https://doi.org/10.7251/SSH2302225I UDC: 796.015.132:796.332
Original scientific paper *Originalni naučni rad*

Using Intermittent Exercises in Training to Enhance Maximum Aerobic Speed and Power in U-19 Football Players

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Abstract: *In the present research, various forms of interval exercises, including short, medium, and long intervals, were incorporated into a prescribed training regimen to assess their impact on the development of specific physical attributes, namely Maximum Aerobic Speed and Speed-Related Strength, in football players under the age of 19. This study employed an experimental method with a single-group design, involving a sample of 14 players from IRB SEDRATA. To this aim, pre-tests, including the YO-YO Endurance Intermittent Test Level 2 and a hop test spanning a 10-meter distance for both legs were conducted. Subsequently, the proposed training program was administered, culminating in post-tests to gauge the program's effectiveness, employing appropriate statistical methods. In conclusion, the results indicate that the proposed training program has a positive impact on enhancing Maximum Aerobic Speed and Speed-Related Strength among the sampled players.*

Keywords: *intermittent exercise, training program, physical abilities.*

INTRODUCTION

The technology of sports training sciences has advanced quickly in to achieve high athletic levels in various sports, whether in a team or individual competitions. This level of improvement did not arise out nothing rather, science served as the foundation to do so, and efforts are being made to gain further understanding. In order to improve training status and achieve high levels, it is necessary to study what is included in the science of sports training's foundations and rules in greater detail. So, it is necessary to throw light on everything that is novel and creative in the field of sports training and its applications. (Albassati, 1998) In comparison with other team sports, football has attracted a sizable following and a great deal of practitioners. It is one of the team sports that became well-known throughout the world, but especially in Algeria. Sports practice has clearly shown that high results cannot be achieved without building a solid base during childhood and adolescence, which necessitates long-term, systematic planning in the field of training (Wiencek, 1997).

In order to build excellent planning and carry out the finest training programs, it is necessary to provide a variety of facilities and means, keep up with new technologies, and teach and develop trainers with a focus on both theory and practice. The coach must know the basic principles based on defining the methods and means and developing different plans in preparing and training the players through the various stages. (Kashef, 1994) The coaches, according to Kashif Ezzat Mahmoud and Muhammad Hassan Allaoui, must fully comprehend the foundations of the various concepts and applications of the science of training, master motor skills and play plans in his field of specialization, and have information related to the foundations of developing and developing motor skills and physical characteristics, as well as methods of acquiring and advancing them, with the need for him to be familiar with the distinct theory and practice of each (Allaoui, 1990).

Given that the activity of the modern player in football matches today witnessed a significant increase in the distance traveled, compared to the outcomes of the century, the informed observer of modern football notes that it relies heavily on the rhythm of fast play that requires high physical efficiency and has witnessed continuous development over the years. According to the playing centers, the performance in the past increased from a distance of 3361 meters in 1952 to 10802 meters in 2007 (Dellal, 2008) The modern physical requirements of this game have resulted in an urgent requirement for providing the players with a high level of physical preparation, in particular considering changes in modern football achievement are linked to the acceleration of defensive and offensive activities with a high level of strength as well as the players' high level of skillful performance, as well as the use of the total ball met-

hod, the player began to occupy more than a position in the team, that is, we see the defender actively contributing to the attack and the attacker retreating to defend his team's goal, and despite the player's endurance of this high effort, he must maintain physical fitness throughout the entire game (Allaoui, 1992).

Consequently, trainers and fitness professionals have increasingly adopted scientific and evidence-based training programs, guided by statistical data provided by organizations such as FIFA. This data reveals that football players engage in various activities during matches, including quick sprints, walking, and dribbling. These intermittent efforts, involving periods of work and rest, highlight the unique physical demands of football. In response, training methodologies have evolved to incorporate intermittent training, which has gained prominence due to its ability to enhance players' explosiveness and aerobic capacity, both of which are distinguishing factors for modern soccer players (FIFA) (Turpin, 2002). Intermittent training has gained significant popularity across all levels of sports due to its ability to replicate the dynamic nature of the gameplay, featuring high-intensity periods interspersed with rest intervals that can last several minutes. This training method has undergone continuous development by scholars in the field, starting with the pioneering work of *Fox* and al in 1977, who focused on interval training in athletics. Later, in 1980, *G. Gacon* advanced the concept of modern intermittent training, which incorporates alternating work and recovery periods in controlled intensity zones based on the maximum aerobic speed (*LT AT*). Subsequently, researchers such as *Bangsbo and Commetti* (2007) integrated this training approach with the specific demands of modern football (Dellal, 2008).

