VASIL LEVSKI NATIONAL SPORTS ACADEMY

DEPARTMENT OF THEORY OF SPORT

IORDANIS ODISSEVS GIANNAKU

ABSTRACT BOOK

MORPHOFUNCTIONAL FEATURES AND MOTOR ABILITIES OF GREEK HANDBALL PLAYERS (GIRLS AND WOMEN) DEPENDING ON AGE, QUALIFICATION AND PLAYING POSITION

FOR THE AWARD OF THE EDUCATIONAL AND SCIENTIFIC DEGREE „DOCTOR“,

field of higher education. 7. Healthcare and sports, professional field 7.6 Sports, doctoral program „Theory and methodology of sports science“

SUPERVISOR:
PROF. DANIELA DASHEVA, DSc.

SOFIA 2021

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The dissertation contains 179 pages of standard type-written pages. It contains 33 figures and 33 tables. The bibliography includes 129 literary sources of which 43 in Cyrillic and 86 in Latin. The dissertation was selected, discussed, and directed for official defense at a meeting of the Department of Theory of Sport at NSA "Vassil Levski".

The public defense of the dissertation will take place on 15 on June 2021, at 2 pm, in Hall A3 of NSA "Vassil Levski".

INTRODUCTION

Handball, from an energy point of view, is a sport with mixed aerobic-anaerobic supply, with interval-variable nature of efforts, in the background of progressive fatigue and with high requirements to the level of manifestation of motor skills, mainly speed and strength endurance.

A study of the literature in recent years shows a significant development in relation to the main components of the game. On this basis, I. Varbanov (2019) identified the following more important trends in the development of the game of handball players:

- ✓ dynamic change of two phases of the game (attack and defense) – the fast transition from attack to defense blocks the quick attacks of the opponent, and the accuracy and timely passing of the goalkeeper are extremely important for the start of the team's attack.
- ✓ priority to fast play, fast counterattacks, and fast execution of a fast center.
- ✓ increasing the effectiveness of the throws to the opponent's door.
- ✓ almost equal opportunities for both sexes for a successful offensive game.

Regarding the trends related mainly to women's handball, I. Varbanov (2015) identified the following:

- ✓ highest efficiency of 7-meter shots, fast attacks, and goals.
- ✓ reduced efficiency of short-range strikes (6 m and wings).
- ✓ low efficiency of long strokes (9 m).

Over the last two decades, several research studies have been also focused on studying the features and importance of morphological characteristics and their relationship to the motor abilities

of handball players (men and women) for success in the game (Bon et al., 2015; Čavala & Katić, 2010; Granados, Izquierdo, Ibanez, Bonnabau, and Gorostiaga, 2007). The obtained results are also the basis for the profiling of players by playing positions and the identification of future sports handball talents (Lidor, Falk, Arnon, Cohen & Segal, 2005), as well as the development of individual and team models of sports performance management.

Body composition attracts the interest of the scientific community, as it is known to be important for performance in sports. It has been established that the body composition of women handball players is an important prerequisite for their good performance, especially with regard to the specific requirements for the game positions (Vuleta, Milanović & Sertić, 1999; Vuleta, Milanović et al., 2009; Urban & Kandrač, 2013; Wagner, Finkenzeller, Würth, & von Duvil-lard, 2014; Zapartidis, et al., 2009).

However, more detailed, and up-to-date anthropometric and morphological studies of handball players are needed.

The improvement of the educational and training process in the sports disciplines is closely related to the study of the peculiarities of the different motor activities. This requires periodic research and release of the main factors and trends of this development, which in turn is an objective prerequisite for a deeper insight into the essence of the phenomenon to improve the preparation and increase the effectiveness of the training work.

The scientific research in this dissertation goes in this direction, namely – determination of basic morphoanthropometric characteristics of physical development, specific motor abilities and sports-technical skills and habits, which are the basis of the high sports results of the Greek handball players, as well as their differentiation by game positions.

FIRST PART

STUDY AND ANALYSIS OF THE SCIENTIFIC LITERATURE

I.1. Characteristics of modern handball

The popularity of handball has grown significantly in recent years. In addition, the development of the game's "siblings" - beach handball, street handball and handball for people with disabilities has led to an even more serious spread of the game, reaching all segments of the population and ages around the world. The increased attention to the optimization of sports performance has made significant progress in terms of basic parameters of the game such as technique, tactics and intensity, as well as physical fitness.

Over the years, the professional side of the sport has developed side by side with the evolution of the rules of the game, which is the basis of its transformation into a fast and very dynamic game. At the 2016 Olympic Games in Rio de Janeiro, handball was the second most popular team sport after soccer. Both male and female games enjoy equal popularity.

Sports results in handball are the function of many factors, but according to research done by Fernández & Rodríguez (2004), Lidor et al. (2005) and Mohamed et al. (2009) the surveys on these factors are still insufficient.

