعدي لصالح القياس البعدي في جميع المجموعات، حيث تبين أن أسلوب تدريب التاباتا تفوق في تنمية القوة العضلية والانفجارية، بينما كان تدريب الفارتلك أكثر فاعلية في تحسين التحمل الدوري التنفسي، في حين تميّز تدريب المرتفعات في تطوير السرعة وتحمل السرعة. وأوصت الدراسة بضرورة تنوع المدربين في استخدام الأساليب التدريبية الحديثة ودمجها ضمن البرامج التدريبية لتحقيق تنمية شاملة للقدرات البدنية والفسيولوجية لدى ناشئي كرة القدم. الكلمات المفتاحية: فاعلية التاباتا، الفارتلك، تدريبات المرتفعات، المتغيرات البدنية، المؤشرات الفسيولوجية، ناشئو كرة القدم.

Introduction:

The physical and physiological requirements in soccer are key determinants of players' success and performance during matches. A soccer player must possess a balanced level of physical fitness, vitality, and alertness to sustain performance throughout the game without signs of fatigue (Al-Nemri, 2013). Soccer is considered an intermittent sport characterized by alternating periods of effort and rest of varying intensity over 90 minutes. This highlights the importance of physical capacities associated with both the aerobic and anaerobic energy systems. A soccer player performs approximately (1,000-1,400) short activities during a match, including sudden sprints, high-intensity runs, tackling, heading, passing, changing direction, and various running intensities (fast, moderate, and light). Such activities demand high efficiency in physical abilities related to the anaerobic system, such as strength, speed, speed-strength, explosive power, strength endurance, and speed endurance, as well as the aerobic system, particularly cardiorespiratory endurance represented by maximal oxygen consumption ($VO_2 \max$).

Thomas et al.(2005) in their review of studies on soccer players, reported that players cover between (9.1-13.8) kilometers during a (90) minute match, which

requires a high level of cardiorespiratory efficiency reflected in VO_2 max. Similarly, (Metaxas & Thomas, 2021) emphasized that elite soccer players must possess a VO_2 max of at least (60)ml/kg/min to perform optimally, indicating the importance of an efficient cardiovascular system for oxygen delivery and muscular efficiency in oxygen utilization.

The three training methods Tabata, slopes, and Fartlek, are considered essential tools for enhancing soccer players' performance, as they improve speed, endurance, and strength, thereby enabling players to achieve higher levels of performance during matches. (Tabata et al., 1996) emphasized the importance of Tabata training, noting that it enhances cardiorespiratory fitness, increases both aerobic and anaerobic capacity, and improves physical performance in competition. Similarly, (Sukri et al., 2024) found that a 12-week Tabata training program significantly improved health-related physical fitness components among healthy, untrained students. Moreover, (Seema et al., 2024) demonstrated that Tabata training enhances cardiorespiratory fitness and muscular endurance among recreational male volleyball players.

Billat (2001) highlighted the value of Fartlek training, asserting that it improves cardiovascular endurance, responsiveness, and performance in situations requiring frequent speed changes. This finding is supported by (Bashir & Hajam, 2017), who reported that Fartlek training produced significant improvements in speed and speed endurance among physical education students at Annamalai University.

In addition, Midgley et al.(2007) indicated that Slopes training contributes substantially to reducing the risk of injuries by strengthening muscles and joints. Similarly, (Salameh et al., 2021) confirmed that slopes training effectively

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enhances physical abilities related to speed, agility, strength endurance, and speed endurance, as well as improving pulmonary volume parameters (TV, IRV, MVV) and VO_2 max among soccer players. Furthermore, (Omar, 2024) demonstrated that treadmill training with incremental incline angles improved digital performance levels among short-distance runners (100, 200, 400 m) representing the Palestine Technical University-Kadoorie athletics team.

The researcher hopes that the findings of this study will provide valuable insights for coaches and practitioners in the field of sports training to enhance the performance of athletes and help them reach elite competitive levels.

Problematic of the study:

Developing physical abilities and physiological indicators is a fundamental factor in enhancing the performance of soccer players, particularly youth players who require effective training methods to improve their physical and functional efficiency. With the continuous advancement in sports training, several modern training methods have emerged that aim to optimize physical performance and strengthen physiological indicators, most notably Tabata, Fartlek, and Slopes training, which have demonstrated effectiveness in various sports studies.

