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RESEARCH ARTICLE

Comparative Analysis of Maximal Aerobic Speed (MAS) in Under-19 Football Players Across Competitive Levels: Evidence from Algerian and French Youth Teams

Badis Rafas
University of Chlef
Algeria
E-mail: rafasbadis@gmail.com

Soufiane Mahi
University of Chlef
Algeria
E-mail: s.mahi.researcher@gmail.com

Mahdi Jouani
University of Boumerdes
Algeria
E-mail: jouani.mahdi@gmail.com

Taqieddine Seghari
University of Setif 2
Algeria
E-mail: seghari.staps@gmail.com

Mansour Benlakehal
University of Mostaganem
Algeria
E-mail: mansour.benlakehal@gmail.com

Rabah Bourzama
University of Chlef
Algeria
E-mail: bourzamaieps@gmail.com

Abdellah Lameche
University of Chlef
Algeria
E-mail : lamechestaps@gmail.com

Mehdi Youcef Achira
University of Chlef
Algeria
E-mail: m.youcefachira@gmail.com

Ibrahim Kadraoui
University of Setif 2
Algeria
E-mail: kadraoui.dz2000@gmail.com

Saad Bekai
University of Chlef
Algeria

	E-mail: bekaisaad@gmail.com
Mohammed Kherroub	University of Chlef Algeria E-mail: kherroubimed@gmail.com
Maamar Badreddine Bensaada	University of Chlef Algeria E-mail: m.bensaada02@gmail.com
Henni Dehli	University of Chlef Algeria E-mail : h.dehli@gmail.com
Fayçal Beldjouher	University of Chlef Algeria E-mail: f.beldjoyher.univ.chlef@gmail.com

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Abstract

The continuous evolution of modern football has significantly increased the physical and physiological demands placed on youth players, particularly with regard to aerobic endurance and high-intensity intermittent performance. Among the physiological indicators used to assess endurance capacity, Maximal Aerobic Speed (MAS) is considered a key determinant of a footballer's ability to sustain repeated high-intensity efforts throughout a match. The present study aimed to compare MAS levels among under-19 football players across different competitive standards, specifically contrasting amateur, professional national, and elite European youth contexts. A descriptive–comparative research design was adopted. The study sample consisted of 60 under-19 male footballers competing during the 2024–2025 season, divided equally into three groups :
(1) Union Sportive Chaouia (USC), representing the Algerian second amateur division (n = 20);
(2) Entente Sportive Sétifienne (ESS), representing the Algerian first professional division (n = 20);
(3) Olympique de Marseille (OM) under-19 team, representing the French professional youth league (n = 20).
MAS values were assessed using the Georges Gacon field test, a validated and widely used protocol for estimating aerobic performance in football players. Data were analyzed using SPSS (version 2025), with one-way analysis of variance (ANOVA) employed to identify statistically significant differences between the three competitive levels. The results demonstrated significant differences in MAS across levels of play, with players from the professional first division exhibiting higher MAS values than those from the amateur second division. Furthermore, under-19 players competing in the French professional league displayed significantly superior MAS values compared to both Algerian amateur and professional players. These findings highlight the influence of training methodology, competition intensity, and developmental environments on aerobic performance in youth football. In conclusion, the study underscores the need for systematic, scientifically grounded conditioning programs within Algerian youth football structures to bridge the physiological gap with elite European academies. Enhancing aerobic capacity during the formative years may facilitate smoother transitions to high-level professional football and improve long-term athletic development.

Citation

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Introduction and Research Problem :

Football in the modern era has witnessed remarkable development, as a result of the increasing reliance on modern and systematic scientific foundations, with the goal of raising player performance to the highest levels in all aspects, whether technical, physical, psychological,tactical or mental. This enables them to perform their roles with complete efficiency, whether defensively or offensively. This has prompted specialists to prioritize optimal preparation for competitions, in alignment with their nature—marked by individual contests and physical confrontations. Moreover, football performance relies on intermittent efforts punctuated by bursts of explosive power and speed, particularly during decisive phases of play. These characteristics serve as a foundation for determining the structure and content of training programs, tailored to the nature of the competition, the players' performance levels, and the specific roles they are expected to fulfill on the field (FIFA, 2018, p.1).

However, observers of national youth championships at various levels can clearly identify a physical deficiency among Algerian players when compared to those trained in European academies. This shortcoming stands as one of the most significant challenges facing Algerian players upon transitioning from the local league to European competitions. Despite their technical prowess—often comparable to the talents of Brazilian and Argentinian players—they struggle to cope with the intense physical demands of these leagues.