The correct dosing of the training loads (Colli, R., Faina, K., Lupo, S., Gallozzi, Ci., 1988) and the study of the physiological laws to which the recovery processes are subject, as well as the search for means and methods for improvement the effectiveness of

rest intervals (between individual exercises and after overall training and competitive loads) are particularly important for handball sports practice (Bosc, G., Grosgeorge, B., 1985; Boss, K., 1988).

Achieving lasting adaptive changes is reduced to a high level of specific performance and the most effective biodynamic and kinematic structure of motor activities in conditions of progressively increasing fatigue (Tsv. Zhelyazkov, D. Dasheva, 2002). According to the authors, the so-called global body fatigue is typical for sports games. It occurs during competitions or training sessions, in which quick breakthroughs, counterattacks or other tactical tasks are repeatedly performed, both in attack and defense. To overcome fatigue, a high level of development of all motor skills is required. For this reason, the research in this area is quite extensive (Newell, P., Bennington, D., 1964; Wilkes, G., 1968; Pheel, M., 1973; Ozerov, Yu., 1974; Gomelsky, A., 1976).

Effective management of the training process requires permanent control over the level of special physical and specific technical and tactical readiness of handball players. The correct application of the mechanisms of this control will allow the necessary adjustments at any stage of sports training, both in the composition of the teams and in the applied training tools and methods.

I.2. Research on the anthropometric and motor profile in handball

According to E. Avramov (2019), the modern effective management of the training process in the handball game requires knowledge of the age peculiarities and the interrelations between the physical development and the physical capacity of the adolescents.

The development of the body is a very complex biological process. Determining factors in this process are the individual genetic talents and the adaptability of somatic traits under the influence of different types of motor activities (Futekova, R., 1990; Toteva, M., 1992; Tsarova, R., 2007), incl. under the influence of the multi-year training process in handball (Chanev, S., 2017).

The significance of the anthropometric characteristics for the successful development on the way of high sports mastery in handball finds its place in the works of I. Yotov, R. Ivanchev (2003).

Growth can have a positive impact, and the average growth in handball, in elite teams is an important factor for sport achievements (Lidor & Ziv, 2018).

E. Avramov (2019) found an average height of 163.29 cm for athletes who play in the position of "pivot". For the other positions in the game, the average values for height are the followings: wings – 163.61 cm, backs – 169.93 cm, center backs – 166.93 cm and goalkeepers - 166.18 cm.

According to I. Yotov (1997), the height and length of the throwing arm have a positive effect on the effectiveness of handball players in performing various types of shooting in the goal.

According to Fieseler et al. (2017) the wings have the lowest height, and the pivots and backs are the highest. A study showed that the average height values in young Croatian handball players were 168.4 ± 6.2 cm (Pastuszak et al., 2018). A similar mean height was reported in another study among handball women (16.1 ± 0.6 years) - 1.69 ± 0.05 m by Saavedra et al. (2018). A higher average height was also found in a study on Spanish women's handball players - 171.31 ± 7.42 cm by Vila et al. (2012).

It has been found that the body composition of handball players is also an important prerequisite for their good performance, espe-

cially in terms of the specific requirements of the game and the specifics of individual playing positions (Vuleta, Milanović, & Sertić, 1999; Vuleta, Milanović, et al., 2009; Urban & Kandrač, 2013; Wagner, Finkenzeller, Würth, & von Duvillard, 2014; Zapartidis, et al., 2009).

A study by E. Avramov (2019) found that the "weight" of the pivots has an average value – 62.61 kg, wings – 55.77 kg, backs – 59.90 kg, center backs – 59.91 kg and goalkeepers – 63.52 kg. The same author concluded that the posts were homogeneous in terms of "weight", except for the pivots and goalkeepers, which were relatively homogeneous.

According to other factors, body weight can affect speed, endurance, and strength, while body composition mainly affects strength and agility (Massuca et al., 2014). Therefore, the measurement of the anthropometric profile and the establishment of the somatotype provide information about the current condition of the athletes and allows coaches to make quality selection and orientation and to design training programs for development.

It is also a fact that body weight can negatively affect the speed and coordination of movements (Massuca, LM., Fragoso I., Teles, J., 2014). Greater muscle mass, however, is an advantage in some sports such as handball, where speed is essential to perform technical actions.

In the selection process, goalkeepers are usually selected based on height and weight and poor mastery of motor skills (Šibila, Pori, Imperl, 2008). However, in order to achieve good competitive performance, goalkeepers are required to have a high level of motor development (Srhoj et al., 2002; Šibila et al., 2008). It has been established that elite handball goalkeepers must be tall and have long limbs that allow them to cover as much space as possible in the

goal area. On average, male goalkeepers in handball are taller than 190 cm and weigh over 90 kg (Srhoj et al., 2002; Šentija, Matković, Vuleta, Tomljanović and Džaja, 1997). Elite handball players and goalkeepers compared to non-elite players are mostly taller, heavier and have more body mass and less muscle mass (Gorostiaga, Granados, Ibanez and Izquierdo, 2005; Hasan, Rahaman, Cable and Reilly, 2007; Massuça and Fragoso 2011; Vasques, Antunes, Duarte and Lopes, 2005).

