

Anthropometric measurements and their relationship to performance in modern women's football, a comparative study between Algerian and French teams 16-20 years

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Received: 30/12 /2024 Accepted: 18/05/2025 Published: 30/05/2025

Abstract: This study examines anthropometric differences between Algerian and French female football players aged 16-20. Ninety players from six clubs (three in each country) were measured for height, weight, body fat, skeletal muscle percentage, muscle mass, and bone mass. Statistical analysis revealed significant differences in weight and bone mass favoring French players, while no notable variations were found in height, muscle mass, or body fat percentage. These findings emphasize the influence of environment and training practices on physical development, highlighting the importance of structured training for improving athletic performance.

Key WORDS: Anthropometric measurements; Modern football ; sports performance ; technological analysis ; morphological characteristics

المخلص: هذه الدراسة تهدف إلى تحليل القياسات الأنثروبومترية للاعبات كرة القدم الجزائرية والفرنسية (16-20 سنة)، باستخدام عينة من 90 لاعبة من ستة فرق ثلاثة جزائرية وثلاثة فرنسية. تضمنت القياسات الطول، الوزن، نسبة الدهون، الكتلة العضلية، وكتلة العظام، بهدف مقارنة الفرق وتحديد الفروق. أظهرت النتائج فروقاً ذات دلالة إحصائية لصالح الفرق الفرنسية، مما يعكس تأثير البيئة والتدريب. أكدت الدراسة أهمية القياسات الأنثروبومترية في تطوير الصفات البدنية وتحسين الأداء الرياضي. كما سلطت النتائج الضوء على أهمية بيئة تدريب ملائمة لتعزيز القدرات البدنية. والتنبؤ بمستويات الأداء العالي، وتحقيق أهداف تطوير كرة القدم النسوية

الكلمات المفتاحية: القياسات الأنثروبومترية، كرة القدم الحديثة، الأداء الرياضي، التحليل التكنولوجي، الخصائص المورفولوجية،

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1-Introduction:

Women's football is currently experiencing unprecedented growth. All over the world, the number of women and girls practicing this sport is steadily increasing. In 2023, there were 16.6 million female players, representing an increase of approximately 24% compared to the 2019 figures, according to the report by the Fédération Internationale de Football Association (FIFA) on the survey of member associations for women's football. This growth is accompanied by increasing professionalization and improved standards, also reflecting the rise in commercial revenues generated by the sport (FIFA, 2019).

A deep understanding of the game's demands is essential for adopting a systematic approach to training (Reilly T., 2005). The anthropometric and physical characteristics of athletes are factors that can influence their performance and health status (Ackland TR & Lohman TG, 2012). According to Oliveira et al., studies on the anthropometry of elite female football players have shown that these athletes typically measure between 167 and 172 cm, weigh between 60 and 64 kg, and have a body fat percentage ranging from 20% to 22% (Oliveira R., 2021). Meanwhile, the study by Datson reveals that female football players have an average height between 161 and 169 cm and an average weight between 55 and 64 kg, with body fat percentage (BF) generally below 20%. Additionally, the body mass index (BMI) observed in these players varies between 20 and 23 kg/m² (Datson N., 2014).

It is important to emphasize that the physical and technical demands vary depending on the different positions or roles of each player within the team. In this regard, there are various classifications of playing positions in a football team. The most commonly described positions are generally goalkeepers, defenders, midfielders, and forwards (Sanchez-Medina, 2017; Vescovi & Favero, 2014). For example, each player covers different distances depending on her position. When analyzing the 2019 World Cup in France, the total

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distance covered was 5,362 meters for goalkeepers, 10,369 meters for defenders, 11,210 meters for midfielders, and 10,979 meters for forwards. Regarding the intensity of distances covered at medium and high intensity (19-23 km/h), defenders covered 253 meters, midfielders 313 meters, and forwards 360 meters. This shows that physical demands, effort intensity, and movements vary according to the playing position (Mallo, Mena, Nevado, & Paredes, 2015).

