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The connection between muscle mass and fat mass measured by in body 720 on maximal aerobic speed in under-19 football players

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***Abstract*---**Our study is descriptive research seeking to identify the link between muscle mass and fat mass with maximal aerobic velocity. The sample was intentionally selected, consisting of 28 football players from the Under-19 team of MC Alger. Our findings indicate no correlational the relationship between muscle tissue percentage and fat mass percentage, and their correlation with maximal aerobic speed.

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Introduction

Given the substantial investment in football and the enormous amounts of money spent annually worldwide in sports clubs and professional academies, researchers and specialists have paid great attention to this sport to enhance its various aspects, including skills, tactics, mentality, and physical condition. This is aimed at achieving and maintaining sports accomplishments by developing physical capabilities and the function of body systems through research in training programs and the development of new ones to improve all components of the sport.

The study delves into body measurements and the physical and physiological characteristics to predict performance and attempt to control factors and variables that affect performance capability. Strength, speed, and endurance are considered fundamental physical attributes that can directly influence performance (Tamanka & Mabsurra, 1982) Researchers have therefore focused on analyzing various physiological and functional aspects to understand even the smallest details, such as body lengths, circumferences, muscle percentage, fat percentage, bones, and body fluids, to discern the different physical disparities from person to person based on age, gender, and physical activity.

Muscles in the body perform numerous important functions, such as facilitating movement, aiding in blood circulation, and moving food through the digestive system. According to several studies, muscle mass constitutes less than 44% of body weight in men and less than 33% in women. This percentage includes:

- Skeletal muscles found throughout the body,
- Smooth muscles found in internal organs,
- Cardiac muscles.

With aging, muscle mass naturally decreases, a phenomenon known as age-related muscle loss. Many people believe that weight is an indicator of body health. However, body health is actually assessed based on its composition. Body composition is divided into two parts: fat mass and fat-free mass (which includes muscles, bones, organs, and fluids). A healthy body can be achieved by reducing fat weight and increasing muscle weight through exercise and healthy dietary practices (Ismail & Kamel Rateb, 1986).

The weight of muscles differs from the weight of fat in terms of density. Muscles have a higher density than fat. For example, one kilogram of cotton, representing fat, will occupy much more space than one kilogram of iron, representing muscles. It is worth noting that an increase in body fat percentage can lead to a higher risk of many diseases, such as high blood pressure, type 2 diabetes, and heart disease. Therefore, it is important to maintain a normal body fat percentage. A good muscle mass percentage is considered an indicator of human health, but currently, there are no specific guidelines indicating the natural and healthy percentages of muscles. However, the healthy percentage of body fat is considered

an indicator of overall body composition. Therefore, the fat-free mass, which includes muscles, bones, organs, and fluids, can be determined by subtracting the fat percentage from 100. This method may be complicated and inaccurate, so it is preferable to measure fat mass and muscle mass using body composition analysis devices (Heymsfield, Arteaga, Manus, Smith, & Moffit, 1983) Nutrition specialists and sports centers use body composition analysis devices, such as the InBody 720, through which researchers can precisely analyze and understand the body composition of athletes to develop and improve training programs.

Study problem

A football player is affected by a set of internal and external factors that influence overall performance and physical exertion. As specialists in the field, we aim to accurately understand these factors to design targeted programs and select the most effective methods to develop and maintain various abilities to achieve the highest level of sports performance. Due to the role of anthropometric measurements in skill performance, they are often used as a basis for success or failure in a specific activity. Anthropometric measurements have gained significant importance in various sports fields, and it has been observed that biomechanical variables play a crucial role in the level of achievement when studied using the latest scientific techniques and devices. (Marwan, Abdul Majeed Ibrahim, 1999) points out that anthropometric measurements are objective measurement tools used to measure body composition and changes in muscles resulting from sports performance. Anthropometric measurements in sports have great importance, as they have been found to be related to many motor abilities and excellence in various activities (Mohamed Nasr El-Din, Radwan, 1997) Additionally, body mass percentage and fat mass percentage are related to many physical abilities (Dellal, 2008) One of the most important indicators that help maintain general health in ordinary individuals and skilled motor performance in athletes participating in various competitions is the relationship between some indicators analyzed using the InBody 720 device and some physical tests. The problem of this study can be formulated in the following main question:
Is there a relationship between fat mass and muscle mass with maximal aerobic speed in under-19 football players of MC Alger?