Chaouachi, Brughelli, Levin, Boudhina, Cronin and Chamari (2009) found that elite handball players playing in different playing positions showed no differences in running speed, endurance, and upper and lower limb strength.

In handball, it is important to develop the physical qualities of the athlete (running speed, agility, coordination, accuracy of movements, ability to throw the ball, dribble, etc.) in accordance with the playing positions. The distribution of players by positions is one of the main principles of playing handball.

Studies show that the throwing speed depends on various factors such as technique, time coordination of different body segments and strength, both upper and lower body muscle groups (Rivilla, J., Martínez, I., Grande, I., Sampedro, J., 2011).

On the other hand, anthropometric characteristics (Marques, MC, Van Den Tillaar, R., Vescovi, JD, González-Badillo, JJ, 2007; Debanne, T., Laaye, G., 2011; Saavedra, JM, Kristjánsdóttir, H. , Einarsson, I.Þ., Guðmundsdóttir, ML; Þorgeirsson, S .; Stefansson, A., 2018) and speed and accuracy of the throw are considered to be among the most appropriate indicators for talent detection (Karaba Jakovljevic, D.; Jovanovic, G., Eric, M., Klasnja, A., Slavic, D., Lukac, 2016).

Handball is a fast game (Hermassi et al., 2015). At critical moments such as gaining possession of the ball and scoring goals depend on the quick actions of the players (Chelly et al., 2014). Rapid shifts in offensive and defensive action require acceleration and sprinting (Krüger et al., 2014). Handball players must be able to accelerate quickly over short distances, as well as be able to change direction abruptly (Matthys et al., 2011). The ability to reproduce high-intensity sprints is essential for achievement in handball.

Handball involves different types of throws (Schwesig et al., 2017). Throwing from a place requires keeping the leading foot in contact with the floor during the throw and is typical of a penalty throw in handball. When throwing from an upright position with a fold, one foot is on the floor after three correct steps or jumping before releasing the ball. And rebound throwing is performed with a vertical jump from one leg after reinforcement (Wagner et al., 2011). Throwing techniques depend on the positions of the game and are dictated by the actions of the defenders (Wagner et al., 2010).

To choose a technology for managing the training process of elite handball players, some issues need to be addressed, such as:

- determination of the main parameters of readiness (morphological, motor and sports-technical) of the competitors, in accordance with the specific functions of the respective game position.
- selection of parameters for detection of promising athletes.
- establishing optimal ranges for the development of individual motor qualities and functional capabilities, based on the developed model characteristics for each game position.
- selection of adequate means, methods, and magnitude of the load during the different stages of sports training.

- selection of means and methods for effective control of the condition of the athletes during the different stages of sports training.

Solving the above questions for optimal construction of the training regime will lead to improved performance of the elite Greek handball players.

In recent years, the Greek Handball Federation has started activities to identify and select young handball players from all over Greece, through a specific talent development program. The results of the present study may confirm the correct direction or indicate in relation to which parameters adjustments need to be made in this program.

The performed literature analysis and the summary of the scientific results allows to formulate the following working hypothesis of our research:

Establishing the state of the main parameters of physical development and specific performance, in general and in a comparative aspect by game positions, will allow, based on developed individual and by the position optimization models, as well as norm framework for control, to improve training process and increase the level of sports and technical mastership of elite Greek women handball players.

SECOND PART

PURPOSE, TASKS, METHODOLOGY AND ORGANIZATION OF THE RESEARCH

The aim of the research is to improve the training process by developing optimization individual and position-specific models of specific motor performance and technical and tactical preparedness of elite Greek women handball players.

To solve the set goal the following main tasks of the research were formulated:

1. Establishing the state of the researched problem according to scientific literature data.
2. Gathering information about the anthropometric status of elite Greek women handball players and revealing the specific features of the various game positions.
3. Determining the somatotype of elite Greek women handball players depending on the game position.
4. Gathering information about the special motor and specific technical and tactical preparedness of elite Greek women handball players and revealing the specific features of playing positions.
5. Disclosing the factor structure and identifying the main factors of the motor and technical-tactical profile of elite Greek women handball players.
6. Developing optimization models and norm framework for control (by game positions).

The object of the research is the process of building individual and position models of the anthropometric profile, the specific motor ability, and the technical-tactical preparedness of Greek women handball players.