Indeed, Boone and colleagues demonstrated that the physiological characteristics of players vary based on their position, highlighting the importance of position-specific training to optimize performance. For example, forwards may require more speed and agility, while defenders focus on power and endurance. Although normative data has been provided by Manson et al. for different age categories, position-specific differences have not been studied in detail. This reveals a gap in research on female footballers, presenting potential for further exploration to better adapt training programs according to the specific demands of each position on the field (Manson, 2014).

There are also variations in body composition throughout different periods of the season, with higher fat tissue values during the transition period compared to the competition period. Additionally, significant differences in anthropometric values are also observed according to playing positions (Madic D. & Obadov S., 2018; Kammoun et al., 2020). It has been found that defenders are generally taller and heavier than other outfield players (Datson, 2014). Goalkeepers have the highest body fat percentages, which can be explained by lower energy expenditure during training and matches compared to other positions (Ascensão A., 2008).

With the rise of women's football and the increase in the number of young female players, studies have been initiated to further explore the anthropometric specifics of female football players, an area that remains under-researched. These studies aim to enrich our understanding of their physical characteristics and performance demands, in order to optimize training processes and talent

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development in this rapidly growing sport. As participation rates rise, the pool of available talent expands. This expansion, coupled with increased competition, forces top-level clubs to develop effective methods to identify and nurture talent. These methods must consider the specificities of the women's game and aim to optimize the recruitment and development of the most promising players. However, there is a lack of literature on talent identification in elite young female football players (Williams AM, 2020).

Despite the significant growth of women's football, research specifically focusing on female players remains largely underrepresented. Indeed, only about 20% of studies on football include women, and among these, more than 15% focus solely on professional players. This reveals a notable imbalance in scientific research, neglecting many other categories of players, especially young athletes and amateur players. This under-representation in studies may limit the understanding of the specific needs of female footballers in terms of physical preparation, training, and injury prevention. It is therefore essential to broaden the scope of research to better meet the demands of women's football at all levels (Kirkendall, 2021).

In North Africa, where women's football is still developing, few studies have been conducted. However, a recent study by Hammami et al. on elite young female footballers in Tunisia showed the positive effect of a season of training on the anthropometric characteristics, physical condition, and technical skills of the players (Hammami, 2023). Such studies are essential to better understand the specific needs of female players in terms of physical development and sports preparation.

In this context, comparing players from two different environments, namely Algeria and France, not only highlights national specifics in terms of physical development but also improves selection and training practices according to cultural and sporting environments. Indeed, the 16 to 20-year age period is particularly important in the

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sporting development of players. It corresponds to the end of growth and the stabilization of anthropometric characteristics, making this age range a critical period for talent detection and performance optimization. This study will allow for the analysis of these young players and better understand the physical factors that influence their development in women's football.

According to various studies, the topic of anthropometric parameters in female footballers remains under-explored. As a result, several questions can be raised:

- What are the most relevant anthropometric parameters for the selection of young female football players in Algeria and France?
- Are there significant differences in physical characteristics between Algerian and French players?
- How do these differences influence performance and selection methods in both countries?

These questions will guide our comparative analysis with the aim of improving the selection and development of young talent in women's football.

2- General objective of the study:

The main objective of this study is to compare the anthropometric parameters of female football players, aged 16 to 20, in Algeria and France. This comparison aims to identify the physical differences between these two groups of players and to assess the impact of these characteristics on selection and athletic performance. By providing comparative data between these two cultural and sporting contexts, this research seeks to better understand how these differences could influence talent identification and development practices in women's football.

3- Procedural definition of the concepts mentioned in the research:

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3.1 Paramètres anthropométriques (Alvero Cruz, et al., 2010) :

L'anthropométrie concerne les différentes mesures des dimensions et des proportions du corps humain. Grâce à ces mesures et à l'utilisation d'équations spécifiques, il est possible d'estimer le pourcentage de masse grasse (FM). Par conséquent, on peut également déduire la masse sans graisse (FFM) du corps.

3.2 Composition corporelle (Wang ZM, 1992) :

Body composition is a fundamental component of physical fitness, both in the fields of health and sports, and is typically studied through a five-level model. In sports studies, the primary focus is on the fourth level, which pertains to tissues and systems. This model divides the human body into two main categories: fat mass and fat-free mass.