Study Hypothesis
This study proceeds from the following main hypotheses:
There is a link between muscle mass, fat mass, and maximum aerobic speed in under-19 football players

The following sub- hypotheses fall under this main hypothesis:

- A correlation exists between muscle mass and maximal aerobic speed in under-19 football players.
- A relationship exists between fat mass and maximal aerobic speed in under-19 football players.

Study Objective

The objective of this study is to enhance the physical fitness level of our athletes by analyzing various components of the athlete's body and working on them. This

is intended to develop and continuously evaluate physical abilities and to determine the relationship between fat mass and muscle mass with maximal aerobic velocity. The goal is to move from randomness and chance to a precise, scientific, and methodical approach in the process of physical preparation and to improve the physiological and functional capabilities of high-level athletes.

1. Study Terminology
Four influential terms were chosen for the study as follows:

1.1 Skeletal Muscle Mass (SMM)
The total weight of the skeletal muscles. This refers to the weight of the body's muscles in kilograms and is sometimes referred to in reports as Skeletal Muscle Mass (SMM), excluding the heart and other internal muscles.

1.2 Body Fat Mass (BFM)
The amount of fat in your body, combining both subcutaneous and visceral fat. Note: BFM (Body Fat Mass) is the weight of fat in your body in kilograms.

1.3 InBody 720
A very advanced device that operates using Bioelectrical Impedance Analysis (BIA), measuring the body's internal resistance when a very small electric current passes through it (excluding the neck and head) without being felt. This device will change your understanding by analyzing your body composition with a detailed report that includes more than 40 measurements, such as fat mass, muscle mass, water, minerals, and protein in the body. It also evaluates your appearance balance and helps you determine the healthiest lifestyle for you. All this is achieved through 8 electrodes attached to the hands and feet, increasing the contact area with the body and making the device 98% accurate.

1.4 Maximal Aerobic Speed (VMA)
The maximum speed reached at VO2 Max (Cazorla, 2016) It is expressed in kilometers per hour (km/h) and is the highest speed an athlete reaches at their maximum oxygen consumption.

2. Literary review
Several previous studies related to the research variables were relied upon, arranged chronologically from the newest to the oldest, with comments at the end of each presentation:

Study by Shiret Hossam Eddine et al., 2022
Titled "Percentage of Body Fat and Body Mass Index (BMI) and Their Relationship with Maximal Aerobic Speed (VMA) in Senior Male Football Players." The study aimed to determine the connection between body fat percentage and BMI with maximal aerobic speed. The researchers found a strong inverse correlation with statistical significance between body fat mass percentage and BMI with maximal aerobic speed.

Study by Fazlawi Hosni, 2020, University Center Nour El-Bashir El-Bayadh
Titled "The Effectiveness of Football Training Programs on Physiological Components Using the InBody 230 Device." The purpose of the study was to

highlight the function and efficacy of training methods implemented by certain football coaches and their effects on various physiological body components of Mouloudia El-Bayadh players over one sports season. The study followed the experimental approach suitable for the study nature and used interviews with coaches and players to explain the Bioelectrical Impedance Analysis (BIA) method using the InBody 230 device. The device assessed body weight, muscle mass, body fat percentage, and total skeletal muscle mass to evaluate the importance coaches place on program planning. The study involved 27 senior players with an average age of 24.00 years and an average BMI of 22.485 kg/m². The players followed the coach's program, leading to a statistically significant rise in the mass of all skeletal muscles mass from the initial value of 30.814 kg to 34.651 kg, an increase of 3.837 kg. Conversely, body fat percentage showed a decrease from 15.190% to 11.970%.

Study by José Francisco da Silva et al., 2020, University of Pernambuco
Titled "The Relationship Between Body Composition and Maximal Aerobic Capacity in Karate Athletes." The study sampled 13 beginner athletes under 21 years old active in the Pernambuco Union Club. After conducting maximal aerobic speed tests and standardized karate tests, along with various anthropometric measurements and body composition indicators such as body mass and fat percentage, the study concluded that there is an inverse relationship between total fat mass and body fat percentage with performance in the standardized karate test. Athletes with lower fat mass and body fat percentage performed better.