The subject of the research are the peculiarities of the anthropometric profile and the specific working capacity of women handball players, as a basis for modeling and programming of the training process.

One hundred and one elite Greek women handball players aged 18 to 25 from 9 handball sports clubs were studied, to reveal the peculiarities of anthropometric status and specific performance on a total of 44 indicators (**Table 1**).

The research approach included the following main research methods:

1. Review study and theoretical analysis of specialized scientific literature.
2. Anthropometry.
3. Calipermetry.
4. Heath-Carter method (1980).
5. Sports and pedagogical testing.
6. Mathematical and statistical methods for processing the results of the research – alternative analysis, descriptive statistics, analysis of variance (ANOVA), discriminant analysis, factor analysis, index method and sigma method.

This study covers the period from December 2017 to March 2021.

Table 1. *List of studied parameters (variables) (summary table)*

№	Variables	Units' measures	Measurement accuracy	Direction of increasing
1.	***Height***	***cm***	0,5	+
2.	***Swing of the arms***	cm	0.5	+
3.	***Upper limb length***	cm	0.5	+
4.	***Lower limb length***	cm	0.5	+
5.	***Span length***	cm	0.5	+
6.	***Span width***	cm	0.5	+
7.	***Shoulder width***	cm	0.5	+
8.	***Chest circumference***	cm	0,5	+
9.	***Respiratory difference***	cm	0.5	+
10.	***Thigh circumference***	cm	0.5	+
11.	***Arm circumference***	cm	0.5	+
12.	***Forearm circumference***	cm	0.5	+
13.	***Contracted arm circumference***	cm	0.5	+
14.	***Dynamometry strong hand***	kg	0,100	+
15.	***Dynamometry weak hand***	kg	0,100	+
16.	***Weight***	kg	0,100	+
17.	***BMI***	kg/m^2	0,01	+-
18.	***Body mass***	%	1,0	
19.	***Liquid***	%	1,0	+
20.	***Muscle mass***	kg	0,100	+
21.	***Bone mass***	kg	0,100	+
22.	***Metabolic age***	age	1,0	+
23.	***Calories***	call	1,0	+
24.	***Pine index***	units	1,0	-

25.	***Fat (body fat)***	%	1,0	-
26.	***20 m sprint***	s	0,01	-
27.	***Long jump from a place***	m	0,01	+
28.	***Triple jump***	m	0,01	+
29.	***Vertical rebound***	cm	0,5	+
30.	***Vertical rebound after reinforcement***	cm	0,5	+
31.	***Abdominal presses for 30 s***	N	1,0	+
32.	***Flexibility***	cm	0,5	+
33.	***Shuttle run (10 x 15m)***	s	0,01	-
34.	***Throwing a solid ball (3 kg)***	m	0,05	+
35.	***Dribbling***	s	0,01	-
36.	***Ball dribbling index***	s	0,01	-
37.	***Moving in defence***	s	0,01	-
38.	***Running around the stands***	s	0,01	-
39.	***Goal throw – time***	s	0,01	-
40.	***Goal throwing – accuracy***	points	1,0	+
41.	***7-meter throw – speed (V)***	km/h	1,0	+
42.	***Throwing from 3 steps – V***	km/h	1,0	+
43.	***Throw with a rebound of 3 steps – V***	km/h	1,0	+
44.	***Throwing a handball at length***	m	0,05	+

THIRD PART

RESULTS ANALYSIS

The first aspect of the analysis was aimed at establishing the mean values and variability of anthropometric and body characteristics. **Figures 7 and 8** show that the sample population is inhomogeneous with respect to:

- the amount of adipose tissue (indicator 21 "fat mass", V21 = 76.5%.
- the degree of physical development and harmonious body composition (V18 = 55.2%);
- metabolic age (V23 = 42.9%) and
- the functional capacity of the chest (indicator 9 „respiratory difference, V9 = 37.7%).

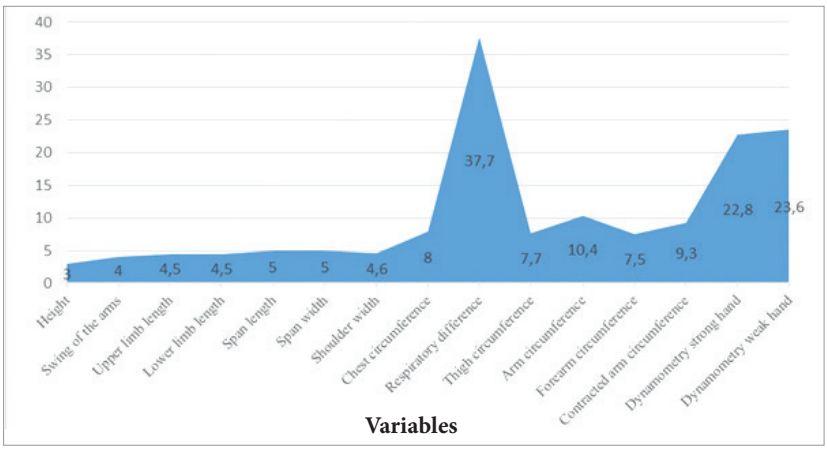

Fig 7. *Dispersion of the anthropometric and strength variables of elite Greek women handball players*

For the other indicators, the coefficient of variation occupies values between 12 and 35%, which gives reasons to consider these indi-

cators as relatively stable, and the studied sample – as relatively homogeneous in terms of the features for which they carry information.