Recent studies have shown that a professional player in the English Premier League covers between 10,617 and 12,600 meters per match. In the Spanish league, players cover distances ranging from 10,496 to 11,649 meters, while in the German league, distances exceed 11,000 meters. In the French league, players cover between 10,425 and 12,029 meters. These statistics underscore the necessity for players to develop both high aerobic and anaerobic capacities (Alexandra Dellal, 2008, pp. 14–31).

In a study conducted by G. Cazorla and A. Farhi on the physical and physiological demands of football matches, it was found that approximately 70% of match time relies on the aerobic system, primarily through moderate-intensity running. Around 15% is sustained through a mixed energy system (aerobic and anaerobic) during high-intensity running, while the remaining 15% depends on the alactic anaerobic system during short bursts of sprinting and jumping (Cazorla & Farhi, 1998, p. 63). As a result, it has become essential for players to develop a high level of aerobic capacity, enabling them to sustain high-intensity performance for extended periods—up to 120 minutes in some matches. This level of endurance requires substantial oxygen consumption, which is directly influenced by the efficiency of biochemical reactions within the mitochondria to produce energy through muscle fibers. Research indicates that each kilogram of muscle mass consumes approximately 70 milliliters of oxygen per minute at rest—a rate that increases significantly during intense physical exertion, approaching the athlete's maximal oxygen uptake (VO_2max) (Chicha Fouad, 2018, p. 31).

VO_2max is widely recognized as a key indicator of overall aerobic fitness. It reflects the respiratory system's capacity to absorb oxygen from the air, the cardiovascular system's ability to transport it to the muscles, and the muscle tissue's efficiency in utilizing it for energy production (Alexandra Dellal, 2008, p. 490). Therefore, it is crucial to incorporate training sessions focused on high-speed efforts aimed at developing aerobic power, particularly by enhancing maximal aerobic speed (MAS)—a key reference point for VO_2max. This can be achieved through interval training (effort-recovery) using intensities ranging from 90% to 120% of MAS, depending on the training objectives, the player's performance level, and the specific demands of their position on the field.

Maximal aerobic speed (MAS) assessment is an effective tool for determining a player's training level. It also supports the planning of training sessions based on the team's overall fitness level, while addressing the specific demands of different levels of play—whether in amateur competitions, the national professional league, or European championships (Gacon & Assadi, 1990, p. 37; Chicha Fouad, 2018, p. 32).

Several studies have examined differences in physical and morphological attributes among players depending on their level of play. Ould Hamou Mustafa (2011, p. 30) identified clear differences between professional and amateur players in certain physical and morphological indicators among under-18 and under-20 age groups. By contrast, the study by Shtiwi Abdelmalek (2020, pp. 36–37) found no significant differences between elite and amateur players in the junior category in terms of selected physical and morphological characteristics.

The findings of Aqboubi Habib et al. (2021, p. 411), however, pointed to the possibility of differences in physical and morphological variables between playing levels among senior players. These findings motivated us to adopt Maximal aerobic speed (MAS) as a key performance indicator to analyze and evaluate such differences accurately and to identify the distinguishing physical traits at each level of play.

Based on this, the current study aims to compare MAS values among under-19 footballers across three competitive levels: the amateur second division, the national professional championship, and the French professional league. The goal is to identify potential differences in aerobic capacity that may differentiate players by their level of competition.

Accordingly, the main research question was formulated as follows:

Are there significant differences in Maximal aerobic speed (MAS) among under-19 footballers across different levels of play (amateur second division, national professional league, and French professional league)?

From this central question, the following sub-questions arise:

- Are there significant differences in MAS between amateur second division players and national professional league players?
- Are there significant differences in MAS between amateur second division players and French professional league players?
- Are there significant differences in MAS between national professional league players and French professional league players?

Study Hypotheses:

General Hypothesis:

The study hypothesizes that there are differences in maximal aerobic speed (MAS) among under-19 footballers based on their level of play (Second Division Amateurs, First Professional Division, French Professional League).

Sub-hypotheses:

- Under-19 footballers in the professional first division show higher Maximal aerobic speed (MAS) values compared to those in the amateur second division.
- Under-19 footballers in the French professional league show higher Maximal aerobic speed (MAS) values compared to those in the amateur second division.
- Under-19 footballers in the French professional league show higher Maximal aerobic speed (MAS) values compared to those in the professional first division.