In recent years, football has undergone significant changes, including an increase in playing systems and a higher level of skill, physicality, and tactical performance. It has evolved into a sport characterized by intermittent efforts and distinctive stages. A thorough analysis of players' exertion in official matches revealed a wide range of movements, including explosive runs (92-109), stops and changes of direction (40-70), tackles (6), dribbles (13), headers (11), movements without the ball (30), and movements with the ball (27) (Turpin, 2002). This has led to assert that football is a team sport with intermittent physical activity dominance. Many countries around the world, recognizing the importance of physical fitness in football, have prioritized the development of their players' physical abilities to ensure global competitiveness. This emphasis on physical efficiency is evident in modern football, characterized by rapid movements under varying tactical plans (Dellal & Javier, 2017).

The physical capabilities of players have a significant and evident impact on their success or failure, as well as the performance of sports clubs. This impact is particularly prominent in football, which is described as the main driving force and crucial pillar for performance. The individual's physical influence plays a vital role in enhancing their career progression and overall organic development, including body systems and organs. Consequently, physical attributes, skills, movements, abilities, tactical plans, and volitional traits all undergo continuous improvement and development. (Allaoui, 1992). Prominent football figures such as *De Bruyne, Benzema, Kante, Messi, and Ronald*o have demonstrated their artistic potential and tactical prowess, transcending physical limitations. According to Dellal and Javier, players cover a distance of 10 to 13.8 kilometers per match, engaging in 79-146 accelerations with maximum speeds ranging from 22 to 33 km/h. For instance, striker Robben achieved a speed of 37 km/h while carrying the ball when he scored the fifth goal for the Netherlands against Spain during the 2014 World Cup in Brazil. Meanwhile, defender Ramos reached a speed of 30 km/h without the ball (Dellal & Javier, 2017).

Considering the aforementioned factors, along with the theoretical knowledge and practical experience of researchers, it has become evident that interval training is underutilized despite its suitability for accurately simulating competitive conditions. The importance of training conditions closely resembling actual competition is emphasized, as well as the significance of training at the same intensity as in competitive matches (Hamad, 2001). Therefore, the researchers were motivated to develop a training program aimed at investigating the impact of intermittent training on the development of specific characteristics in football players under 19 years old. This age category is considered optimal due to the players' physiological, morphological, and mental capabilities. Consequently, the researcher must address the following question as a primary concern:

- Do the intermittent exercises within the proposed training program affect in the improvement of speed aerobic maximum (VMA) and the power characteristic of speed for soccer players under 19 years old?

MATERIALS AND METHODS

Research Design

A single-group experimental design was employed in this study to investigate the impact of a training program incorporating intermittent exercises on the physical abilities of football players under 19 years old. This approach was chosen as the most suitable method to achieve the research objectives, which involve examining the effects of the training program on the selected sample.

Research population and sample

The study focused on football players under the age of 19 who were affiliated with the regional association Annaba. The regional association consisted of 61 teams, divided into 7 groups, with each group comprising 7 to 10 teams. From this group of teams, the intentional sampling method was employed to select the IRB SEDRATA team from the Sports Federation team of the municipality of Sedrata, which consisted of 14 players.

Characteristics of the study sample:

By age: The sample consists of 03 players aged 18 years, 09 players aged 17 years, and two players aged 16 years. The following table shows the sample members according to the age variable.

Table 1. *The distribution of the respondents according to the age variable*

Number of individuals	Age
03	18 years
09	17 years
02	16 years

By (Physical variables): (weight - height).