However, there remains a pressing need to verify the effectiveness of these training methods in developing key physical variables such as muscular strength, explosive power, speed-strength, and strength endurance, as well as in improving physiological indicators such as vital capacity (VC) and maximal oxygen consumption (VO_2 max) among youth soccer players.

Accordingly, the problem of this study is to identify the effectiveness of modern training methods (Tabata, Fartlek, and Slopes training) in developing selected physical variables and physiological indicators among youth soccer players.

Study Questions:

The present study sought to answer the following research questions:

1. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Tabata training group?
2. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Fartlek training group?
3. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Slopes training group?
4. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) in the post-test results of selected physical variables and physiological indicators among youth soccer players attributable to the training method used?

Study Objectives:

The present study aimed to:

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- Identify the differences in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Tabata training group.
- Identify the differences in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Fartlek training group.
- Identify the differences in the development of selected physical variables and physiological indicators among youth soccer players between the pre- and post-tests of the Slopes training group.
- Examine the post-test differences in selected physical variables and physiological indicators among youth soccer players attributable to the training method.

Method and Procedures

Study Methodology:

The researcher used the experimental approach with a single group and repeated measurements due to its suitability for the purposes of the study.

Study Population:

The study population consisted of youth soccer players from Faroun Sports Club and Al-Thaqafi Sports Club in Tulkarm district, West Bank- Palestine, totaling (60) players for the year 2025.

Study Sample:

The current study was conducted on a purposive sample of (24) players, divided into three groups: one trained using the Tabata method, another using the Fartlek method, and the third using the Slopes training method, with (8) players in each group. Thus, the study sample represented (40%) of the study population.

Table 1: presents the characteristics and homogeneity of the study sample.

Variables	Unit of Measurement	Mean	Standard Deviation
Age	Years	15.16	0.86
Body Mass	kg	64.64	7.88
Height	cm	168.70	5.11

It is evident from Table (1) that the skewness coefficient values fall within (± 3), indicating that the study sample follows a normal distribution.

Participants were randomly assigned to one of the three training groups using modern training methods. To ensure equivalence among the three groups in terms of age, body mass, height, and pre-test measurements of the study variables, a one-way ANOVA was used. The results are shown in Tables (2, 3).

Table 2: Means and Standard Deviations of Age, Body Mass, Height, and Study Variables According to the Training Method (n=24)

Dependent Variables	Measurement	Unit	Training Method	N	Mean*	Standard Deviation
Age	Years		Tabata	8	15.63	0.74
			Fartlek	8	14.75	0.88
			Slopes Training	8	15.13	0.83
Body Mass		kg	Tabata	8	63.75	2.82

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			Fartlek	8	67.94	5.42
			Slopes Training	8	62.25	5.35
Height		cm	Tabata	8	168.88	10.09
			Fartlek	8	169.50	5.52
			Slopes Training	8	167.75	8.36
Physical Variables	30-m Sprint	Seconds	Tabata	8	4.29	0.14
			Fartlek	8	4.38	0.28
			Slopes Training	8	4.28	0.13
	30-m × 5 Repeated Sprints	Seconds	Tabata	8	30.55	1.22
			Fartlek	8	29.99	1.75
			Slopes Training	8	29.75	1.74
	Vertical Jump	cm	Tabata	8	38.50	1.51
			Fartlek	8	34.63	1.68
			Slopes Training	8	37.63	2.26
	Push-ups (15 sec)	Repetitions	Tabata	8	12.75	1.98
			Fartlek	8	13.13	2.16
			Slopes Training	8	14.63	1.76
	Sit-ups (30 sec)	Repetitions	Tabata	8	22.25	2.91
			Fartlek	8	22.63	3.92
			Slopes Training	8	24.63	3.85
Physiological Indicators	VC	L/min	Tabata	8	3.64	0.12
			Fartlek	8	3.78	0.27
			Slopes Training	8	3.60	0.22
	VO ₂ max	L/min	Tabata	8	41.24	1.94
			Fartlek	8	42.92	1.88
			Slopes Training	8	43.14	1.53

Table 3: Results of the one-way ANOVA test indicating the significance of differences in the pre-test measurements of age, body mass, height, and the study variables according to the training method (N = 24).