Study Objectives:

This study aims:

- To determine whether there are differences in the Maximal aerobic speed (MAS) among under-19 footballers according to different levels of play (Second Division Amateurs, First Professional Division, French Professional League).
- To determine whether there are differences in the Maximal aerobic speed (MAS) among under-19 footballers between the Second Division Amateurs and the First Professional Division.
- To determine whether there are differences in the Maximal aerobic speed (MAS) among under-19 footballers between the Second Division Amateurs and the French Professional League.
- To determine whether there are differences in the Maximal aerobic speed (MAS) among under-19 footballers between the First Professional Division and the French Professional League.

Significance of the Study:

This study holds considerable importance as it provides a comprehensive overview of the efforts made to develop maximal aerobic speed (MAS) in under-19 footballers, across different levels of play (Second Division Amateurs, First Professional Division, French Professional League). It contributes to evaluating the physical characteristics specific to each level, thereby offering a scientific basis for planning training sessions and determining workload intensities. These insights are drawn from comparative analyses with international standards and are supported by relevant references and studies, particularly those conducted by the Fédération Internationale de Football Association (FIFA) in the field of physical preparation and player conditioning.

Key Concepts in the Study:

Maximum Aerobic Speed (MAS): MAS refers to the speed at which an athlete reaches their maximum oxygen uptake (VO_2max). It serves as a reference point for training planning, session structuring, player categorization based on performance, and the determination of training load intensities.

Levels of Play:

Linguistic Definition: The term "levels" refers to divisions or categories.

Terminological Definition: In football, levels are classifications that differentiate between amateur and professional categories. Additionally, there are age-based classifications, such as: minors (U13), cadets (U15), juniors (U17/U19), and seniors. (Ameen Khazaal Abd, 2014, p. 28). Operational Definition**:** In Algeria, levels of play are structured as follows:

- Pre-Honor Division, Provincial Division, Second Regional Division, First Regional Division, and Inter-League Division.
- Amateur Second Division: Composed of two groups – Central-East and Central-West.
- First Professional Division: Consists of 20 professional teams competing in the Algerian professional league.
- French Professional League: Comprises 20 professional teams and is considered one of the most prestigious football leagues in Europe and worldwide.

Previous and Related Studies:

The First Study: Cazorla and Farhi's (1998) study, entitled: "Current Physical and Physiological Requirements of Professional Footballers" (Exigences physique et physiologiques actuelles).

This study aimed to develop a comprehensive profile of the physical and physiological capabilities of professional footballers by monitoring their performance during official matches. The researchers employed a set of physical tests and measurements, designed as a test battery that included assessments of height, thigh and calf circumference, and body fat percentage.

Various physical performance tests were conducted to evaluate speed (10m, 20m, and 60m), a 2 kg medicine ball throw, trunk flexion to measure flexibility, and vertical jump to assess lower limb explosive power.

By the end of the study, the researchers were able to determine a specific physical profile for each playing position, emphasizing the importance of speed and explosive strength across all roles. Midfielders were particularly noted for their endurance and high maximal aerobic speed (MAS). The second study: The study by Ould Hamou Mustafa et al. (2011) entitled: "Physical and Technical Characteristics of Footballers and Their Role in Determining Performance Level."

This study aimed to identify the key factors that determine the performance level of footballers in the under-18 and under-20 age categories. These age groups represent the final stages of athletic development and the transition toward senior-level (elite) competition. The researcher conducted a comparative analysis between two groups of players from different competitive levels (professional and amateur). This comparison was based on the results of various anthropometric measurements as well as physical and technical tests. The main objective was to identify the

distinguishing criteria that define performance differences between players at both levels, and to highlight the characteristics that set professional players apart from amateurs.

General Study Question:

The study sought to answer the central question: How were some players able to achieve this high level of athletic excellence while others were not? Is early football practice sufficient in itself to achieve excellence?

Methodology: The study followed a descriptive comparative approach, as it is the most appropriate for analyzing differences between different groups according to specific criteria.

Study Sample: The sample consisted of 59 footballers, randomly selected and distributed across the two age groups as follows:

Under 18 years: 11 professional players, 16 amateur players.

Under 20 years: 18 professional players, 14 amateur players.

Study Tools: The study relied on a physical and technical testing protocol that included players from two different levels (professional and amateur).

Study Results:

The results revealed that anthropometric measurements and lower limb strength, particularly with regard to speed and endurance, are among the most prominent determinants of the performance of players in the under-18 and under-20 categories. The study also demonstrated the importance of systematic basic training in the early stages, which helped professional players develop basic physical abilities, most notably speed and muscle strength, which are required to develop at a certain age. It was found that professional players who underwent systematic scientific training outperformed their amateur counterparts, whose training was limited due to the lack of available human and pedagogical resources.