Table 2. *The values of the autosomal variables.*

physical variables	Value
Weight (kg)	63.80
length (centimeters)	177.25

Data collection tools

- ***The maximum aerobic speed test:*** (YO-YO Endurance intermittent test level 2)

This test was developed by the Danish physiologist Jens Bangsbo in 1994, it is characterized as an intermittent, progressive, and maximal assessment method.

Objective of the test: This test was devised with the primary objective of gauging the player's maximum oxygen consumption, maximum aerobic speed, and capacity for rapid recovery. Additionally, it aims to facilitate the execution of a maximal number of shuttle runs between two lines situated 20 meters apart, with progressively escalating speeds.

Description of the test: The athlete initiates the test by positioning themselves at line B. Upon receiving a signal, the athlete proceeds to line C, which is situated 20 meters from the starting point. Subsequently, a 5-second active recovery period is observed within the designated area (A - B), positioned at a distance of 2.5 meters, after every 40 meters covered. The initial velocity is set at 11.5 km/h. (Dellal, 2013)

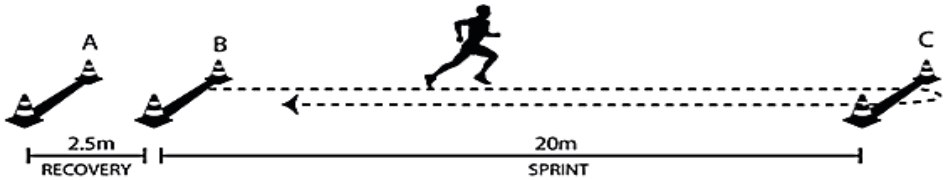

Figure 1. *Test YO-YO Endurance intermittent level 2*

- ***Partridge test for both legs for a distance of 10 meters using photoelectric device cells):***

The aim of the test: to measure the speed-related strength of the leg muscles.

Description of the test: The assessment protocol permits the player to execute two consecutive jumps using their right leg and an additional two using their left leg. Consequently, the testing region is demarcated by two lines: one serving as the starting point and the other as the termination point, separated by a standardized distance of 10 meters. Within this designated region, specialized equipment, namely photoelectric cells, is strategically positioned at both the initiation and culmination points. A dedicated recorder announces the participants' names initially and meticulously documents their respective performance durations subsequently. Simultaneously, an observer closely monitors the precision and accuracy of the execution of the jump sequences. The most favorable outcome derived from all the attempted jumps is the one considered for analysis and evaluation. (Taha, 1989)

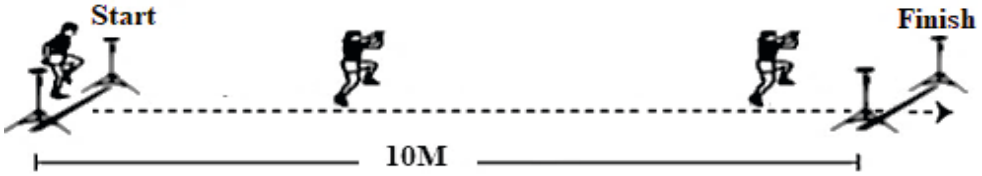

Figure 2. *Test Partridge test for both legs for a distance of 10 meters using a device (Photoelectric cells)*

Scientific basis for the tests

The stability and validity of the tests: The test's stability refers to its ability to produce consistent results when repeated on the same participants under the same conditions. The initial test was administered to a sample of 06 players on 11/16/2021, and the test was repeated on 11/22/2021 using the same sample and conditions. Subsequently, the Pearson correlation coefficient was calculated, and the significance values (sig) were compared with the predetermined significance levels of 0.05 and 0.01, with a degree of freedom of 4. The results indicated that the probability values were lower than the significance levels, confirming a high level of test reliability. Additionally, the self-validity was assessed by calculating the square root of the stability coefficient, which further demonstrated a high degree of self-validity. The findings are summarized in the following table:

Table 3. *the reliability and validity of the physical tests adopted in the study*

physical exams	Sample volume	degrees of freedom	significance level	Stability coefficient	Subjective validity coefficient	probability value sig	the decision
Yo-Yo Endurance intermittent test	06	04	0,05	0,837	0,914	0,038	Statistically D
Partridge test for both The two men are 10 meters apart			0,0 1	0,997	0,998	0,000	

Content of the training program

Following extensive consultations with numerous coaches and esteemed experts in the realm of football, the researchers reached the determination that it was imperative to formulate a comprehensive training regimen spanning eight weeks, encompassing a frequency of two sessions per week. This structure amounted to a total of 16 sessions, commencing from the phase of specialized physical preparation. During the development of this training program, careful consideration was given to the selection of suitable exercises within the training modules, along with meticulous adjustments to the training components and their associated loads.