Study by Mendra Sandra and Williams RJ, University of Texas, 2018
Titled "The Relationship Between Maximal Aerobic Capacity and Body Fat Percentage in Athletes and Non-Athletes." The study sampled 4 athletes aged 19-28 years and 5 non-athletes aged 19-28 years. After conducting physical tests for maximal aerobic speed and capacity and taking various anthropometric measurements such as height and weight, the study found that body fat percentage is higher in non-athletes compared to athletes. It also concluded that maximal aerobic capacity achieves higher values based on sports training and body fat percentage, indicating a relationship between the amount of physical exercise and body fat percentage with maximal aerobic capacity.

Study by Jamal El-Din Abdel Aziz Murad, 1986:
The study focused on morphological measurements and their relationship with the requirements of some team sports at the international level in the Arab Republic of Egypt. The aim was to determine some morphological measurements for players in selected team sports (football, handball, volleyball, basketball). The study concluded that:

- Differences in body composition affect performance.
- There are differences between players in the selected team sports in some measured morphological dimensions.
- Morphological characteristics related to human composition are closely related to muscular work.

2.1 Analysis of the Studies

From the previous presentation of related research on our study variables, we find that these studies focused on finding the relationship between various measurements and body indicators with maximal aerobic speed and aerobic capacity. They share data collection tools and the methodology used in the study and align with our study in finding the relationship between different measurements and body indicators with maximal aerobic capacity. However, our study differs from the mentioned studies in the accuracy of data collection, especially the physical measurements and indicators used in our research, which were obtained using the most precise body composition analysis device in the world, the InBody 720. They were relied upon and benefited from in identifying the research problem and enriching the theoretical aspect of the current study, as well as understanding the various methodological procedures and their results.

3. Study Methodology

The researcher relied on several points as follows:

3.1 Research Method

The descriptive method, It is a type of scientific analysis and interpretation of a particular phenomenon or topic, and its portrayal as it is by gathering systematic data and information regarding the phenomenon or issue, classifying, analyzing, and subjecting it to a thorough study (Atallah, 2009).

3.2 Study Population

In this research, the study population consists of under-19 football players in the first professional league.

3.3 Study Sample

The study sample consists of under-19 football players from the MC Alger team, totaling 82 players.

3.4 Experimental Control of Variables

Experimental control refers to attempts to eliminate and isolate extraneous influences on the dependent variable (Mohamed Hassan, Alawi, 1996) to avoid affecting the experimental results. These influences, such as age, some morphological traits, nutrition, or water distribution in the body, cannot be controlled by the researcher. Based on these considerations, several procedures were carried out to control the variables, including personal supervision of body measurements and physical tests, ensuring consistent laboratory and field conditions to ensure the accuracy of results and avoid the effects of extraneous factors. The researcher adopted the experimental group method for pre- and post-application tests, relying on the intentional selection of sample members and comparing the means of certain variables. Skewness coefficients were calculated for all variables to find homogeneity among the sample members in different variables, which were controlled (weight, age, and height) to ensure these variables' equivalence before conducting the experiment. The following table explains this:

Table 01: Skewness Coefficient for Weight, Age, and Height

Variables	Unit of Measurement	Median	Mean	SD	Skewness Coefficient
Weight	kg	64.39	66.2	3.7	0.39-
Age	years	18.08	18.55	2.83	0.52-
Height	cm	166	168	4.32	0.40-

SD= Standard Deviation

Source: Prepared by researchers based on SPSS 22 results.

4. Tools and Tests Used in the Research

The InBody 720 device was used to measure muscle mass index and fat mass.

4.1 Device Specifications

Figure 01: InBody 720 Device

Source: (Indiamart, 2023)

The InBody 720 device: A 60-second test that provides quick measurements in less than a minute for fat mass, muscle mass, and body water levels without exposure to water, pricking, or any discomfort. Simply stand and hold the electronic hand grips. The InBody device does not rely on statistics: It depends solely on resistance to determine actual body composition analysis results, away from experimental estimates such as asking for gender and age to predict body composition based on other similar patient data. A dedicated database for the InBody device: All data from the InBody 720 is automatically sent to the InBody 720 software account, where it is saved in a dedicated database for easy viewing and management of your results and tracking your progress anytime, anywhere.