The Third Study : Saada Badr Eddine and Saadawi Mohamed (2012)

Study Title: Indicators of Aerobic Capacity in Footballers

(Indicateurs de la capacité aérobie des joueurs de football)

General Objective: The aim of this study was to determine the values of VO_2max and VMA among U19 footballers according to their playing positions (defense, midfield, and attack), in order to identify which position requires greater aerobic capacity in football.

Methodology: The researchers used a descriptive method to achieve the study objectives.

Study Sample: The sample consisted of 15 players from the Olympique de Chlef U19 team, distributed as follows: 8 defenders, 4 midfielders, and 3 forwards.

Study Tool: The Vameval Test was used to assess VO_2max and VMA levels.

Study Results: The results showed no significant differences in VO_2max and VMA values among players based on their positions. However, a general weakness in aerobic capacity was recorded across the group, which the researchers attributed to overall player performance and the tactical approach used—both of which fell short of the expected level.

The Fourth Study: Aqboubi El-Habib (2017)

Title of the Study: Physiological Indicators among Algerian Footballers According to Their Levels and Playing Positions.

General Objective:

This study aimed to identify certain physiological and morphological characteristics among youth category footballers in Algeria, in addition to examining the differences in these characteristics based on performance level and playing position.

General Research Question:

What are the main physiological and morphological indicators among Algerian footballers according to performance level and playing positions?

Methodology: The researcher adopted a comparative descriptive approach to achieve the study's objectives.

Study Sample: The sample consisted of 129 youth players aged between 17 and 20 years, belonging to seven clubs from the National League (first level) in the central region of Algeria.

Study Tools: The researcher used a battery of physiological tests along with a toolkit for morphological measurements.

Study Results: The findings revealed a clear decline in the physiological level of under-20 Algerian footballers when compared to high-performance levels or FIFA standards, as well as in comparison to some neighboring countries. Additionally, there was a notable similarity in morphological characteristics between high-level and low-level players within this age group.

Recommendations: The study recommended assigning training responsibilities to qualified specialists and adhering to a scientific approach in training, particularly during the developmental phase.

The Fifth Study: Chetoui Abdelmalek (2020)

Study Title: Levels of Certain Physical Characteristics in U19 Footballers

General Objective:

The study aimed to measure the levels of selected physical attributes in U19 footballers and compare them with those of elite-level players in the same age category.

Main Research Question: What are the levels of certain physical characteristics in U19 footballers?

Methodology: The researcher adopted a descriptive comparative approach.

Study Sample: The sample consisted of 17 U19 players from the amateur club Tolga. The researcher conducted several physical tests, including a 30-meter sprint, horizontal jump, agility, flexibility, and aerobic endurance (using the Mini Cooper test). The results were compared with those of elite U19 players.

Research Tools: A battery of physical fitness tests was used to evaluate the targeted attributes.

Study Results: The results indicated that the physical performance levels of Tolga's amateur club players were close to those of elite players in most of the tested physical attributes. However, slight differences were observed in some areas such as the 30-meter sprint and strength. These differences were attributed to several factors, primarily the variation in training volume between professional and amateur players — in terms of the number of sessions and the

time allocated to develop specific abilities — as well as the presence of a physical trainer in professional clubs, which is typically lacking in amateur teams.

Applied Aspect :

Methodological Approaches Followed:

Exploratory Study:

It provided us with the opportunity to visit the training sites of the teams relevant to the research, which include players under 19 years old. It also facilitated coordination with the physical trainers of these teams in order to set a suitable date to conduct the "Georges Gacon" physical test, aimed at measuring the Maximum Aerobic Speed (MAS).

Study Methodology:

This study employed the comparative descriptive method, which is a type of descriptive methodology. This approach aims to compare three different samples in order to derive facts and data that help explain the differences among them.

Study Population:

The first step in selecting the sample involves identifying the research population the researcher intends to study—i.e., the broader group to which the results of the research can be applied. According to Abdelkader Abbas (2013, p. 118), the research population includes the individuals targeted by the researcher in their study. In our field study titled: "A Comparison of Maximum Aerobic Speed (MAS) among Under-19 Footballers Based on Playing Levels", which was conducted on the teams of USM Chaouia (USC), ES Sétif (ESS), and Olympique de Marseille (OM), the research population includes:

- Players from the First Professional Division.