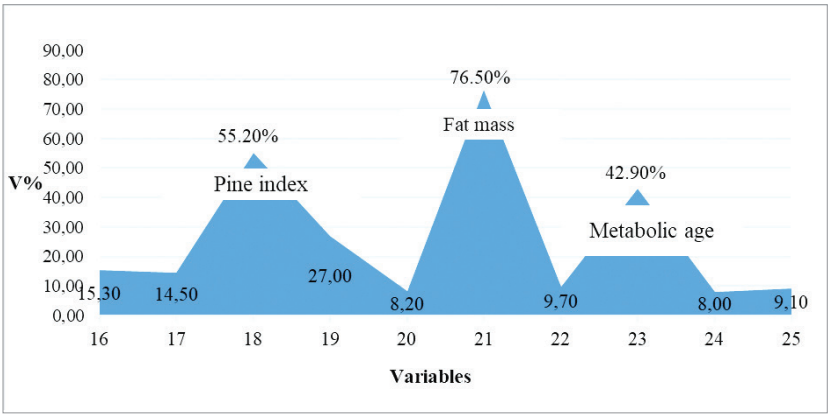

Fig. 8. *Dispersion of the variables for the body structure*

The analysis of the average values and variability of the characteristics of the specific performance of elite Greek women handball players shows that the highest coefficient of variation is variable 20 m (V1 = 61.86%) and informs about the very high heterogeneity of handball players in terms of their speed capabilities (**Fig**. 9).

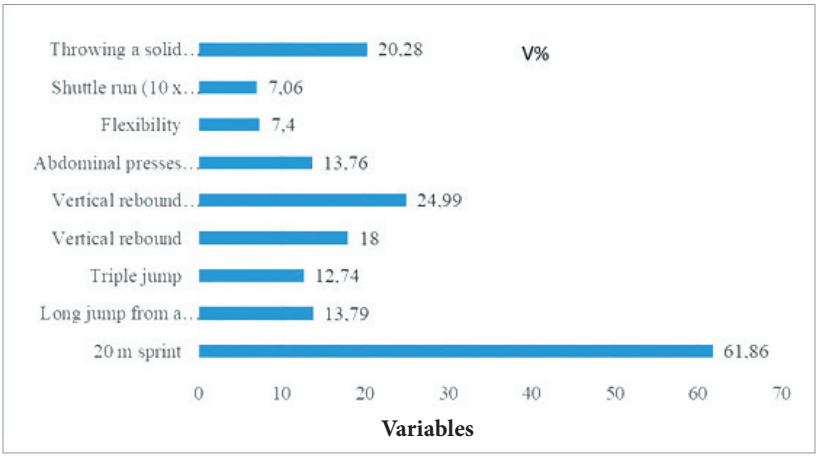

Fig. 9. *Coefficients of variation of the variables for the motor performance*

This is probably due to the different playing positions in which they specialize. In terms of technical preparedness indicators, quite naturally, the level of development of the special speed of movement on the field with a change of direction (indicator 13 - X13 = 7.17 ± 0.54 s) is closely related to the ability of handball players to move on the field with keeping the ball at high speed. This skill is extremely valuable in handball because it allows players to move around the field independently, mastering the ball. Without this skill, players cannot successfully make quick breakthroughs. The analysis of **fig. 10**, however, shows that the coefficient of variation of indicator 11 is extremely high (V11 = 63.66%), which indicates a high heterogeneity of the sample in terms of the ability to move on the field with a dribble at high speed.

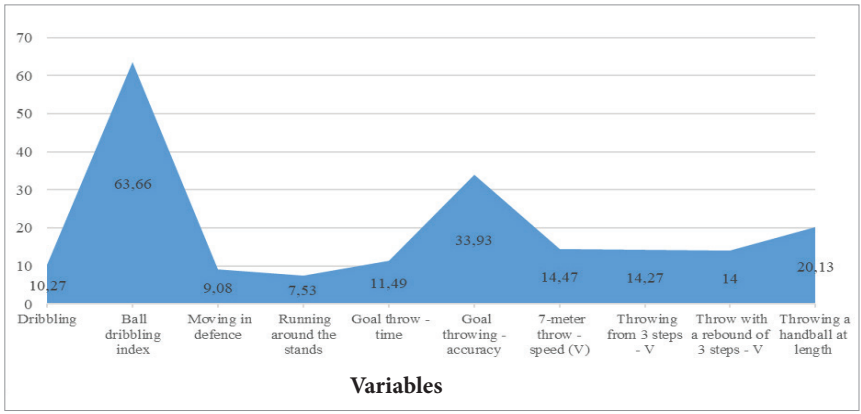

Fig.10. *Coefficients of the variation of the variable for the technical and tactical preparedness (%)*

The reason for this, in our opinion, is the specific features of the various game positions.

