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Physical development and body composition of Algerian handball players, members of national teams.

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Abstract : The aim of this study is to analyse the body composition and physical performance in male and female handball players. Male handball players aged 31.45 ± 4.47 , with a height of 179.23 ± 7.17 cm and a weight of 75.66 ± 10.58 kg, and female handball players aged 17.55 ± 0.83 , height of $169 \text{ cm} \pm 5.18$ and weight of $64.15 \text{ kg} \pm 9.96$ were included in this study. Height, weight, various physical development indexes, and body mass components were assessed using anthropometric methods. The data were analysed using SPSS 16 statistical software. As a result, it was determined that the body composition of handball players in this age group affects physical performance.

Keywords: Physical development indexes, Body composition, Handball, Gender

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1. INTRODUCTION

Part of athletic performance is, of course, linked to training and physical preparation (Platonov, 1987). However, a significant part of sporting success is also linked to diet (Bigard et al. 2017). It must be adapted to the type of sport practised, the athlete's body type, age and level of practice. It must aim to put the body in the best possible condition to achieve performance while ensuring that the athlete's health is not endangered. Adapting one's diet is a fundamental and long-term task that must be carried out by a nutritionist but also by the athlete in their daily life (ITEPS, 2017). The nutritional advice resulting from this research is intended to be personalised (according to certain individual genetic components and athletic level) and applicable to all sports that require strength and endurance. Similarly, a well-targeted diet will help your body perform better, recover faster and progress more quickly. (Julien Vensson, 2011).

As part of our work, we have limited ourselves to one sport, namely HANDBALL. Handball is a sport that requires strength and speed, as well as other physical qualities such as endurance, flexibility, strength, speed, etc. In addition to the lack of Algerian studies discussing this issue (body composition and physical development index), this prompted us to take an interest in the problem of nutrition among athletes in general. Our study focuses on determining the physical development indices and body composition of handball players of both sexes who are members of national teams.

Practising a sport requires performance, which depends on several factors that support, maintain and execute the body's functions: an organism and physiology that must be capable of meeting all the demands of the discipline.

Body composition assessment varies depending on the purpose of the study, the discipline and the target population. The most commonly used models today are physiological compartment models, regardless of their anatomical location or chemical nature. In nutrition, 2-, 3- and 4-compartment models are the most commonly used:

During intensive training, muscle mass increases and could therefore lead to total body weight gain. Muscle mass in athletes varies depending on the type of sport, the intensity of training and the type of diet (Bigard et al, 2014).

Body mass index (BMI) does not take muscle proportion into account, so it is unsuitable for certain categories of the population, particularly athletes, who are very often overweight, even though they are often in better physical shape (Martin and Golay, 2014).

Handball, a constantly evolving sport, is a fast-paced, dynamic, offensive and aggressive game, both in attack and defence, regardless of the playing position (Bayer, 1993 in Buchheit M, 2003). This discipline is characterised by a high number of short (2-7 s) and intense efforts, the performance of which is decisive during the match (Chelly et al., 2011). In other words, handball is an intermittent



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sport based on technical and tactical skills, mainly represented by short, intense efforts such as sprints, jumps, shots, blocks and counter-attacks, as well as efforts dependent on anaerobic capacity (Goran et al., 2010; Buchheit et al., 2009; Ingebrigtsen et al., 2012).

Many studies have focused on the morpho-functional characteristics of handball players. Morphological characteristics and the proper development of muscle strength and power, as well as jumping and shooting speed, are the most important factors for success in high-level handball (Lidor et al., 2005; Gorostiaga et al., 2006; Ziv and Lidor, 2009). Increases in body weight, muscle mass and associated gains in strength and power can significantly improve performance.

Consequently, handball players must follow a specific training programme to improve their performance by applying new training strategies aimed at developing speed and power (Marques, 2010; Povoas et al., 2012) through a balance between recovery periods, training load, and the intensity and frequency of technical and tactical work. However, these factors must be improved during the sporting season according to an optimal programme.

Physical effort is a complex process responsible for improving the body's functional capacities. It causes central functional adaptations and peripheral muscular adaptations (Chatard and Millet, 2007) by alternating physical work with specific and technical work (Werchoschanski et al, 1992). These adaptations to variations in functional demand aim to improve the athlete's performance by responding to the body's needs during exercise and to prevent the harmful effects that training load can have on the body. This results in adaptive responses from the various muscles involved, which may vary depending on the type of exercise, and cardiovascular adaptations that lead to greater exercise tolerance and improved performance.