- Players from the Amateur Division.

- Players from the French Professional League (U-19 category).

Test Used: The Georges Gacon 45/15 test was used, which is considered one of the best tools for data collection in scientific research due to the accuracy of the results it provides, helping to meet the objectives of the study (Wajih Mahjoub, 2014, p. 188).

Objective of the Test: To measure the Maximum Aerobic Speed (MAS) of each player, based on the competitive level they are active in.

Tools and Protocol Used: - This test relies on progressive intermittent running, where the speed increases by 0.5 km/h at each stage (Palier), each lasting one minute—comprising 45 seconds of running and 15 seconds of rest.

- The test begins at a speed of 10 km/h, and the pace is regulated using audio signals (Bips). Both speed and distance are predetermined.

- The MAS is calculated based on the last speed the player was able to complete successfully.

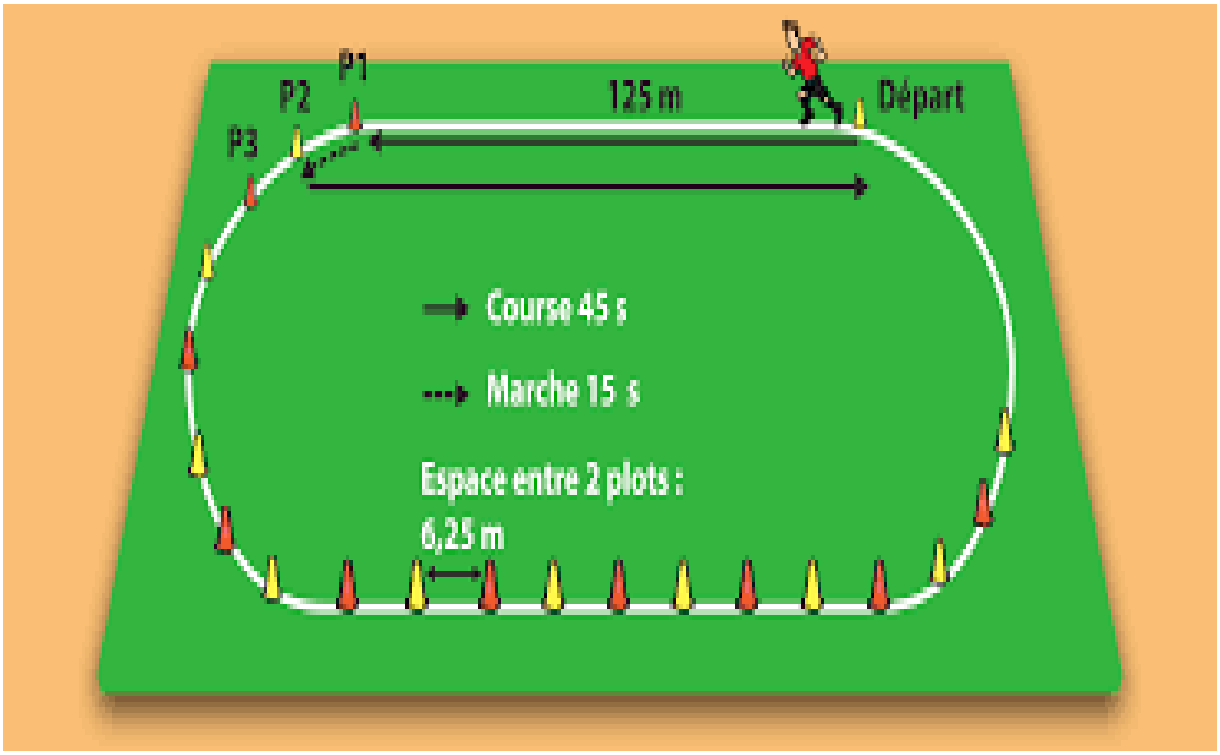
- The Georges Gacon 15/45 test is considered one of the most suitable for measuring MAS in footballers, as it aligns well with the physical demands of the sport.

- Final MAS values are extracted based on the following table:

Table No. 01: Analysis of the Results of the Georges Gacon (15/45) Test.