The next aspect of analysis in the dissertation is aimed at revealing the features of the physical and technical-tactical preparedness of elite Greek women handball players, depending on the specifics of the game positions.

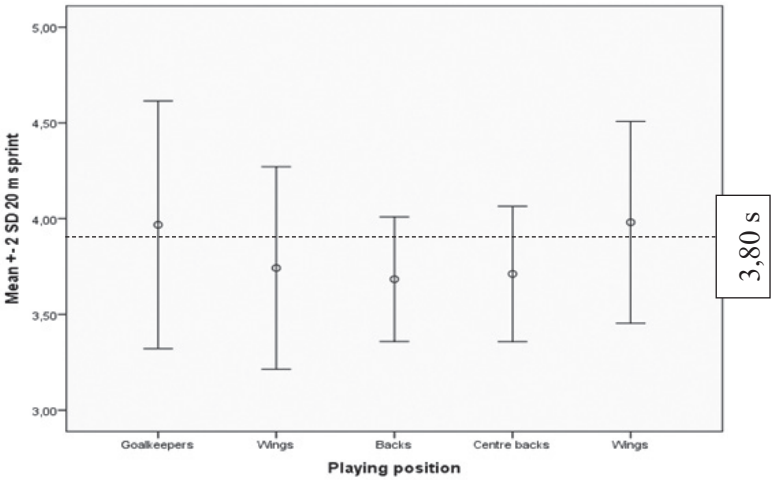

Fig. 11. *Average levels and variability of sprinting abilities of the handball players from the different game positions*

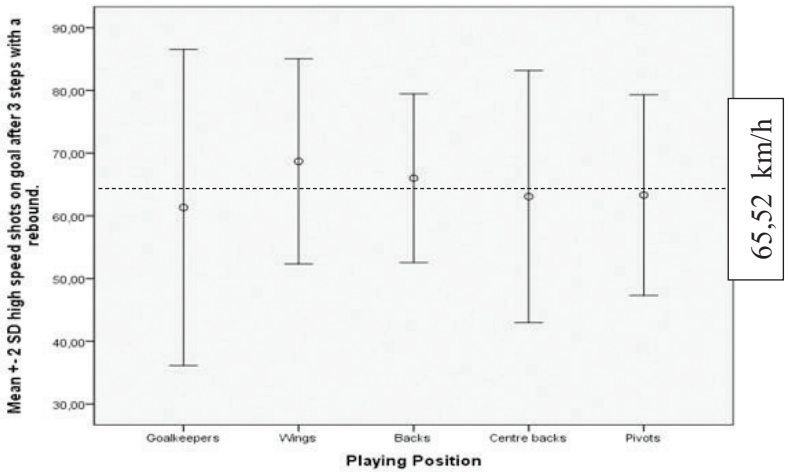

Fig. 16. *Average levels and variability of the ability of the players from the different playing positions to perform high speed shots on goal after 3 steps with a rebound.*

Figures 11 and 16 in the form of error bar diagrams show a comparative aspect of the statistically significant differences found in some of the parameters (variables). These are sprint abilities, ex-

plosive abilities of the lower limbs, speed capabilities and the ability to play in defense. The results also reveal that center back players are better at speed running, have higher explosiveness of both the upper limbs when throwing, and the lower limbs when performing various types of rebounds to pass or hit the opponent's goal or to perform of several defensive actions and taking away the ball. They are more flexible than players in other gaming positions. As for the strength indicators and speed endurance – they are dominated by backs.

The performed discriminant analysis derives four main discriminant functions (**Table 22**). The elite Greek women handball players, according to their playing position, differ mainly in terms of speed abilities and dynamic strength abilities, and speed endurance. The results also reveal that the center backs are better at running speed, the explosiveness of the upper limbs when throwing, the explosiveness of the lower limbs (jumping) and the flexibility compared to the competitors at the other positions, while the backs are better at the speed endurance.

The wings and the backs determine the organization of the game in a quick attack, along with the pivots and center backs, and the goalkeepers lead the defense and organize the start of the attack.