Even though there may be exceptions at the highest level in terms of physical characteristics, certain profiles tend to be common depending on the position. Height and wingspan are important factors in identifying goalkeepers, just as speed, explosiveness and jumping ability are essential assets for wingers. At the back, height and jumping ability are also among the most sought-after qualities. Weight can also be a determining factor for pivots, who are constantly involved in physical battles. But it is mainly taken into account for its influence on athletic performance, hence the importance of looking at not only the handball player's body fat, but also their lean body mass. However, the search for the complete player, i.e. one who possesses speed, explosiveness, strength and power combined with an imposing athletic build, often appears to be a priority. As in the vast majority of sports, diet has a direct impact on an athlete's performance as it provides them with energy. It is therefore necessary to follow basic physiological principles (hydration, meal frequency, etc.) and monitor the development of players' physical indicators.



Handball is a team sport played in intertwined spaces, with alternating attack and defence, and opposing teams moving back and forth in each camp. It is therefore an activity that requires intermittent effort, involving a series of brief, intense, explosive movements consisting of short, repeated efforts over a training session lasting between 1 and 1.5 hours. In addition, during training or a match, it is essential to monitor the development of physical parameters.

Many handball players find it difficult to manage their diet and hydration on a daily basis. This is often due to a lack of time and organisation related to their professional, personal and sporting lives. In short, it's not easy being an athlete.

Research methodology:

Monitoring the physical development and body composition indices of handball players would enable better management of the training of future champions.

- Knowing the physical development indices will improve performance during training according to each player's category.
- Knowledge of body composition would enable us to take a better approach to preparing handball players.

To achieve these objectives, we conducted an anthropometric study and calculated various physical development indices. We also assessed the components of body weight.

Sample :

Table 1: Characteristics of handball players men

	Mean	Standard Deviation	Minimum	Maximum	C.V %
Age (année)	31,45	4,73	21	37	15,03
Poids (kg)	75,66	10,58	60	98	13,98
Taille (cm)	179,25	7,17	167	193	4

Table 2 : Characteristics of handball players women

	Mean	Standard Deviation	Minimum	Maximum	C.V %
Age (année)	17,55	0,83	16	20	4,70
Poids (kg)	64,15	9,96	42	84,9	15,32
Taille (cm)	169	5,18	161,8	179,4	3,07

Anthropometric measurements were collected in the morning in the Biometry Laboratory of the Higher School of Sports and Technology (ES/STS), Algiers, under standardized conditions at 22 °C using established anthropometric protocols. The athletes had engaged in regular physical training for more than ten



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years and continued to train with their respective clubs outside national-team camps; weekly training volumes differed among clubs.

A G.P.M. (Siber Hegner) anthropometric kit was employed, comprising a Martin-system anthropometer for stature and segment lengths, an olive-tipped bicondylar caliper for bone breadths, and a flexible measuring tape for body circumferences. Skinfold thicknesses were assessed with a Harpenden caliper.

Basic anthropometric techniques were applied at readily identifiable landmarks—bony prominences, skin-fold sites, or other specific anatomical markers—standardized by Martin (1928) and later refined by Ross et al. (1982). Each variable was measured in accordance with the anthropometric guidelines established by the 1912 International Congress (Valois, 1948).

We then calculated the following index of physical development:

Body surface area (BSA)—expressed in square metres (m²)—is regarded as a primary indicator of an athlete's physical development, with larger values reflecting a higher level of development. BSA was estimated from body mass and stature using the formula of Izackson (1956).

$$S (m^2) = 1 + (P + (T-160)/100))$$

- S – body surface area (m²), T – stature (cm), P – body mass (kg)

Schreider Robustness Index (E. Schreider, 1953)

$$IR = P/Sa \text{ kg/m}^2$$

Expressed in kg · m⁻², this index reflects an individual's degree of morphological robustness

where **IR** is the robustness index, **P** is body mass (kg), and **Sa** is absolute body surface area (m²).