Level	Speed km/h	Running distance in 45 seconds	Time per 100m
5	10.0	125 m	36.00
6	10.5	131.25 m	34.29
7	11.0	137.5 m	32.73
8	11.5	143.75 m	31.30
9	12.0	150 m	30.00
10	12.5	156.25 m	28.80
11	13.0	162.5 m	27.69
12	13.5	168.75 m	26.67
13	14.0	175 m	25.71
14	14.5	181.5 m	24.83
15	15.0	187.5 m	24.00
16	15.5	193.75 m	23.23
17	16.0	200 m	22.50
18	16.5	206.25 m	21.82
19	17.0	212.5 m	21.18
20	17.5	218.75 m	20.57
21	18.0	225 m	20.00
22	18.5	231.25 m	19.46
23	19.0	237.5 m	18.95
24	19.5	243.75 m	18.46

(Alexandra dellal ,2008, p276-277)



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Statistical Methods and Techniques Used in the Study:

The statistical analyses were conducted using SPSS 2025. The arithmetic mean and standard deviation were calculated, and the data were processed using the One-Way Analysis of Variance (ANOVA) through the F-test to determine the statistical significance of the differences.

Presentation, Interpretation, and Discussion of Results:

Table No. (02) presents the results of the ANOVA test comparing footballers from the Second Amateur Division (USC) and the First Professional Division (ESS) in terms of Maximal Aerobic Speed (MAS) for the under-19 age category.

The hypothesis under investigation posits that there are statistically significant differences in MAS levels between players of ES Sétif (ESS) and those of US Chaouia (USC) in the under-19 category.

The findings are detailed in **Table No. (02),** which displays **the F-test results indicating the significance of differences in Maximal Aerobic Speed (MAS) levels.**

The Variable	Sports Teams	Number	Arithmetic mean	Standard Deviation	F-value	Degrees of freedom	Level of significance
MAS	**USC**	**20**	**15,44**	**1,86**	**6.17**	*59*	**0.00**
	ESS	**20**	**16,03**	**1,47**			

Analysis: As shown in Table No. (02), the p-value was (0.00), indicating statistical significance at the (0.05) level. This indicates the presence of statistically significant differences between the mean scores of the two teams regarding the level of (MAS) among their players. The results favor the players of team (ESS), whose average (MAS) level is (16.03), higher than that of the players of team US Chaouia (USC). Accordingly, it can be concluded that there are statistically significant differences at the (0.05) level, in favor of the players of team (ESS).

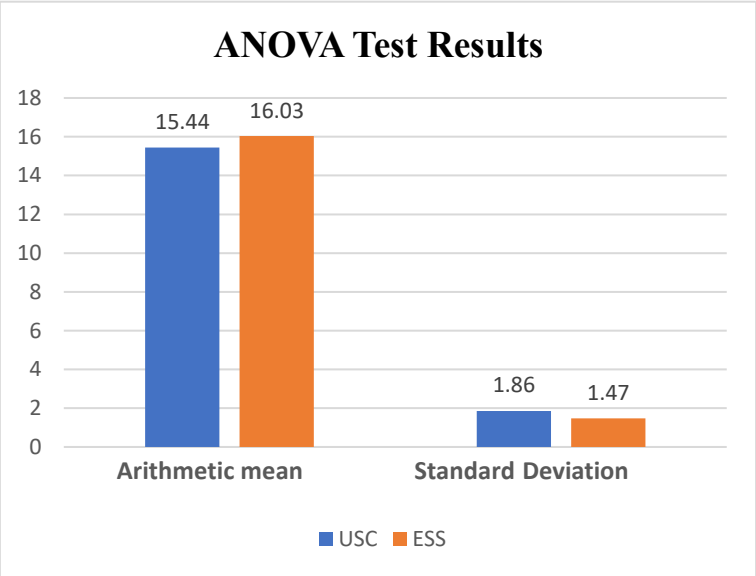


Table No. (03):

This table presents the results of the one-way ANOVA test comparing footballers from the Second Division Amateurs (USC) and those from the French Professional League (OM) in terms of maximal aerobic speed (MAS) for the under-19 age category.

The test is based on the hypothesis that there are statistically significant differences in the MAS level between players of Olympique de Marseille (OM) and those of US Chaouia (USC) within the same age group.

The results are shown in the table below, where Table No. (03) illustrates the F-test outcomes indicating the significance of differences in MAS levels.

The Variable	Sports Teams	Number	Arithmetic mean	Standard Deviation	F-value	Degrees of freedom	Level of significance
MAS	**USC**	20	15,44	1,86	6.17	59	**0.00**
	OM	20	17,04	0,85			

Analysis: According to Table (03), the p-value for the significance level is (0.00), which is significant at the (0.05) level. This indicates that there are differences between the mean results of the two teams regarding the (MAS) level of their players. The results favor the (OM) team players, as their (MAS) mean level is (17.04), higher than that of

the (USC) team players. Therefore, it can be concluded that there are statistically significant differences at the (0.05) level, in favor of the (OM) team players.