Typically, the interval training component comprises between 2 to 5 sets, each spanning 6 to 12 minutes in duration. The exertion level during these intervals is maintained at or above 100% of the Maximum Aerobic Speed (VMA). Following each intense interval, participants observe recovery periods spanning 7 to 10 minutes. (Hervé & Cometti, 2007).

Various types of interval exercises (short, medium, long) were used in their various forms (speed interval exercises, strength interval exercises, mixed " strength-speed" exercises). Consideration of the attributes specific to the target age cohort is integral, alongside adhering to established training principles, during the formulation and executi-

on of the envisioned training regimen. This meticulous approach is undertaken with the primary aim of mitigating the risk of injuries that might impede the successful completion of the training program. Notably, these considerations encompass factors such as individual disparities, progressive training regimes, adaptability, program integration, specificity, and the comprehensiveness of the training regimen.

The levels of load, with respect to both intensity and magnitude, are systematically tailored to align with the distinct training phases and the proficiency level of the athletes.

RESULTS

View and analyze study test results:

Table 4. *The test for normality of the normal distribution of the results of anthropometric measurements and physical abilities*

Statistical variables	Kolmogorov-Smirnov		the decision	Shapiro- Wilk		the decision
	statistic	(Sig)		statistic	(Sig)	
Yo-Yo Endurance intermittent test	0,216	0,076	Submit	0,862	0,033	no submit
a test partridge Baklata The two men are 10 m	0,138	0,200	Submit	0,973	0,911	submit

The values obtained from the Yo-Yo Endurance intermittent test did not follow a normal distribution, as evidenced by the non-significant Kolmogorov-Smirnov test (p = 0.076) at the 0.05 level of significance. However, the Shapiro-Wilk test yielded a significant result (p = 0.033), indicating a departure from normality. Consequently, nonparametric tests, specifically Wilcoxon's test, were employed instead of parametric tests. On the other hand, the values of the partridge variable for both legs at a distance of 10 meters were normally distributed. This was supported by the non-significant Kolmogorov-Smirnov test (p = 0.200) and the non-significant Shapiro-Wilk test (p = 0.911) at the 0.05 level of significance. Therefore, parametric tests could be used for further analysis.

Table 5. *Wilcoxon test for differences between pre and post-tests in a variable Yo-Yo Endurance intermittent test*

Appreciation	Total ranks	probability value Sig	value Z	middle ranks	the number N	cases
Statistically D at (0,01)	3,00 75,00	Asymptomatic (bilateral) 0,004	-2,84	3,00 6,82	01 11 02 14	Pre-test > Post-test Pre -test Post- test Pre-test = post-test the total

Based on the table, significant differences were observed between the pre and post-tests of the Yo-Yo Endurance intermittent test. The statistical value (z) was -2.84, indicating a significant result at a 0.01 level of significance. This conclusion is supported by the Asymp. Sig. a (2-tailed) probability value of 0.004, which is lower than the significance level of 0.01. Among the cases, 11 showed higher scores in the post-test with an average score of 6.82, while one case had a higher pre-test score with an average of 3.00. Additionally, two cases maintained the same level, with pre-tests equal to post-tests.To calculate the effect size using the Wilcoxon test for paired samples, the binary correlation coefficient (r_{prb}) known as the Matched-Pairs Rank Biserial Correlation is computed using the following equation: [Please provide the equation for calculating the binary correlation coefficient.] (Safi, 2019).

$$r_{prb} = \frac{4T_{+}}{n(n+1)} - 1$$

Where: $4T_{+}$ The sum of the ranks with a positive sign, *n* the number of pairs of degrees.
explains (r_{prb}) In light of the following simulations:

- The effect size is weak if it is 0,4 > r_{prb}
- The mean effect size was 0.7 > $r_{prb} \geq$ 0,4
- The effect size is significant if it is 0.9 > $r_{prb} \geq$ 0,7
- The effect size is very large $\geq \geq$ 0,9 r_{prb}

According to Table 5, the statistical significance value (Sig) is 0.004. This indicates that there are statistically significant differences between the pre and post-measurements of the Yo-yo test at a significance level of 0.01. These differences can be attributed to the program that was implemented, with the post-test showing favorable results compared to the pre-test.