Energy-Expenditure Index

According to Touabti-Mimouni (2015), this index gauges how economically an athlete expends energy relative to body surface area and mass, reflecting the limitation of unnecessary depletion of energy reserves. Smaller values indicate better energy economy and, consequently, greater resistance to high workload

This index is calculated as follows:

$$SP = Sa/P \text{ cm}^2/\text{kg}$$

SP: energy expenditure index expressed in cm^2/kg ; Sa: absolute body surface area in m^2 ; P: body weight in kg

- Quételet index:

This index reveals an individual's level of physical development. It is expressed in g/cm , according to Quetelet's formula (1869), with a value of 350 for sedentary individuals and over 400 g/cm for high-level athletes. (Mimouni, 1996).

$$IQ = P/T \text{ g}/\text{cm}$$

IQ: Quetelet index in g/cm ; P: body weight in kg; T: height in centimeters

- **Kaup index (1921) or BMI:**

Or Davenport's Body Build Index (1921), divides body weight by the square of height, expressed in g/cm^2 . Its formula is as follows:

$$IK = P/T^2 \text{ g}/\text{cm}^2$$

To interpret the results of this index, we use the following scale, developed by Davenport and cited by Vandervael (1980) :

Table 3: Evaluation of the Kaup index (WHO)

Values	Interpretation
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1,40 à 1,80	Very thin
1,81 à 2,14	Thin
2,15 à 2,56	Average
2,57 à 3,05	Overweight
3,06 et plus	Obese

- Sheldon index:

This index provides information about an individual's slenderness. It is also the inverse of the Livi index and is calculated using the following formula:

$$ISh = T^3/\sqrt{P}$$

SH: Sheldon index expressed in cm/g; T: height in centimetres; P: body weight in kg.

To better assess the body composition of handball players and the various components, we used Mateigka's formulas (1921).

Results:

Analysis of the total parameters of handball players:

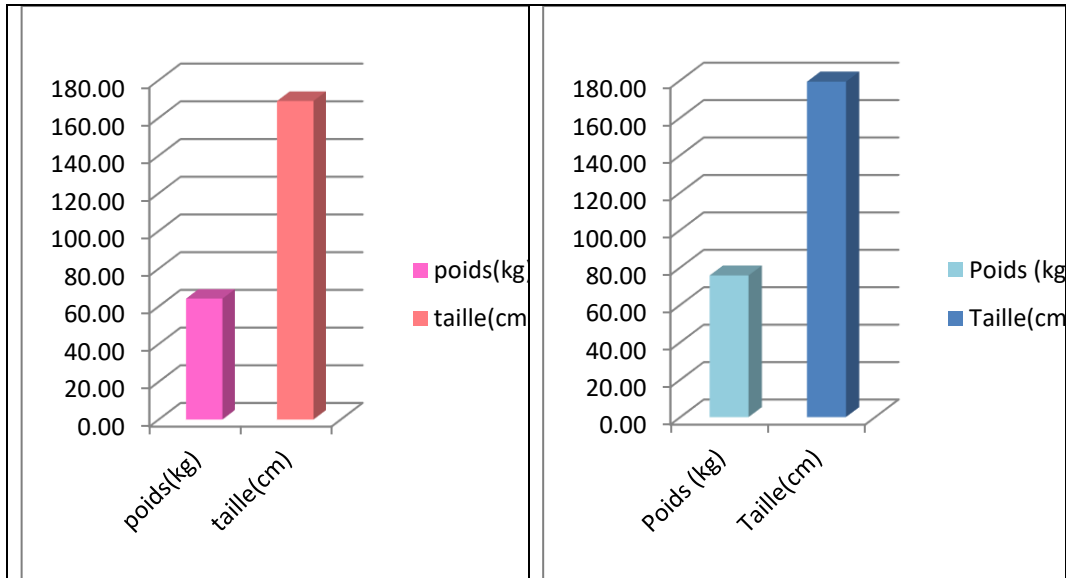


Figure 1: Graphical representation of the total parameters for girls and boys

	Girls	CV%	Boys	CV%
Weight kg	64,15	15,52	75,66	13,98
Heigh cm	169	3,07	179,25	4

Analysis of the overall parameters shows average homogeneity in terms of weight for both girls and boys, while in terms of height, the athletes are very homogeneous.

Analysis of physical development indexes

Physical development indexes give us a clear idea of the athletes' strength and build. Among the multitude of existing indexes, we have chosen the body mass index or BMI, which reflects the individual's build, the Sheldon index, which provides information on the subject's linearity, and the Quetelet robustness index (P/T in g/cm).