Figure (03):

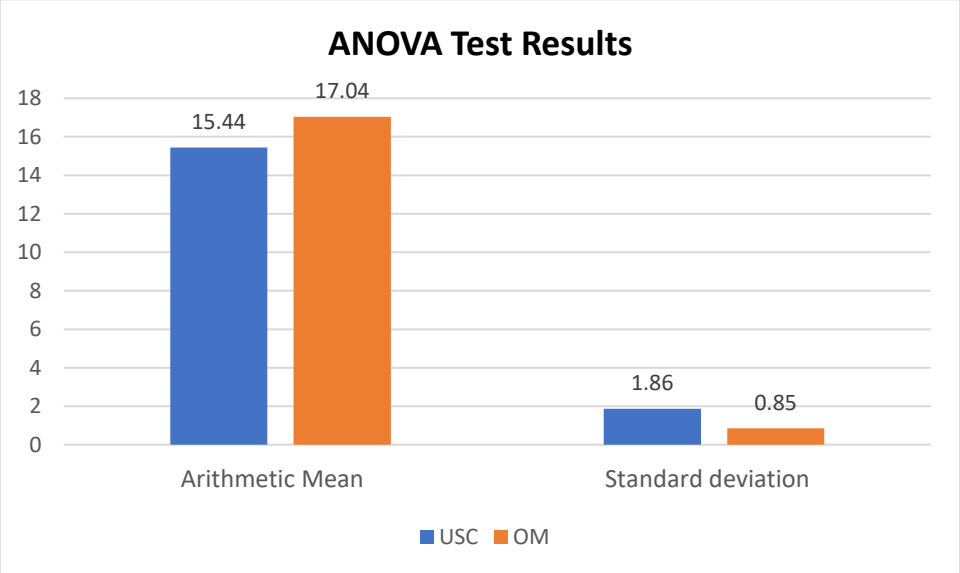


Table (04): This table presents the results of the "ANOVA" test comparing footballers from the first professional division team "ES Sétif (ESS)" and players from the French professional league team "Olympique de Marseille (OM)" in terms of maximal aerobic speed (MAS) for the under-19 age category.

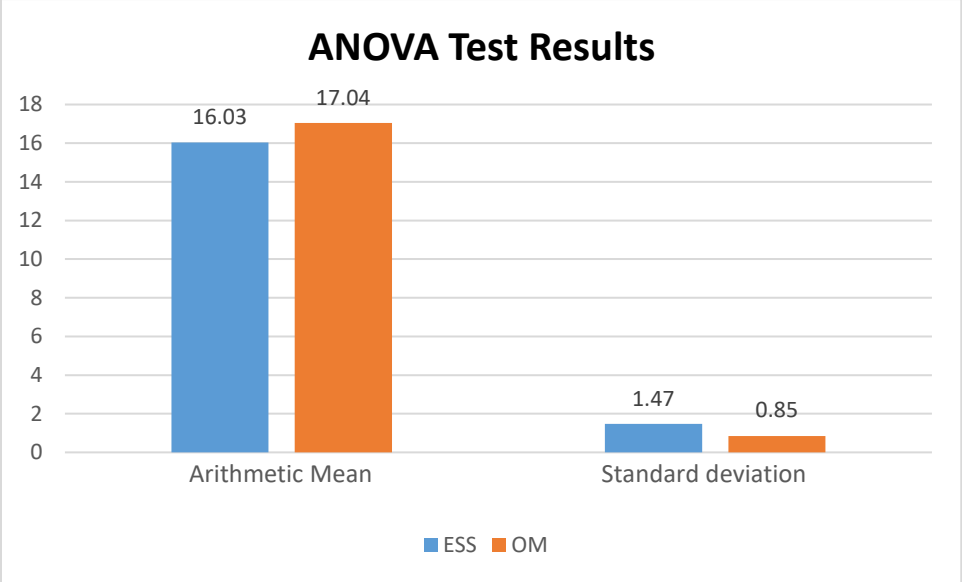
The table relates to the hypothesis stating that there are statistically significant differences in the MAS level between players of Olympique de Marseille (OM) and those of ES Sétif (ESS) in the under-19 category.

The results are shown in Table (04), which displays the outcomes of the F-test used to determine the significance of differences in MAS levels.