4.2 Device Purpose

The InBody device provides a detailed report on the results sheet, including weight, total body water percentage, intracellular and extracellular water, fat mass, muscle mass, BMI, basal metabolic rate, minerals, proteins, and the

amount of fat and muscle in the arms, legs, and trunk. Each test from the InBody 720 provides a complete report of the results, detailing the percentages of muscles, fat, and water in the body. The InBody 720 is considered the top device for providing the most comprehensive body analysis. In addition to the body composition analysis report, it provides a detailed report on body water composition (total body water, intracellular water, extracellular water, detailed water distribution in the body, etc.).

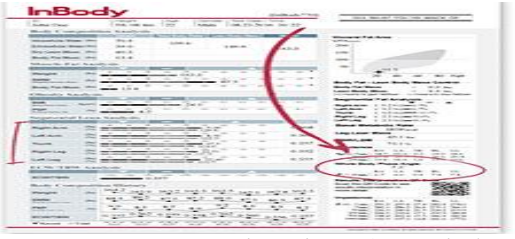

Figure 02: Test Results Sheet (InBody 720)
Source: (Indiamart, 2023)

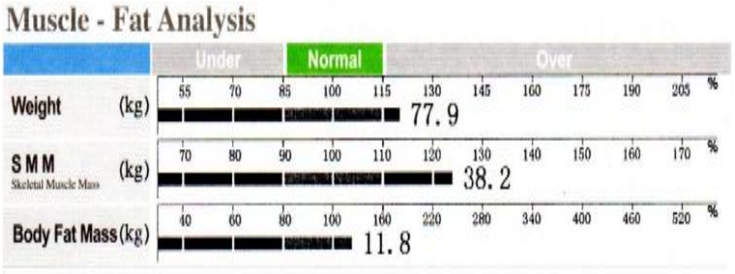

Figure 03: Section Taken from the InBody 720 Test Sheet
Source: (Indiamart, 2023)

4.3 Guidelines

For best results, InBody recommends conducting body composition analysis every 2-4 weeks.

4.4 Hand and Foot Position

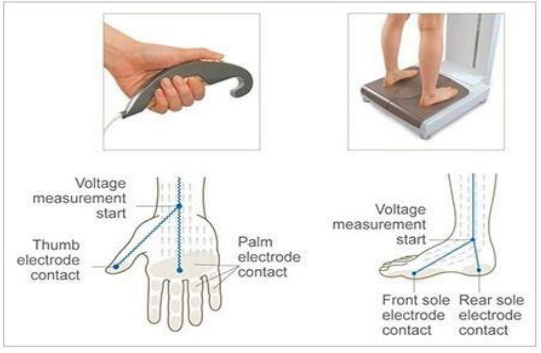

Figure 04: Diagram Showing Hand and Foot Position in the InBody 720 Device
Source: (Indiamart, 2023)

4.5 Maximal Aerobic Speed Test

Using the 30-15 IFT Test by Martin Buchheit

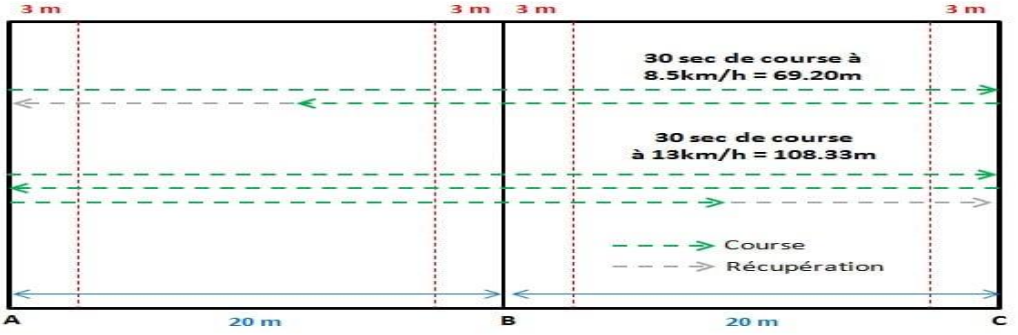

Figure 05: Diagram of the Test Track for the 30-15 IFT Test
Source: (Prepa-Physique, 2023)