3.3 Sélection des talents sportifs (Sarmento, 2023) :

La sélection des talents sportifs est le processus qui consiste à identifier les athlètes ayant le potentiel de réussir au niveau élite, en évaluant leurs capacités physiques, techniques, tactiques et psychologiques dans une approche multidimensionnelle.

4- The methodological procedures used in the study:

4-1 Method and tools:

4-1-1 Approach used:

In our study, we used an experimental approach involving anthropometric tests conducted at two different points during the competitive phase of the sports season (pre/post-test). This approach allowed us to objectively observe the anthropometric characteristics of female football players and verify the validity of our hypotheses. The measurements included weight, height, body mass index (BMI), body fat (measured via skinfolds), muscle mass, bone mass, protein percentage, and age, while noting the position of each player. This method enabled us to control several variables while observing the effects of training and competition on the athletes.

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4-2 Methods

4-1-2 Sample

The sample was selected from a group of 90 female soccer players distributed across six clubs (three in Algeria and three in France), with an average age of 17.25 ± 2.1 years. These players have been practicing soccer for a minimum of three years in their respective clubs. They follow a regular training program consisting of three sessions per week, with a total duration of 4.5 hours per week. The detailed characteristics of the sample are presented in Table 1. The participants reported not using any medications, exogenous supplements, or other substances that could alter their physiological balance during the study, and none reported severe menstrual disorders that could affect their performance.

The participants, along with their parents for minor players, were informed about the experimental procedures, with assurances that the data collected during the study would be treated confidentially and anonymously. Each player was informed about the purpose of the study and provided their consent. For minor players, a consent form was signed by their parents.

Table 1: Sample characteristics (mean: (M) $\pm$ standard deviation (SD))

Number of athletes	Age (year)	Weight (kg)	Taille (m)	IMC
90	17.25 ± 2.10	61.23 ± 9.50	1.68 ± 0.07	21.8 ± 3.20

Source: Table made by author's

Presentation and Analysis of Results:

Table 2: Description of anthropometrics tests

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TESTS	OBJECTIFS
Body Height Measurement	Measure body height
Body Weight Measurement	Measure body weight
Body Mass Index (BMI) Calculation	Calculate body mass index to assess body weight status

Body Fat Percentage Measurement	Assess body fat percentage for body composition analysis
Body Water Percentage Measurement	Measure body water percentage to understand hydration levels
Skeletal Muscle Percentage Measurement	Evaluate skeletal muscle percentage for muscle mass distribution
Muscle Mass Measurement	Measure total muscle mass in kilograms
Bone Mass Measurement	Measure bone mass in kilograms for skeletal health
Protein Percentage Measurement	Assess protein percentage for overall body composition

Source : Table made by author's

Scientific Basis of the Tool:

We utilized field tests to evaluate our research hypothesis regarding the anthropometric differences between female soccer players from Algerian and French clubs. As with any measurement instrument, it was essential to ensure the reliability and validity of the tests we employed.

Reliability: To verify the reliability of our tests (presented in Table 03), we calculated the correlation between the results obtained during the pre-test and the post-test. This method allowed us to measure the

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consistency of performances and confirm the reliability of the instruments used, including the Tanita bioimpedance analyzer.

	Height (m)	Weight (kg)	Body Fat (%)	Skeletal muscle (%)	Muscle mass (kg)	Bone mass (kg)	Protein (%)
Béjaïa	1.0	0.990083 7322474 805	0.997319 5764003 231	0.982354 0116197 819	0.988569 4852935 509	0.999999 9999999 999	1.0
Boulogne	1.0	0.990076 1991812 523	0.998261 4869241 895	0.980512 6007821 677	0.980132 0021740 49	0.999999 9999999 999	1.0
Constantine	1.0	0.987019 9730311 835	0.997560 2174181 173	0.984013 6806922 48	0.991714 6819370 732	0.999999 9999999 999	1.0
Oran	1.0	0.991080 8171318 195	0.995812 6368470 318	0.993139 2183012 22	0.990532 3094466 296	0.999999 9999999 999	1.0
Sarcelles	nan	nan	0.999720 0245369 701	0.984216 2894345 298	0.980942 8347647 203	nan	0.999999 9999999 998
Versailles	0.9999 99999 99999 98	0.992844 7099423 62	0.998769 9385868 13	0.961225 1035144 409	0.981187 0928422 234	1.0	1.0

Source: Table made by author's

The analysis of the table above shows a Pearson correlation coefficient that varies between 97% and 99%. This means that there is a strong correlation between the pre and post-tests, so we conclude that our tests are reliable and can be applied in our study.