Table 22. *Discriminant functions*

Playing positions	1	2	3	4
Goalkeepers	1,409	0,621	0,535	0,349
Wings	-0,590	0,735	-0,237	-0,057
Backs	-0,546	-0,728	0,003	0,493
Center backs	-0,615	-0,405	0,796	-0,642
Pivots	0,962	-0,525	-0,462	-0,329

The analysis of the somatotype shows that in terms of game functions the handball players are relatively homogeneous, and the endomorphic somatotype dominates (**Fig. 20**). We assume that this is due to the typical body structure and peculiarities of the somatotype of the Greek nation. It can be noted as a positive fact that endomorphism and mesomorphism can be influenced by training to a large extent, in contrast to the ectomorphic component.

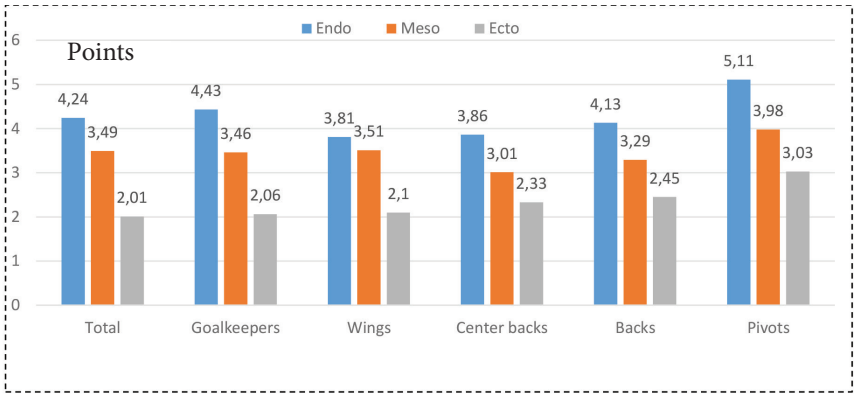

Fig. 20. *Generalized characteristics of the somatotype of elite Greek handball players*

The last aspect of the analysis was focused on the control over the physical development and the specific working capacity of elite Greek women handball players. The results of the factor analysis show that the factor structure of the anthropometric profile of the studied handball players is very specific and is determined by a small number of factors, but with a high percentage of explained variance of the initial values (81.66%).

In future studies of this kind, it is necessary to better specify and minimize the individual parameters, especially those that have a factor weight lower than that determined for the sample size. In terms of specific performance, the factor structure of elite Greek

women handball players is determined by 3 main and two additional factors (**Table 32 and Fig. 22)**, which together explain a relatively high percentage of the initial variance of the studied phenomenon.

Table 32. *Factor structure of the specific working capacity of elite Greek women handball players*

№	I	II	III	IV	V	h2	1 - h2
1.	-0,250	0,734	-0,300	0,218	0,067	0,743	0,257
2.	-0,057	0,816	-0,375	0,015	-0,100	0,820	0,180
3.	0,246	-0,559	0,614	0,118	0,120	0,778	0,222
4.	0,237	-0,483	0,702	0,171	0,041	0,813	0,187
5.	0,140	-0,229	0,880	-0,012	0,093	0,855	0,145
6.	0,219	-0,089	0,868	0,093	-0,066	0,822	0,178
7.	0,706	-0,064	0,112	0,169	0,354	0,669	0,331
8.	0,061	-0,285	0,342	0,475	0,246	0,488	0,512
9.	-0,050	0,748	-0,425	-0,052	-0,074	0,751	0,249
10.	0,043	0,019	0,039	-0,058	0,873	0,769	0,231
11.	-0,644	0,476	-0,305	-0,151	0,135	0,775	0,225
12.	-0,748	-0,047	-0,085	-0,198	0,243	0,668	0,332
13.	-0,300	0,704	-0,152	-0,367	-0,072	0,749	0,251
14.	-0,126	0,668	0,129	-0,249	0,127	0,557	0,443
15.	0,125	-0,077	0,047	0,789	-0,122	0,661	0,339
16.	0,804	-0,219	0,106	-0,290	-0,009	0,789	0,211
17.	0,876	-0,203	0,147	0,047	0,040	0,833	0,167
18.	0,836	-0,161	0,119	0,010	-0,024	0,739	0,261
19.	0,750	-0,124	0,181	0,225	0,236	0,717	0,283
Σα	23,83%	19,81%	16,63%	7,25%	6,15%	73,67%	