Dependent Variables	Measurement	Source of Variance	Sum of Squares	df	Mean Square	F- Value	Sig. Level*
	Age	Between Groups	3.083	2	1.542	2.272	.128
		Within Groups	14.250	21	0.679		
		Total	17.333	23			
	Height	Between Groups	12.583	2	6.292	.093	.911
		Within Groups	1416.375	21	67.446		
		Total	1428.958	23			
	Body Mass	Between Groups	139.021	2	69.510	3.151	.064
		Within Groups	463.219	21	22.058		
		Total	602.240	23			
Physical Variables	30-m Sprint	Between Groups	0.043	2	0.022	.555	.582
		Within Groups	0.815	21	0.039		
		Total	0.858	23			
	30-m × 5 Repeated Sprints	Between Groups	2.670	2	1.335	.526	.599
		Within Groups	53.337	21	2.540		
		Total	56.007	23			
	Vertical Jump	Between Groups	66.083	2	33.042	1.671	.110
		Within Groups	71.750	21	3.417		
		Total	137.833	23			
	Push-ups (15 sec)	Between Groups	15.750	2	7.875	2.011	.159
		Within Groups	82.250	21	3.917		
		Total	98.000	23			
	Sit-ups (30 sec)	Between	26.083	2	13.042	1.010	.381

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Physiological Indicators	VC	Groups					
		Within Groups	271.250	21	12.917		
		Total	297.333	23			
	VO ₂ max	Between Groups	0.141	2	0.070	1.483	.250
		Within Groups	0.996	21	0.047		
		Total	1.137	23			
		Between Groups	17.367	2	8.684	2.691	.091
		Within Groups	67.762	21	3.227		
		Total	85.129	23			

*Statistically significant at the level ($\alpha \leq 0.05$)

It is evident from Table (3) that there are no statistically significant differences at the significance level ($\alpha \leq 0.05$) in the pre-test measurements of age, body mass, height, and the study variables according to the training method. This indicates that the three groups were equivalent before implementing the proposed training program.

Study Instruments

Validity and Reliability:

Physiological tests are considered relative measurements, meaning they possess a high degree of validity and reliability. To ensure the validity and reliability of the physical tests, the researcher used intrinsic validity and test–retest reliability. The tests were administered and then re-administered after four days to a pilot sample consisting of five junior football players from the study population but outside the main study sample. The Pearson correlation coefficient was used to determine the relationship between the two applications. Table (4) presents the

values of the Pearson correlation coefficients that indicate the reliability and intrinsic validity of the physical tests applied to the pilot sample.

Table 4: Results of Pearson correlation coefficients for determining the reliability and intrinsic validity of the physical tests on the pilot sample (N = 5).

Variables	Unit of Measurement	First Test (Mean)	First Test (SD)	Second Test (Mean)	Second Test (SD)	r Value*	Self-Validity
30-m Sprint	Seconds	4.2800	0.16386	4.1920	0.18539	0.963	0.927
30-m × 5 Repeated Sprints	Seconds	30.07	2.07	29.78	2.01	0.965	0.931
Vertical Jump	cm	37.00	2.54	38.00	3.60	0.952	0.906
Push-ups (15 sec)	Repetitions	15.60	1.34	15.20	1.30	0.915	0.837
Sit-ups (30 sec)	Repetitions	26.40	2.70	27.00	3.31	0.976	0.952

*Statistically significant at the level ($\alpha \leq 0.01$)

It is evident from Table (3) that the physical tests under investigation demonstrate a high degree of validity, as the intrinsic validity values ranged between (0.837 – 0.952), indicating the appropriateness of these tests for measuring the intended variables.

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Regarding reliability, the results revealed a statistically significant correlation at the significance level ($\alpha \leq 0.05$) between the first and second test administrations of the physical tests under study, with Pearson correlation coefficients ranging from (0.915 – 0.976). These findings confirm that the physical tests used in the study are both reliable and valid for achieving the study's objectives.

Instruments and Equipment

- Data collection form.
- Timing gates for measuring players' sprint speed.
- Electronic spirometer for measuring vital capacity (VC); the researcher used an American-made AstraTouch Electronic Spirometer.
- Electronic stopwatch accurate to 1/100 of a second (Diamond brand).
- Athletics track.
- Measuring tape (Kraker type, 50 meters).
- Standard meter tape.
- Fitness mat.
- Plastic poles, cones, and a whistle.