Validity: to check the validity of our tests, we will proceed to calculate the root of the correlation coefficient between the pre and pos-tests.

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Table N° 04: Presentation of the validity results of the pre/post tests

Variable	Pearson Correlation	Significance
Height (m)	1.0	Significant
Weight (kg)	0.9898968457759358	Significant
Body Fat (%)	0.9993142770944377	Significant
Skeletal muscle (%)	0.991179910754528	Significant
Muscle mass (kg)	0.993237881089643	Significant
Bone mass (kg)	1.0	Significant
Protein (%)	0.9999999999999999	Significant

Source: Table made by author's

The analysis of the tables above shows a validity coefficient ranging from 98% to 100%. This indicates that our tests are valid and can be confidently applied within the framework of our study.

Statistical Tools:

For descriptive statistics, we calculated the mean and standard deviation. For analytical statistics, we used Student's t-test for paired and independent samples, as well as a two-factor ANOVA to compare the French and Algerian clubs. The calculations were performed using SPSS 24 and Excel 2019, with a significance level of $p=0.05$ $p = 0.05$ $p=0.05$.

5-Presentation and Analysis of Results:

The different results of the physical tests are reported in Table N°05 and the descriptive parameters are elaborated in mean values $\pm$ standard deviation.

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Table N° 5: Descriptive and analytical statistical data of anthropometrics tests

Anthropometric Tests	Algérie	France	T-Student's test
Height (m)	1.65 ± 0.07	1.68 ± 0.08	Insignificant difference (sig < 0.05)
Weight (kg)	59.3 ± 6.1	61.5 ± 5.4	Significant difference (sig > 0.05)
Fat (%)	17.8 ± 3.9	18.2 ± 4.1	Insignificant difference (sig < 0.05)
Skeletal muscle (%)	41.9 ± 3.5	42.5 ± 3.2	Significant difference (sig > 0.05)
Muscle mass (kg)	24.8 ± 3.0	25.3 ± 2.8	Insignificant difference (sig < 0.05)
Bone mass (kg)	2.8 ± 0.2	2.9 ± 0.3	Significant difference (sig > 0.05)
Protein (%)	16.5 ± 1.9	16.7 ± 1.8	Insignificant difference (sig < 0.05)

Source: Table made by author's

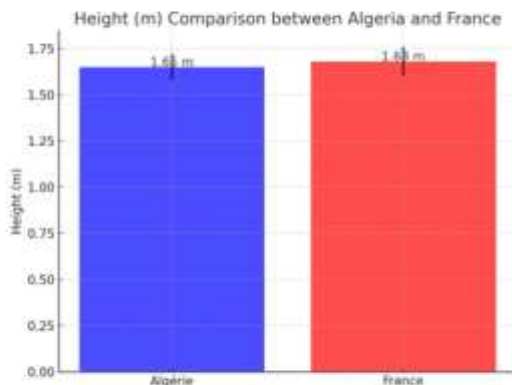
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5.1-Height (m):

The analysis of the height data reveals a slight increase in the mean height from 1.65 meters for Algerian players to 1.68 meters for French players, with a standard deviation of ± 0.07 for Algeria and ± 0.08 for France. The T-student's test shows an insignificant difference ($\text{sig} < 0.05$), indicating that the variation in height between the two groups is not statistically significant.