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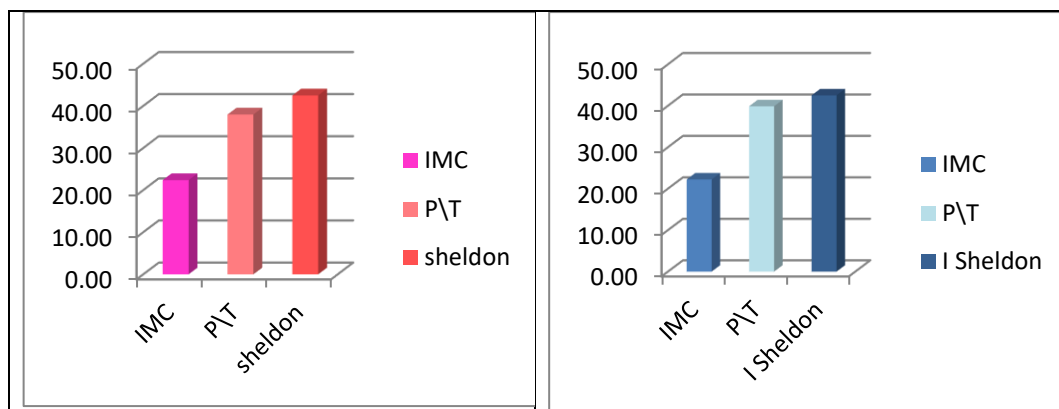


Figure 2 : Physical development indexes

	Women			Men		
	IMC	P/T	I Sheldon	IMC	P/T	I Sheldon
Mean	22,37	37,96	42,49	22,22	39,87	42,50
Standard deviation	2,73	5,16	1,66	16,74	11,31	1,40
CV %	12,19	13,58	3,90	7,53	2,84	3,28

The handball players have a body mass index (W/H^2) of 22.37, which characterises them as having a normal weight according to the WHO scale.

However, we note that they have average homogeneity (CV: 12.19%).

The same is true for the Quételet index (W/H), which represents the athlete's robustness, with a CV of 13.58%.

The Sheldon index, which represents the subject's linearity, shows that our sample has a very high degree of homogeneity with a CV of 3.90%.

The handball players, members of the national team, show very high homogeneity for all aspects of physical development.

Absolute and relative surface area analysis

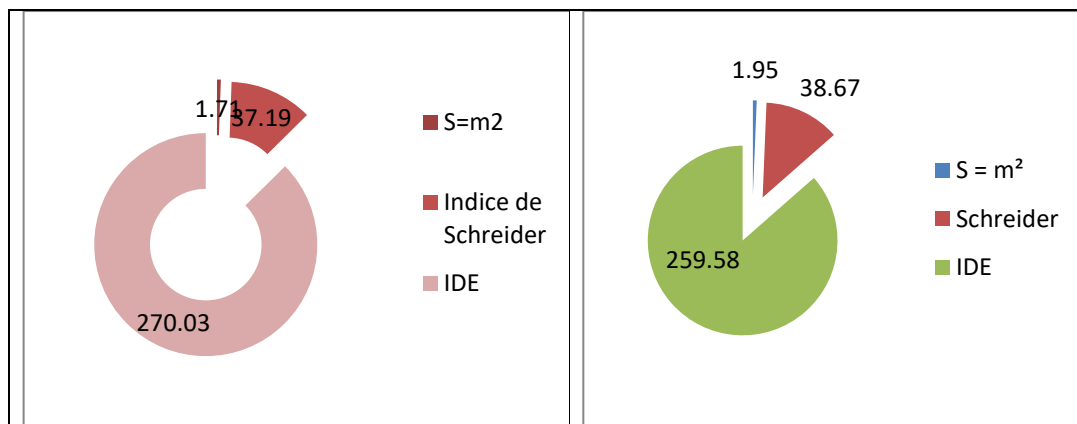


Figure 3: Absolute and relative surface areas of female and male handball players`

Women				Men			
	S=m2	Schreider Index	IDE		Schreider Index	IDE	S=m2
CV%	9,43	6,58	6,95	CV%	6,15	6,40	8,39

Total surface area, an indicator of physical development, provides information about the athlete's fitness level. We note that our sample is very homogeneous for both girls and boys. Schreider's robustness index also shows great homogeneity within the group.

For the energy development index, we find that our athletes have high values, indicating a lack of training. However, the sample is homogeneous for both sexes.