5. Test Specifications

This test was created by Martin Buchheit, a sports scientist, exercise physiologist, and former performance director at Paris Saint-Germain. The test involves 30-second stages interspersed with 15 seconds of recovery. Players run according to the auditory signal (which indicates running speed), and at the end of each stage, 15 seconds of recovery allow players to walk to the next line (A - B or C, depending on the end of the run). Refer to the two examples in the diagram. The test starts at a speed of 8 km/h, which is a fast walk, and increases by 0.5 km/h at each stage. The 30/15 IFT test ends for the player when they can no longer reach the tolerance zones 3 consecutive times (in red). Coaches should note the speed of the last completed stage (not the dropout speed).

5.1 Guidelines

The IFT 30/15 test can be conducted during football physical preparation or throughout the sports season.

6. Presentation and Analysis of Results

6.1 Presentation and Analysis of the First Hypothesis

Is there a relationship between muscle mass and maximum aerobic speed in under-19 football players? To verify the hypothesis, Pearson's correlation coefficient between muscle mass and peak aerobic velocity was calculated. The following table shows this:

Table 02: Results of the Relationship Between Muscle Mass and Maximal Aerobic Speed

Tests	UM	Median	SD	r	S.t **Sig**	S.t D
Muscle Mass	kg	35.27	3.72	0.324-	0.093	Not Sig
Maximal Aerobic Speed	seconds	20.26	1.23			
Sample: 28			Significance Level: 0.05			

UM = Unit of Measurement, r = Pearson's Correlation Coefficient, S.t Sig = Statistical Significance S.t D = **Statistical Decision**

Source: Prepared by researchers based on SPSS 22 results.

From the table, it is evident that the mean and standard deviation values for muscle mass are 35.27 and 3.72, respectively. The following figure illustrates this further.

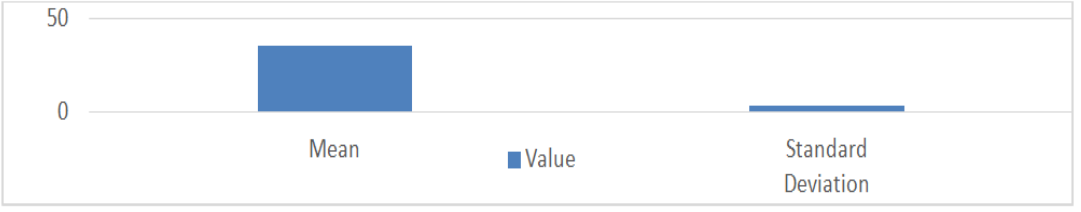

Figure 6: Bar Graphs of the Mean and Standard Deviation for Muscle Mass

Source: Prepared by researchers based on SPSS 22 results.

From Table 02, it is clear that Pearson's coefficient value is -0.324, indicating a weak inverse correlation but without statistical significance, as the p-value is 0.093, which exceeds the significance level of 0.05. This indicates no correlation between muscle mass and maximal aerobic speed, meaning the hypothesis is not confirmed.

6.2 Presentation and Analysis of the Second Hypothesis

Is there a relationship between fat mass and maximal aerobic speed in under-19 football players? To verify the hypothesis, Pearson's correlation coefficient between fat mass and maximal aerobic speed was calculated. The following table shows this:

Table 03: Results of the Relationship Between Fat Mass and Maximal Aerobic Speed

Tests	UM	Mean	SD	r	S.t **Sig**	S.t D
Fat Mass	kg	8.403	3.079	-0.257	0.157	Not sig
Maximal Aerobic Speed	seconds	20.26	1.23			
Sample: 28			Significance Level: 0.05			

UM = Unit of Measurement, r = Pearson's Correlation Coefficient, S.t Sig = Statistical Significance S.t D = **Statistical Decision**

Source: Prepared by researchers based on SPSS 22 results

The table makes it evident that the fat mass's mean and standard deviation are, respectively, 8.403 and 3.079. This is further illustrated in the following graphic.