Figure 1: Comparative Bar Chart of Average Heights: Algeria vs France



Source: made by author's

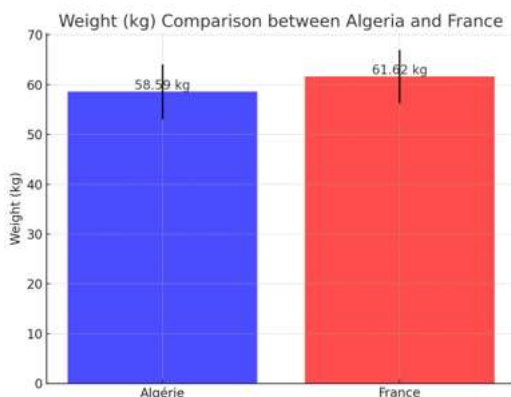
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5.2-Weight (kg):

The weight comparison between Algerian and French players shows a mean increase from 59.3 kg to 61.5 kg, respectively, with standard deviations of ± 6.1 kg and ± 5.4 kg. The T-student's test reveals a significant difference ($\text{sig} > 0.05$), meaning that French players tend to have a higher body weight than their Algerian counterparts, and this difference is statistically significant.

Figure 2: Weight (kg) Comparison between Algeria and France



Source: made by author's

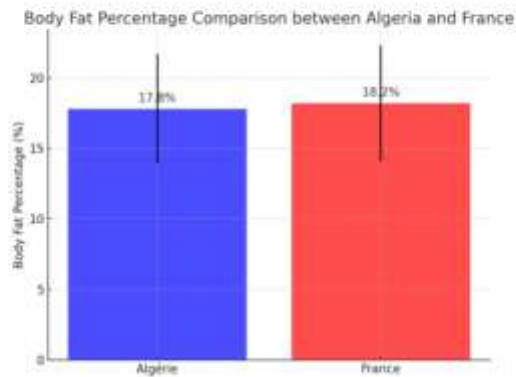
5.3-Body Fat Percentage:

The mean body fat percentage slightly increases from 17.8% for Algerian players to 18.2% for French players, with standard deviations of $\pm 3.9\%$ and $\pm 4.1\%$. The T-student's test shows no significant difference ($\text{sig} < 0.05$), indicating that the body fat percentage is comparable between the two groups.

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Figure 3: Body Fat Percentage Comparison between Algeria and France

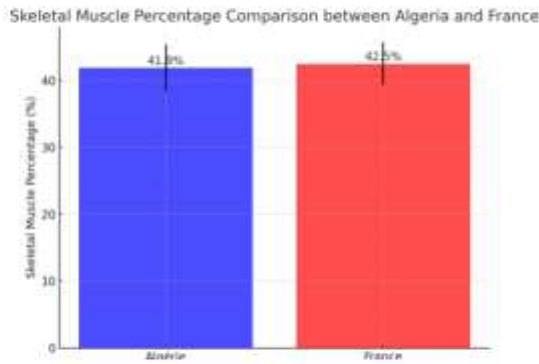


Source: made by author's

5.4- Skeletal Muscle Percentage: The French players demonstrate a slightly higher mean skeletal muscle percentage (42.5%) compared to Algerian players (41.9%), with respective standard deviations of $\pm 3.2\%$ and $\pm 3.5\%$. The T-student's test reveals a significant difference ($\text{sig} > 0.05$), suggesting that French players have a higher muscle mass compared to their Algerian counterparts.

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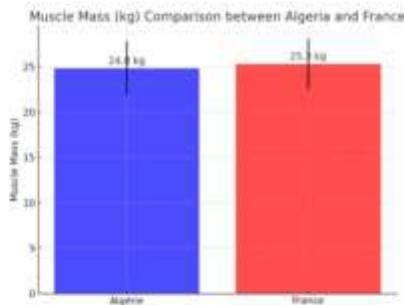
Figure 4: Skeletal Muscle Percentage Comparison between Algeria and France



Source: made by author's

5.5- Muscle Mass (kg): The muscle mass is comparable between the two groups, with Algerian players having a mean of 24.8 kg and French players a mean of 25.3 kg. The standard deviations are ± 3.0 kg for Algeria and ± 2.8 kg for France. The T-student's test shows no significant difference ($\text{sig} < 0.05$), indicating similar muscle mass between both groups.