Body composition of handball players

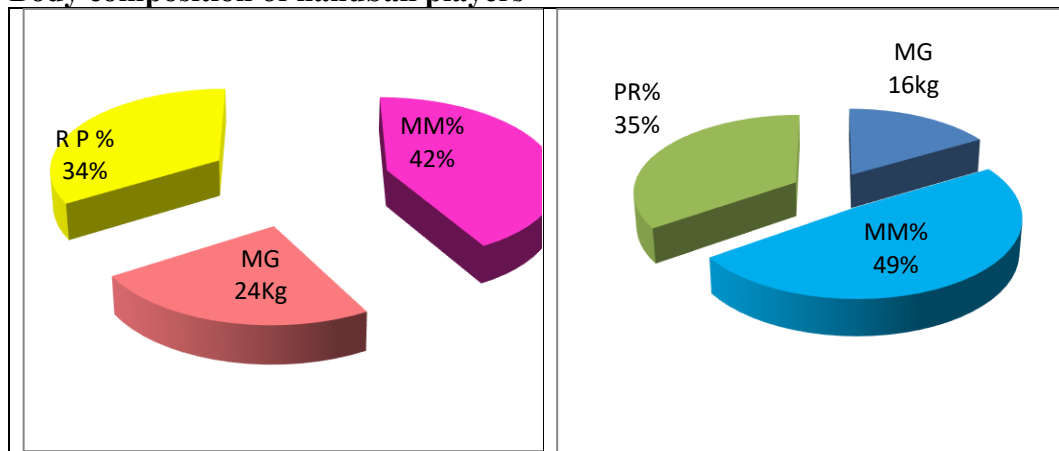


Figure 4 : Body composition of des handball players (girls and boys).



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Figure 4 shows the components of body weight: MM% represents lean mass (bones + muscles); MG represents fat mass in kilograms; and PR represents fat mass as a percentage.

	Women			Men		
	MM%	MG kg	R P %	MM%	MG kg	PR%
CV%	7,01	23,01	7,93	10,27	28,08	273,54

Analysis of the body composition of female and male handball players shows:

- Greater lean mass in both categories, but more so in males. The group is very homogeneous among boys and moderately homogeneous among girls.
- Fat mass in kilograms is quite high in both sexes, which is reflected in the heterogeneous coefficient of variation. This parameter should be taken into account by coaches. We also assume that this problem is probably due to the dietary profile that does not exist in these teams.

Skele index and Wingspan of handball players

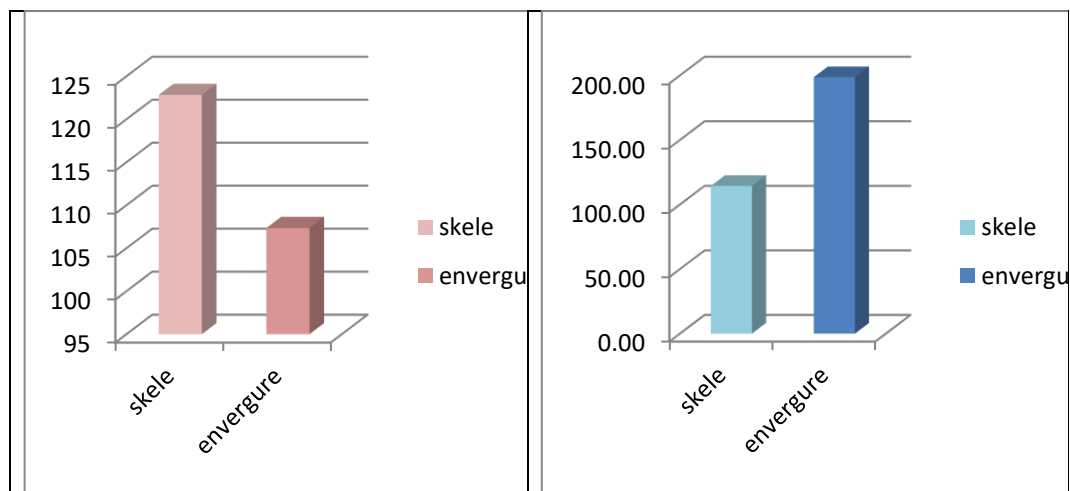


Figure 5 : Graphic Representation of Skele and Wingspan indexes

	Women		Men	
	Skele	Wingspan	Skele	Wingspan
CV %	209,86	5,46	7,50	4,43



- The Skele index is often used to characterise the length of the lower limbs in relation to the length of the torso. We find that our handball players are macroskeletons with a value of 114.39%. They are fairly homogeneous.
- Wingspan, which is the biacromial width plus the length of both upper limbs, is very important in handball, especially when shooting. Our handball players have a good wingspan and the group is very consistent.