Physical and Physiological Tests Used

- 30-meter sprint test to measure maximum speed.
- 30-5 × meter sprint test to measure speed endurance.

- Vertical jump test to measure explosive power.
- 15-second push-up test to measure speed strength.
- Sit-ups (30 seconds) test to measure muscular endurance.
- Yo-Yo test, Level 1, to estimate maximum oxygen consumption ($\text{VO}_2 \text{ max}$).
- Measurement of vital capacity (VC).
- Measurement of maximum oxygen consumption ($\text{VO}_2 \text{ max}$).

Training Program

Based on a review of relevant literature, scientific references, previous studies, and his own experience in the field of training, as well as consultations with football experts and specialists, the researcher designed three training programs.

The first program employed the Tabata training method, the second used the Fartlek training method, and the third utilized Slopes training. Each program was implemented with a separate training group, so that each group trained using one of the three methods. The following are the details of the three training programs:

Tabata Training Method

- Duration: 8 weeks
- Frequency: 3 days per week
- Training session length: 20–30 minutes (excluding warm-up)

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- Exercise format: 20 seconds of exercise / 10 seconds of rest × 8 rounds (4 minutes per set)
- Number of sets: 4–6 sets per exercise

Fartlek Training Method

- Duration: 8 weeks
- Objective: To improve endurance, cardiorespiratory fitness, speed, and fat metabolism through irregular alternation between fast and slow running.
- Frequency: 3 days per week
- Exercise duration: 30–60 minutes (excluding warm-up)
- Equipment: None required; exercises can be performed on a track, open roads, or a treadmill.

Slopes Training Method

- Duration: 8 weeks
- Frequency: 3 days per week
- Exercise duration: 30–45 minutes (excluding warm-up)
- Required equipment: A natural Slopes or incline.

Study Variables

A. **Independent Variables:** The three training methods (Tabata, Fartlek, and Slopes training).

B. **Dependent Variables:** The physical tests and selected physiological indicators: 30-meter sprint, 30 × 5-meter sprint, vertical jump, 15-second push-ups, 30-second sit-ups, vital capacity (VC), and maximum oxygen consumption ($\text{VO}_2 \text{ max}$).

Statistical Treatments:

The data were processed using the SPSS statistical software package through the following statistical procedures:

- Means, standard deviations, and skewness coefficients to verify the normal distribution of the study sample; one-way analysis of variance (ANOVA) to test differences in pre-measurements among the three groups (Tabata, Fartlek, and Slopes training) and to ensure group equivalence.
- Means, standard deviations, and paired-samples t-test to determine differences between pre- and post-tests and to calculate the percentage of change, addressing the first, second, and third research questions.
- One-way ANOVA to identify post-test differences among the three groups, with the LSD test applied where necessary to answer the third research question.

Presentation and Discussion of Study Results:

First: Results related to the first research question, which states: Are there statistically significant differences at the significance level ($\alpha \leq 0.05$) in the

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Dependent Variables	Variable Levels	Unit of Measurement	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	(t) Value	Significance Level*	Improvement (%)
Physical Variables	30 m Sprint	Sec	4.29	0.14	4.20	0.11	3.987	*0.005	-2.10
	30 m × 5 Repetitions Sprint	Sec	30.55	1.22	27.64	1.16	11.871	*0.000	-9.53
	Vertical Jump	cm	38.50	1.51	42.50	1.77	-10.583	*0.000	10.39
	Push-ups (15 sec)	Reps	12.75	1.98	14.87	1.64	-9.379	*0.000	16.63
	Sit-ups (30 sec)	Reps	22.25	2.91	25.50	1.60	-5.508	*0.001	14.61
Physiological Indicators	Vital Capacity (VC)	L/min	3.64	0.12	3.96	0.11	-7.126	*0.000	8.79
	Maximum Oxygen Uptake (VO ₂ max)	L/min	41.24	1.94	43.61	2.83	-4.057	*0.005	5.75

development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Tabata training group? To answer this question, a paired-samples t-test was employed, and the results are presented in Table 5.

Table 5: Results of the Paired samples (t) Test for the Significance of Differences in Developing Some Physical Variables and Physiological

Indicators Among Junior Football Players Between the Pre- and Post-Measurements of the Tabata Training Method Group (N = 8)

* Statistically significant at the level ($\alpha \leq 0.05$)

The results presented in Table 5 indicate the presence of statistically significant differences at the significance level ($\alpha \leq 0.05$) in the development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Tabata training group, favoring the post-test measurements. The percentage improvements for all variables were, respectively (-2.10%, -9.53%, 10.39%, 16.63%, 14.61%, 8.79%, 5.75)%. The researcher attributes this improvement to the effectiveness of Tabata training in developing the physical capacities under study.