Figure 5: Muscle Mass (kg) Comparison between Algeria and France



Source: made by author's

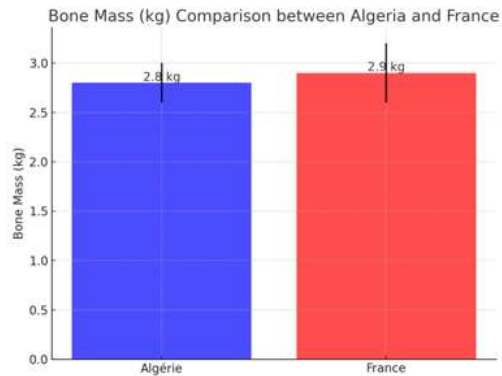
5.6- Bone Mass (kg): There is a slight increase in bone mass for French players (2.9 kg) compared to Algerian players (2.8 kg), with

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standard deviations of ± 0.3 kg and ± 0.2 kg. The T-student's test reveals a significant difference ($\text{sig} > 0.05$), suggesting that French players may have stronger or denser bones than Algerian players.

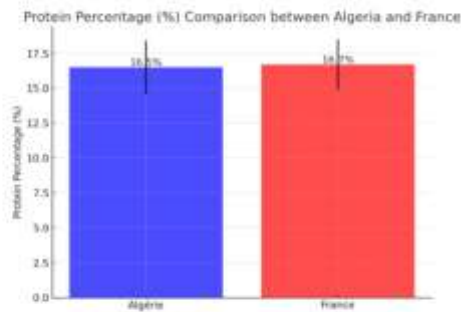
Figure 6: Bone Mass (kg) Comparison between Algeria and France



Source: made by author's

5.7- Protein Percentage (Protein %): The mean protein percentage is similar between the two groups, with 16.5% for Algerian players and 16.7% for French players. The standard deviations are $\pm 1.9\%$ and $\pm 1.8\%$, respectively. The T-student's test shows no significant difference ($\text{sig} < 0.05$), indicating that the protein composition is similar between Algerian and French players.

Figure 7: Protein Percentage (%) Comparison between Algeria and France



Source: made by author's

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4-3 Discussion and interpretation of the results:

The results indicate an insignificant difference in height between Algerian and French players (1.65 m vs. 1.68 m), aligning with previous studies that suggest height is not a determining factor in soccer performance (**Datson N, 2014**).

However, French players exhibited a significantly higher weight (61.5 kg vs. 59.3 kg), likely due to differences in diet, training intensity, and advanced nutritional support (**Thomas, 2016; Vescovi J. D., 2014; Oliveira et al., 2021**).

Body fat percentage showed no notable variation between groups (17.8% vs. 18.2%), indicating comparable training and dietary habits (**Datson N, 2014; Ackland, 2012**). French players had a higher skeletal muscle percentage (42.5% vs. 41.9%), attributed to advanced conditioning and sports science support, enhancing their strength and power (**Boone, 2015; Mallo J. M., 2015; Sánchez-Medina et al., 2017**).

Despite this, overall muscle mass was similar (24.8 kg vs. 25.3 kg), likely reflecting uniform training intensities and comparable experience levels (**Madic D. O., 2018; Kammoun et al., 2020**).

Bone mass was slightly higher in French players (2.9 kg vs. 2.8 kg), influenced by better nutrition and high-impact training known to increase bone density (**Wang, 1992; Oliveira, 2021; Julian, 2017**).

Protein levels were comparable (16.5% vs. 16.7%), suggesting balanced nutritional intake in both groups (**Wikstrom-Frisén, 2017**).

These findings underscore the role of environment and training in shaping players' physical attributes.

Conclusion:

High-level sports participation among women is often limited by sociocultural beliefs about physical differences (**Seck et al., 2013**). This study highlights significant anthropometric differences between Algerian and French players, particularly in weight and bone mass, influenced by environment and training. In contrast, height, muscle mass, and body fat percentage showed no significant differences, suggesting similar physical preparation approaches in both contexts (**Oliveira et al., 2021**). Future research on physiological and biomechanical factors, along with broader samples, could offer deeper insights into optimizing female athlete development.

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