- Through the previous equation to calculate the effect size when using a test Wilcoxon for the eyes Associated, we find that:

(T_+) = 75,00
(n) = 14 So the value of r_{prb} Equal:

$$r_{prb} = \frac{4 \times 75}{14 \times 15} - 1 = 0{,}42$$

- **effect size:** This indicates that there is an average effect of the training program on the maximum aerobic speed based on the Yo-Yo Endurance intermittent test.

✓ ***Calculate the effect size through the second equation using the Wilcoxon test:***

The effect size R is calculated as Z statistic divided by square root of the sample size (N), (Z/ √ N). (fritz et al.,2012; Ivarsson et al., 2013)

Effect size: R= 2.848/√14 = 0.761

- 0.1-0.3 = small
- 0.3-0.50 = medium
- ≥0.50 = large

- In this case, the effect size is considered large because "r" is higher than 0.50.

From the first and second equations we see that the effect size value when applying the Wilcoxon test ranges from medium to large, and from the percentage of improvement between pretest and posttest we see that the first equation is closest to the application.

Table 6. *Comparison of the pre-test and the post-test results for the study sample in the partridge test for both legs 10 m at the significance level 0.05 at degree of freedom 13*

the test	Arithmetic mean	standard deviation	Sample volume	correlation coefficient	t value calculated	probability value sig	Statistical significance
Pretest	4.06	0.61	14	0.805	5.848	0.000	D
Posttest	3.49	0.52					

Based on Table 6, we observe the comparison of the pre and post-test results of the study sample in the Partridge test (Baklata) for a distance of 10 meters. In the pre-test, the study sample achieved an average score of 4.06 with a standard deviation of 0.61. In the post-test, they achieved an average score of 3.49 with a standard deviation of 0.52. The calculated "t" value was 5.84, and the probability value "sig" was 0.000, which is less than the significance level of 0.05. These findings indicate that there are statistically significant differences between the pre- and post-measurements in favor of the post-test results for this sample. Therefore, the proposed training program, which incorporated intermittent exercises and was applied to the study sample, had a positive contribution to the development of the speed-strength characteristic.

✓ ***Calculate the effect size using Cohen's d equation:***

$$d = \frac{t}{\sqrt{n}}$$

where: (T) = 5.84, (N) = 14, (√ N) = 3.741.

$$d = \frac{5.84}{\sqrt{14}} = 1.56$$

- d = 0.2, small effect
- d = 0.5, medium effect
- d = 0.5, large effect
- d = 1.3, very big effect (Sullivan, & Feinn, 2012)

- Through the following measure: we conclude that the effect size value of (1.56) is very large.

Table 7. *The results of the percentage differences between the pre and post-measurements in the partridge test for both men 10 m*

variants	df	value (tc) calculated	Eta square value (Eta²)	rate variance	difference ratio
Partridge test for both men 10 m	13	7,97	0,8301	83.01%	16,99%

From the table, it is evident that the effect size, measured by the "Eta squared" (η^2) value, is 0.8301. This indicates that 83.01% of the observed variation in the individuals' performance in the Partridge test for both legs at a distance of 10 meters can be attributed to the effect of the proposed program. This is a substantial percentage, demonstrating a clear and significant impact of the program. The remaining 16.99% represents the residual variation. Furthermore, the calculated value of "tc" is 7.97, indicating statistical significance and demonstrating the accuracy and objectivity of utilizing training programs incorporating intermittent exercises for enhancing the physical attribute of speed-related strength.