Tabata training, characterized by performing high-intensity, rapid, and repeated exercises over short durations with brief rest periods, significantly contributes to the development of aerobic physical capacities, including cardiovascular endurance, speed endurance, and strength endurance. As noted by (Tabata, 2019), high-intensity Tabata workouts, which involve short bursts of exercise followed by brief rest periods, increase the body's oxygen demand, thereby improving cardiovascular performance, enhancing fat metabolism, promoting overall physical fitness, and improving muscular strength, flexibility, speed, reaction time, balance, and neuromuscular coordination.

In general, the results of this research question are consistent with the findings of (Abdelghani & Ahmed, 2024; Al-Rashidi, 2024; Elsharkawy et al., 2024; Kv et al., 2024; Anbalagan et al., 2024; Piralaiy et al., 2024), which demonstrated the effectiveness of Tabata training on physical capacities related to strength, speed, and endurance. Furthermore, these results align with (Paul & Banupriya, 2024),

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(Sukri et al., 2024), and (Seema et al., 2024), which reported the effectiveness of Tabata training on physiological variables related to cardiovascular and pulmonary efficiency.

Second: Results related to the second research question: which states: Are there statistically significant differences at the significance level ($\alpha \leq 0.05$) in the development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Fartlek training group? To answer this question, a paired-samples t-test was employed, and the results are presented in Table 6.

Table 6: Results of the Paired samples (t) Test for the Significance of Differences in Developing Some Physical Variables and Physiological Indicators Among Junior Football Players Between the Pre- and Post-Measurements of the Fartlek Training Method Group (n = 8)

Dependent Variables	Variable Levels	Unit of Measurement	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	(t) Value	Significance Level*	Improvement (%)
Physical Variables	30 m Sprint	Sec	4.38	0.28	4.25	0.15	2.564	*0.037	-2.97
	30 m × 5 Repetitions Sprint	Sec	29.99	1.75	27.87	1.45	6.740	**0.000	-7.07
	Vertical Jump	cm	34.63	1.68	35.87	1.35	- 3.989	**0.005	3.58
	Push-ups (15 sec)	Reps	13.13	2.16	13.87	1.55	- 3.000	*0.020	5.64
	Sit-ups (30 sec)	Reps	22.63	3.92	24.12	3.18	- 4.583	**0.003	6.58
Physiological Indicators	Vital Capacity (VC)	L/min	3.78	0.27	4.26	0.10	- 4.462	**0.003	12.70
	Maximum Oxygen Uptake (VO ₂ max)	L/min	42.92	1.88	47.20	2.57	- 8.501	**0.000	9.97

* Statistically significant at the level ($\alpha \leq 0.05$).

The results presented in Table 6 reveal statistically significant differences at the significance level ($\alpha \leq 0.05$) in the development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Fartlek training group, favoring the post-test measurements. The percentage improvements for all variables were, respectively (-2.97%, -7.07%, 3.58%, 5.64%, 6.58%, 12.70%, 9.97)%. The researcher attributes these improvements to the nature of Fartlek training, which involves performing exercises at varying speeds and durations (slow, moderate, fast; slow, fast; upSlopes, downSlopes, and obstacle navigation depending on terrain).

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These exercises induce changes in heart rate ranging from (140–160) beats per minute up to 180 beats per minute by increasing running intensity for short periods of (5–30) seconds. This effectively enhances physical capacities related to both aerobic and anaerobic systems.

Overall, the results of this research question are consistent with the findings of (Nadimikeri & Joshi, 2022; Patil et al., 2021; Shingala & Shukla, 2019; Lukose & Jose, 2020; Kumar, 2015), all of which demonstrated the effectiveness of Fartlek training in improving various physical capacities as well as physiological variables related to cardiorespiratory fitness.

Third: Results related to the third research question: which states: Are there statistically significant differences at the significance level ($\alpha \leq 0.05$) in the development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Slopes Sprints training group? To answer this question, a paired-samples t-test was employed, and the results are presented in Table 7.