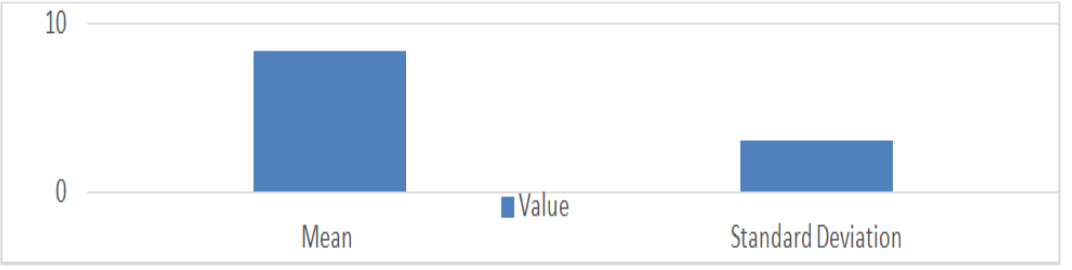

Figure 07: Bar Graphs of the Mean and Standard Deviation for Body Mass
Source: Prepared by researchers based on SPSS 22 results

From Table 03, it is evident that Pearson's coefficient value is -0.257, indicating a weak inverse correlation but without statistical significance, as the p-value is 0.157, which is greater than the significance level of 0.05. This indicates no correlation between fat mass and maximal aerobic speed, meaning the hypothesis is not confirmed.

7. Discussion and Interpretation of Results

7.1 Discussion of the First Hypothesis:

The first hypothesis states that there is a relationship between muscle mass and maximal aerobic speed in under-19 football players. The results obtained were contrary to what the researcher hypothesized and what several studies in this field have confirmed. As shown in Table 2, there is no correlational relationship between muscle mass and maximal aerobic speed in under-19 football players. The researcher attributes this to the small sample size and the ideal muscle mass, which is below the usual figure and close in weight among the players. The correlation value obtained contradicts the opinions of scientists regarding the relationship between the level of sports performance in various sports activities and body composition. The nature of bodies varies, and the percentage of fat and muscle differs depending on the type of specialized sports activity (StéphaneCascua, 2010)

7.2 Discussion of the Second Hypothesis:

The second hypothesis states that there is a relationship between fat mass and maximal aerobic speed in under-19 football players. The results obtained were contrary to what the researcher hypothesized and what several studies in this field have confirmed. As shown in Table 3, there is no correlational relationship between fat mass and maximal aerobic speed in under-19 football players. The researcher attributes this to the small sample size and the ideal fat mass among the players, with their weights being similar. The correlation value obtained contradicts the findings of scientists in their research regarding the relationship between fat mass and achieving the highest performance in terms of maximal aerobic speed (Mohamed Sobhi, 2008)

7.3 Discussion of the General Hypothesis:

Based on the analysis and discussion of the research hypotheses and the results obtained, although body measurements and indicators play an important role in all physical activities and are related to various physical attributes, as scientifically proven in most research, this was not the case in our study. Our hypothesis that there is a relationship between muscle mass and fat mass with maximal aerobic speed in under-19 football players was not confirmed. The general hypothesis is not realized due to the failure to confirm the partial hypotheses, which were not statistically significant. Therefore, the general hypothesis is rejected.

Conclusion

In conclusion, based on what has been presented in the theoretical part of the research and its emphasis on the importance of anthropometric measurements and body indicators on physical and skill performance and their importance in improving the athlete's level to achieve the highest level of performance, several previous and similar studies have been explored, addressing several fundamental topics with significant efforts and conducting various research and studies. Moving on to the practical side of presenting, analyzing, and discussing the results to understand the relationship between muscle mass and fat mass with maximal aerobic speed in the under-19 age category, we found that elite and high-level athletes have ideal muscle mass and fat mass with close figures that influenced their relationship with maximal aerobic speed. This contradicts what scientific studies in this field confirm and what most researchers affirm, that body weight does not affect maximal aerobic speed. However, there is a relationship between fat mass and its percentage, as confirmed by (Dellal, 2008) We hope this study will motivate similar scientific research and studies related to the topic of our research and extend beyond it, aiming to raise other questions in this area.

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