The Variable	Sports Teams	Number	Arithmetic mean	Standard Deviation	F-value	Degrees of freedom	Level of significance
MAS	**ESS**	20	**16,03**	**1,47**	**6.17**	*59*	**0.00**
	OM	20	**17,04**	**0.85**			

Analysis: Table (04) shows that the p-value for the level of significance is (0.00), which is statistically significant at the (0.05) level. This indicates the presence of differences between the mean results of the two teams regarding the maximal aerobic speed (MAS) of their players. The results favor the players of Olympique de Marseille (OM), whose average MAS level is (17.04), higher than that of the players of ES Sétif (ESS). Therefore, it can be concluded that there are statistically significant differences at the (0.05) level, in favor of the OM team players.

Figure (04):



Discussion and Interpretation of Results:

The observed differences in maximal aerobic speed (MAS) among under-19 footballers across various competition levels—specifically between players in the French professional league (Olympique de Marseille – OM), the Algerian professional league (ES Sétif – ESS), and the second amateur division (US Chaouia – USC)—are primarily attributed to disparities in weekly training volume (Micro cycle), including both the number of sessions and the duration dedicated to developing this physical attribute.

These findings align with the results of several studies conducted in Algeria that assess physical and physiological capabilities. For instance, the study by Houssam Cherrit (2021, p. 60) attributed the superior MAS levels of professional under-19 players to their greater training volume. OM players were shown to engage in more frequent and longer training sessions than ESS players, while ESS players, in turn, had a greater training volume than USC players.

In contrast, Modric D. et al. (2020) explained these differences through variations in the rhythm and intensity of competition, as well as the number of matches played.

Samer Abdelwarath et al. (2022) suggested that the type of rest adopted during the transitional phase—specifically "positive rest"—by OM and ESS players played a key role in performance differences.

Additionally, the study by Draji Abbas et al. (2019) highlighted that professional clubs rely on modern training methods, facilitated by the presence of qualified physical trainers, a resource generally lacking in amateur clubs.

Fouad Shiha (2015) pointed to differences in the availability of training and recovery equipment, which are present in professional clubs but nearly absent in amateur settings.

Furthermore, the study by Rafas Badis et al. (2025, p. 202) emphasized the use of advanced technological tools in professional under-19 clubs for evaluating MAS, a practice that is rarely found in amateur clubs.

A fundamental contributing factor is the structured and progressive physical development program implemented by professional clubs for their youth categories. This was also confirmed in the study by Allouche Mohamed (2019, p. 164), which attributed the observed differences to scientifically designed training frameworks used throughout all stages of youth development in professional clubs—resulting in a significant improvement in MAS compared to amateur club youth systems.

Based on all of the above, the researcher attributes these differences to the presence of specialized physical trainers in the youth categories of professional clubs, a role that is mandated by regulation and largely absent in amateur club youth structures.

Conclusions:

- Under-19 footballers in the professional first division show higher Maximal aerobic speed (MAS) values compared to those in the amateur second division.
- Under-19 footballers in the French professional league show higher Maximal aerobic speed (MAS) values compared to those in the amateur second division.
- Under-19 footballers in the French professional league show higher Maximal aerobic speed (MAS) values compared to those in the professional first division.

Recommendations:

- It is essential to assign qualified physical trainers to the youth categories of amateur clubs.
- Leverage the expertise of sports training specialists to conduct training sessions for coaches and physical trainers on how to use modern training tools effectively.
- Introduce modern technological systems in amateur clubs to monitor, assess, and update training programs in line with the demands of modern football.
- Prioritize the use of modern recovery techniques—such as massage, cold baths, and saunas—over traditional methods for youth players in amateur clubs.
- Focus on structured physical development programs in the youth systems of amateur clubs to enhance fundamental athletic capabilities.

Ethical Considerations

This study was conducted in accordance with the ethical principles of scientific research involving human participants. Prior to data collection, informed consent was obtained from all participants and their legal guardians. Participation was voluntary, and confidentiality of personal data was strictly maintained. The research protocol complied with institutional ethical standards and the principles outlined in the Declaration of Helsinki.

Author Contributions

- Conceptualization & Study Design: Soufiane Mahi, Mansour Benlakehal
- Data Collection: Mehdi Youcef Achira, Rabah Bourzama, Ibrahim Kadraoui
- Statistical Analysis: Mahdi Jouani, Mohammed Kherroubi
- Interpretation of Results: Fayçal Beldjouher, Maamar Badreddine Bensaada
- Manuscript Writing & Revision: All authors
  All authors reviewed and approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interest related to this study.

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