DISCUSSION

During the statistical analysis of the collected data in this study, a notable statistical dispersion was observed between the initial and final measurements in the Yo-Yo Endurance intermittent test, as indicated in Schedule 5. This finding can be attributed to the implementation of the training program, which incorporated various forms of intermittent exercises. These exercises included running, shuttle runs, and different durations of intervals (long, medium, short, and very short). This observation aligns with previous studies and research in the field, such as the thesis *by Hervé Assadi* in 2012 titled *"Physiological responses during the performance of interval training exercises,*" which found that various interval training exercises enhance maximum aerobic speed. Other studies by Kharoubi Mohamed Faisal (2016), Sadouki Bilal (2016), also support this notion, as indicated by (Billat et al., 2001).

Intermittent training, alongside other training methods, has been recognized as an effective approach to developing maximum aerobic capacity (Cazorla, 2012). states that short, high-intensity intermittent exercises, such as running at 110-120% of the maximum aerobic speed with short recovery periods (15-20-30 seconds) repeated 30-40 times, are the most effective for developing maximum aerobic speed without excessive lactate production. Several studies have provided evidence to support this claim. Overall, the findings of this study and the existing literature emphasize the efficacy of incorporating intermittent exercises, particularly high-intensity short intervals, in improving maximum aerobic speed. This was confirmed by both studies (Sara Aliberti et al., 2021) which is titled" Three workouts compared: interval training, intermittent training and steady state training for the improvement of VO2max and BMI" Intermittent training and interval training contribute effectively to improving aerobic capacity. Based on the statistical analysis of the study results, it is evident that the training program utilizing various forms of intermittent exercises has proven effective in developing maximum aerobic speed (VMA) in football players under 19 years old.

Furthermore, significant improvements were observed in the partridge test for both legs at a distance of 10 meters, as indicated in Tables 6 and 7. These findings consistently support the positive impact of the training program. The researchers assert that the implementation of the training program, which incorporates different types of intermittent exercises, has contributed to the development of power, specifically speed, which is a crucial physical capacity in football. This can be further explained by the insights of (Gacon, 1983, 1990), who suggests that interval training emphasizes exercises involving plyometric contractions. This type of training helps improve the speed of recruiting motor units in muscles, increases neural stimulation frequency, and enhances the synchronization of motor units. These factors collectively contribute to the enhancement of explosive power and the power characteristic of speed. Overall, the findings support the notion that the training program utilizing intermittent exercises effectively enhances maximum aerobic speed and power, particularly speed, in young football players.

The findings of the study align with the results of Mansouri's thesis titled *"A comparative study between the long and short interval training methods and their impact on both the maximum Aerobic speed and the Speed characteristic of senior Football players*" (2019). Mansouri's study also concluded the effectiveness of a training program incorporating long and short-interval training in developing the power characteristic of speed in senior football players. These consistent findings further support the notion that training programs utilizing different forms of intermittent exercises have proven effective in enhancing the power and speed characteristics in football players. Therefore, based on the results of your study and the supporting evidence from Mansouri's thesis, it can be confidently stated that the proposed training program utilizing various forms of intermittent exercises has demonstrated its effectiveness in developing the power characteristic of speed.

CONCLUSION

The study aimed to investigate the effectiveness of incorporating intermittent exercises (specifically focusing on strength and speed) within a proposed training program in improving the maximum aerobic speed and the power characteristic of speed in soccer players under 19 years old. The experimental approach was employed, using a one-group design with a sample of 14 players from IRB SEDRATA. The study included pre-tests, followed by the implementation of a 16-session training program with two sessions per week, starting from the special physical preparation stage and concluding with post-tests. Upon analyzing and processing the collected data, it was observed that the application of intermittent exercises within the proposed training program had a positive impact on enhancing both the maximum aerobic speed (VMA) and the power characteristic of speed in soccer players under 19 years old. These findings suggest that the utilization of intermittent exercises, specifically focusing on strength and speed, can be an effective approach to improving the physical performance of young soccer players in terms of their aerobic capacity and speed-related abilities.

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Primljen: 12. jun 2023. / Received: June 12, 2023
Izmjene primljene: 03. oktobar 2023. / Changes Received: October 03, 2023
Prihvaćen: 08. decembar 2023. / Accepted: December 08, 2023