Table 7: Results of the Paired samples (t) Test for the Significance of Differences in Developing Some Physical Variables and Physiological Indicators Among Junior Football Players Between the Pre- and Post-Measurements of the Slopes Training Method Group (N= 8)

Dependent Variables	Variable Levels	Unit of Measurement	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	(t) Value	Significance Level*	Improvement (%)
Physical Variables	30 m Sprint	Sec	4.28	0.13	4.15	0.12	8.220	**0.000	-1.87
	30 m × 5 Repetitions Sprint	Sec	29.75	1.74	27.38	1.27	7.834	**0.000	-7.97
	Vertical Jump	cm	37.63	2.26	39.63	3.28	-12.689	**0.000	5.31
	Push-ups (15 sec)	Reps	14.63	1.76	14.67	1.63	-3.416	*0.011	0.27
	Sit-ups (30 sec)	Reps	24.63	3.85	25.21	2.73	-2.986	*0.020	2.35
Physiological Indicators	Vital Capacity (VC)	L/min	3.60	0.22	4.08	0.18	-10.456	**0.000	13.33
	Maximum Oxygen Uptake (VO ₂ max)	L/min	43.14	1.53	45.53	2.82	-8.985	**0.000	5.54

* Statistically significant at the level ($\alpha \leq 0.05$).

The results presented in Table 7 indicate statistically significant differences at the significance level ($\alpha \leq 0.05$) in the development of certain physical variables and physiological indicators among youth soccer players between the pre-test and post-test for the Slopes Sprints training group, favoring the post-test measurements. The percentage improvements for all variables were, respectively, (-1.87%, -7.97%, 5.31%, 0.27%, 2.35%, 13.33%, 5.54)%. The researchers attribute these improvements to the effectiveness of up Slopes and down Slopes sprint training, which enhanced the physical capacities under study.

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(Al-Fadhli, 2010) noted that Slopes training is one of the forms and methods of developing strength, speed, explosive strength, strength endurance, and speed endurance in soccer. (Fares, 2012) indicated that Slopes sprints improve stride length and frequency due to their significant effect on the quadriceps, hamstrings, and calf muscles. This was further supported by (Galligan et al., 2000), who stated that the load on the hamstrings and quadriceps during Slopes training exceeds that of flat surface training by twofold or more and can even be comparable to resistance training. This contributes significantly to muscle strength development, increased leg muscle elasticity, and improved player speed through enhanced stride length and frequency.

Overall, the results of the current study are consistent with the findings of (Vernillo et al., 2015; Cassirame et al., 2022; Roussos et al., 2019; Pinillosa et al., 2018; Vernillo et al., 2017 ; Giandolini et al., 2016; Lemire et al., 2021), which demonstrated that upSlopes sprint training significantly improves players’ speed by increasing stride length and frequency, as well as enhancing the efficiency of the cardiovascular and respiratory systems.

Fourth: Results related to the fourth research question: which states: Are there statistically significant differences at the significance level ($\alpha \leq 0.05$) in the post-test measurements of certain physical variables and physiological indicators among youth soccer players attributed to the training method? To answer this question, the means and standard deviations were calculated, and a one-way ANOVA was conducted. The results are presented in Tables 8 and 9.

Table 8: Means and Standard Deviations of Physical Variables and Physiological Indicators among Youth Soccer Players According to Training Method (N = 24)

Dependent Variables	Test	Unit	Training Method	N	Mean	SD
Physical Variables	30 m Sprint	sec	Tabata	8	4.20	0.11
			Fartlek	8	4.25	0.15
			Slopes Sprints	8	4.15	0.12
	30 m × 5 Runs	sec	Tabata	8	27.64	1.16
			Fartlek	8	27.87	1.45
			Slopes Sprints	8	27.38	1.27
	Vertical Jump	cm	Tabata	8	42.50	1.77
			Fartlek	8	35.87	1.35
			Slopes Sprints	8	39.63	3.28
	15-sec Push-ups	repetitions	Tabata	8	14.87	1.64
			Fartlek	8	13.87	1.55
			Slopes Sprints	8	14.67	1.63
	Sit-ups (30 sec)	repetitions	Tabata	8	25.50	1.60
			Fartlek	8	24.12	3.18
			Slopes Sprints	8	25.21	2.73
Physiological Indicators	VC	L/min	Tabata	8	3.96	0.11
			Fartlek	8	4.26	0.10
			Slopes Sprints	8	4.08	0.18
	VO ₂ max	L/min	Tabata	8	43.61	2.83
			Fartlek	8	47.20	2.57
			Slopes Sprints	8	45.53	2.82