Discussion:

High-level handball players are characterised by their complete physical development, combining endurance, strength, power, flexibility and agility. They must be able to maintain a high level of intensity throughout the match, withstand physical contact and have good coordination and motor skills. Good nutrition is essential for proper physical development.

A balanced and healthy diet will enable them to maintain maximum energy levels during matches and optimise their performance and energy and physical recovery. The variety and diversity of an athlete's diet depends on the sport they practise and their level of performance. We often only pay attention to athletes' diets during competitions. While body weight may be maintained, its composition may not meet performance and recovery needs, leading to poor physical condition.

Handball is a dynamic sport characterised by the development of motor skills such as speed, reaction speed, agility, explosive strength, speed strength and endurance, as well as coordination (Bounemri-Zaki, et al. 2011).

With regard to age, a study conducted to determine the optimal age for peak performance among athletes during the 1996 Atlanta and 2000 Sydney Olympics, Sterkowicz and Bach (2001) showed that the 20-24 and 25-29 age groups represent the age range for the best athletic performance. We also note that the average age of our national team is 17.55 ± 0.83 for the girls' group and 31.45 ± 4.7 for the boys' group, based on a sample of our national teams.

With regard to height, an anthropometric study was conducted by Medved (1968) on the classification of sports disciplines, which found that handball players tend to be tall. Our female sample has an average height of $169 \text{ cm} \pm 5.18$, while the boys have an average height of $179.25 \text{ cm} \pm 10.58$. Both girls and boys, our handball players are similar in height to their European counterparts (Bayer, 1993).

In terms of weight, male handball players have an average weight of $75.66 \text{ kg} \pm 10.58$, while female handball players weigh $64.15 \text{ kg} \pm 9.96$.

In general, international handball players are tall and robust. Height (a hereditary factor) is a key asset in modern play, and tall players are highly sought after (Guedid, 2005). Body size is quite important. Weight is also considered, especially for certain positions such as pivot. Body mass index is often taken into consideration.



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In morphology, these two overall parameters are very important during play and vary depending on the position in which the athlete plays. Therefore, in order to build a high-performance team, it is essential to take these two parameters into account, along with the various factors (indices) that surround them (Ravier, G and Bouzigon, R., 2014). Morphological characteristics and the proper development of muscle strength and power, as well as jumping ability and shooting speed, are the most important factors for success in high-level handball (Lidor et al., 2005; Gorostiaga et al., 2006; Ziv and Lidor, 2009). Increases in body weight, muscle mass and associated gains in strength and power can significantly improve performance.

Wingspan is also a morphological factor. This quality influences the power of the shot: the longer the arm segment, the greater the range of action and the greater the acceleration that can be given to the ball. This same wingspan also allows goalkeepers to cover a larger area of the goal (Boukhari et al. 2023).

A study conducted by S. Kouidir (2022) shows that weight is very important for handball players, as are the percentage of total body fat and water mass. This confirms the results obtained in our study. The assessment and monitoring of these performance parameters during a sporting season are of paramount importance for the development and refinement of an optimal training programme (Ingebrigtsen et al., 2012) likely to maximise their motor and functional skills (Marques et al., 2007).

Conclusions

Physical preparation therefore plays a decisive role in the smooth running of training sessions and is undoubtedly an essential tool for handball players. A balanced and healthy training programme will enable them to maintain maximum energy levels during matches and optimise their performance and energy and physical recovery.

Achieving optimal athlete training is one of the greatest challenges in developing strategies that promote adaptations that occur as a result of training and competition. Acquiring the knowledge necessary to determine athletes' needs will play a fundamental role in determining nutritional requirements in response to increased exercise demands. At present, it is essential to establish policies and procedures for training coaches in the proper development of athletes' body composition. This must be accompanied by proper physical care to avoid injury, as optimal adaptation can meet the demands of repeated training sessions. This could promote the physiological response to handball, which could lead to better adaptation to exercise and improved performance.



The coach's mastery of morphological parameters, physical preparation and load planning during the different stages of training are the key to successful performance.

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