Table 9: One-Way ANOVA Results for Differences Physical Variables and Physiological Indicators among Youth Soccer Players According to Training Method (N = 24)

Dependent Variables	Test	Source of Variance	Sum of Squares	df	Mean Square	F	Significance
Physical	30 m Sprint	Between Groups	0.038	2	0.0190	1.258	0.305

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Dependent Variables	Test	Source of Variance	Sum of Squares	df	Mean Square	F	Significance
		Within Groups	0.317	21	0.015		
		Total	0.355	23			
	30 m × 5 Runs	Between Groups	6.986	2	3.493	2.434	0.112
		Within Groups	30.134	21	1.435		
		Total	37.120	23			
	Vertical Jump	Between Groups	184.750	2	92.375	30.853	*0.000
		Within Groups	62.875	21	2.994		
		Total	247.625	23			
	15-sec Push-ups	Between Groups	8.083	2	4.042	1.594	0.227
		Within Groups	53.250	21	2.536		
		Total	61.333	23			
	Sit-ups (30 sec)	Between Groups	26.083	2	13.042	1.010	0.381
		Within Groups	271.250	21	12.917		
		Total	297.333	23			
Physiological Indicators	VC	Between Groups	0.141	2	0.070	1.483	0.250
		Within Groups	0.996	21	0.047		
		Total	1.137	23			
	VO ₂ max	Between Groups	52.378	2	26.189	4.225	*0.029

Dependent Variables	Test	Source of Variance	Sum of Squares	df	Mean Square	F	Significance
		Within Groups	130.182	21	6.199		
		Total	182.559	23			

*Significant at $\alpha \leq 0.05$.

The results presented in Table 9 indicate that there were no statistically significant differences at the significance level ($\alpha \leq 0.05$) in the post-test measurements for certain physical variables (30 m sprint, 30 m $\times$ 5 runs, 15-sec push-ups, and 30-sec sit-ups) and the physiological indicator (VC) among youth soccer players attributable to the training method. However, statistically significant differences were observed at the significance level ($\alpha \leq 0.05$) in the post-test measurements for the physical variable vertical jump and the physiological indicator VO₂ max, attributable to the training method. To determine the direction and source of these differences, the LSD post-hoc test was conducted, and the results are presented in Table 10.

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Table 10: LSD Post-Hoc Comparison of Mean Differences in Vertical Jump (Physical) and VO₂ max (Physiological) among Youth Soccer Players by Training Method (N = 24)

Dependent Variable	Training Method	Mean	Tabata	Fartlek	Slopes Sprints
Vertical Jump	Tabata	42.50	-	6.63*	2.87*
	Fartlek	35.87		-	3.76*-
	Slopes Sprints	39.63			-
VO ₂ max	Tabata	43.61	-	3.59*-	1.92-
	Fartlek	47.20		-	1.67
	Slopes Sprints	45.53			-

*Significant at $\alpha \leq 0.05$.

The results presented in Table 10 indicate statistically significant differences at the significance level ($\alpha \leq 0.05$) in the mean values of the physical variable vertical jump among youth soccer players according to the training method. Significant differences were observed between the Tabata and Fartlek means in favor of the Tabata group, as well as between Tabata and Slopes Sprints, also in favor of Tabata, while a significant difference was observed between Fartlek and Slopes Sprints in favor of Slopes Sprints.

Similarly, significant differences were found at the significance level ($\alpha \leq 0.05$) in the mean values of the physiological indicator VO₂ max according to the training method. Differences were observed between Tabata and Fartlek in favor of the Fartlek group, while no significant differences were found between Tabata and Slopes Sprints, or between Fartlek and Slopes Sprints.

The researcher attributes the differences in vertical jump performance between Tabata and Fartlek, favoring Tabata, to the nature of Tabata training, which

involves very high intensity for short durations. This type of training activates fast-twitch muscle fibers, enhances neuromuscular control mechanisms, and increases the ability to develop force rapidly, thereby improving physical capacities related to strength and explosive power. In this regard, (McArdle et al., 2015) noted that Tabata training activates Type II muscle fibers, forcing the body to recruit fibers responsible for generating high force, enhancing muscular endurance, and improving the muscles' ability to withstand stress for longer periods without significant performance loss. (Tanimoto & Ishii, 2006) reported that Tabata training stimulates hormonal responses by increasing testosterone and growth hormone secretion, contributing to greater muscle strength and hypertrophy. Additionally, (Cormie et al., 2011; Zatsiorsky & Kraemer, 2006) stated that high-intensity Tabata training improves neural adaptations and increases motor unit recruitment speed, enhancing explosive force production. (Komi, 2003) also noted that repetitive movements in Tabata, such as rapid jumps or weighted exercises, improve the tendons' and muscles' ability to store and release energy quickly, boosting performance in explosive movements.

Consequently, Tabata training had a greater effect on explosive strength, as reflected in the vertical jump test, compared to Fartlek training, which relies more on aerobic systems than anaerobic systems, placing it third in effectiveness after Tabata and Slopes Sprints. Slopes Sprints, which largely depend on bodyweight running and sprinting without additional loads, rank second in influencing explosive strength in the vertical jump test, while Tabata training occasionally incorporates extra weights, increasing its impact. Overall, these findings align with (Abdelghani & Ahmed, 2024; Al-Rashidi, 2024), Kv et al., 2024; Anbalagan et al., 2024; Piralaiy et al., 2024).

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The differences in VO_2 max between Tabata and Fartlek, favoring Fartlek, are attributed to the nature of Fartlek training, which primarily relies on the aerobic system through continuous running or jogging over longer durations. This improves physical capacities associated with the aerobic system, enhancing the efficiency of the cardiovascular and muscular systems, including oxygen uptake, transport, and utilization by the lungs and muscles. Moreover, repeated physical effort increases the density of capillaries around the alveoli in the lungs, either by reopening dormant capillaries or forming new ones, which, in turn, elevates red blood cell and hemoglobin production by the spleen and bone marrow in response to the physical demand. Additionally, hypoxia induced during Fartlek training triggers kidney release of erythropoietin (EPO) and liver-derived globulin, which together stimulate erythropoiesis in the red bone marrow, increasing red blood cell count and hemoglobin levels.

Overall, these findings are consistent with (Salameh, 2013; Salameh et al., 2021; Salameh & Qadumi, 2020; Nadimikeri & Joshi, 2022; Patil et al., 2021; Shingala & Shukla, 2019; Lukose & Jose, 2020; Kumar 2015), all of which reported the effectiveness of Fartlek training in improving various physical capacities as well as physiological variables related to cardiorespiratory fitness.

Conclusions:

In light of the study results and discussion, the researcher reached the following conclusions:

- Tabata, Fartlek, and Slopes Sprints training all contribute to improving and developing physical capacities and physiological indicators related to speed,

speed endurance, strength with speed, strength endurance, explosive strength, vital capacity (VC), and maximal oxygen uptake ($\text{VO}_2 \text{ max}$).

- Tabata training is highly effective in developing and enhancing explosive strength more than Fartlek and Slopes Sprints training.
- Slopes Sprints training is more effective than Fartlek training in developing explosive strength.
- Fartlek and Slopes Sprints training are highly effective in developing maximal oxygen uptake ($\text{VO}_2 \text{ max}$), more so than Tabata training.
- Tabata training has limited effectiveness in improving $\text{VO}_2 \text{ max}$.

Recommendations:

Based on the study objectives and results, the researcher recommends the following:

- Fitness coaches should diversify the use of training methods to develop physical capacities and improve physiological indicators in players.
- Coaches should integrate Tabata training into training programs to enhance muscular strength, explosive strength, strength with speed, and strength endurance.
- Coaches are encouraged to use Fartlek training as an effective method to improve cardiovascular endurance and overall physical performance.

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- The importance of Slopes Sprints training should be emphasized for developing speed and speed endurance due to its positive impact on athletic performance.
- Training programs should include Tabata, Fartlek, and Slopes Sprints due to their effectiveness in enhancing physical and physiological capacities in soccer players.
- Similar studies should be conducted on different age groups and various sports to expand understanding of these training methods' effects on athletic performance.
- The impact of combining different training methods in a unified training program should be studied to evaluate their interaction and optimize performance outcomes.
- Regular assessments should be conducted to evaluate players' responses to different training types through periodic tests measuring physical and physiological performance improvements.

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