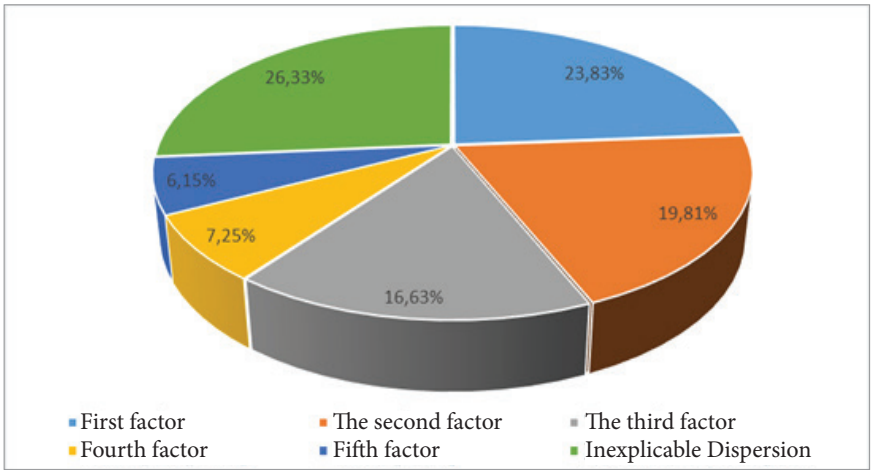

Fig. 22. *Relative distribution of the explained and unexplained from the derived factors initial variance of the specific working capacity of elite Greek women handball players*

The most significant contribution to the specific performance is the ability to quickly perform various throws in the opponent's goal, associated with the specific speed and power abilities of the upper limbs, which is a key feature of the game and determines its speed and strength.

However, in the spirit of correctness, it should be noted that most of the variables included in the test battery are aimed at establishing the effectiveness of the attacking actions of handball players. This requires some adjustments and the addition of a larger number of indicators that reveal the skills of the defenders.

Presented model characteristics of the studied elite Greek women handball players by positions based on the calculated T-scores, which are dimensionless quantities, allow comparison of all studied features, regardless of their units of measurement. They also allow to reveal the specific features of each of these sets (**Fig. 26-30**).

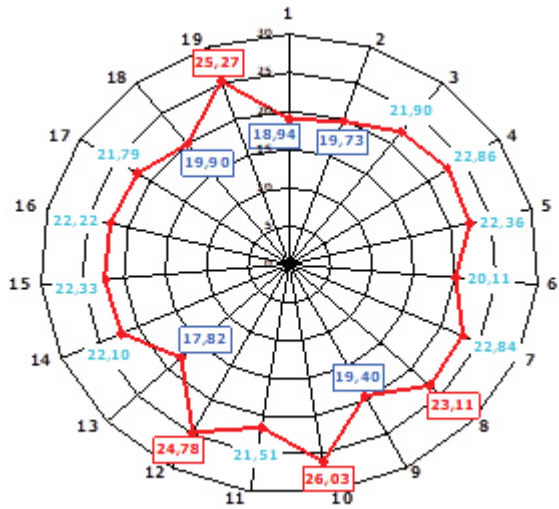

Fig.26. *Model characteristic of the specific working capacity of elite Greek handball players playing on the position "goalkeeper"*

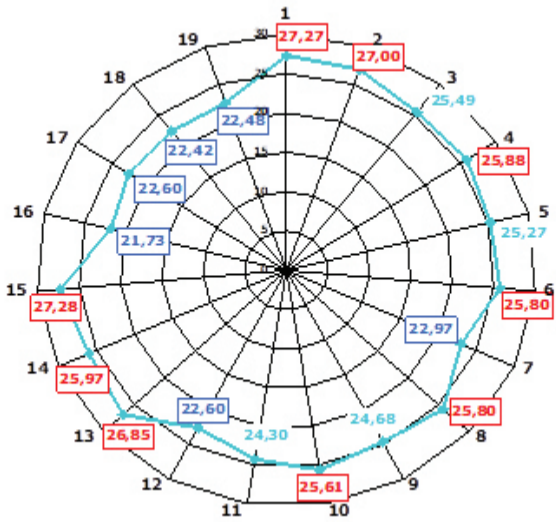

Fig.27. *Model characteristic of the specific working capacity of elite Greek handball players playing on the position "wing"*

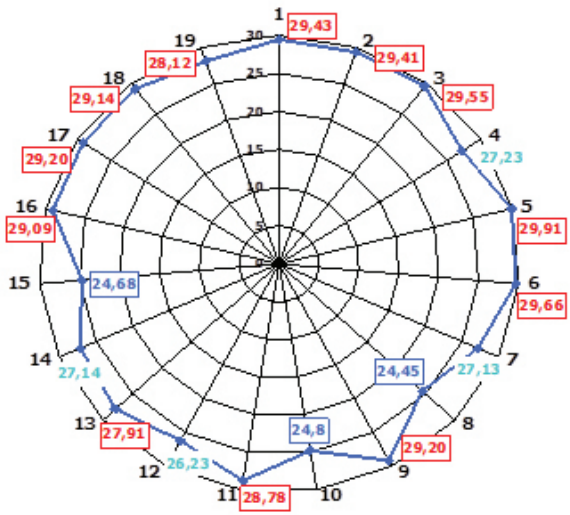

Fig.28. *Model characteristic of the specific working capacity of elite Greek handball players playing on the position "back"*

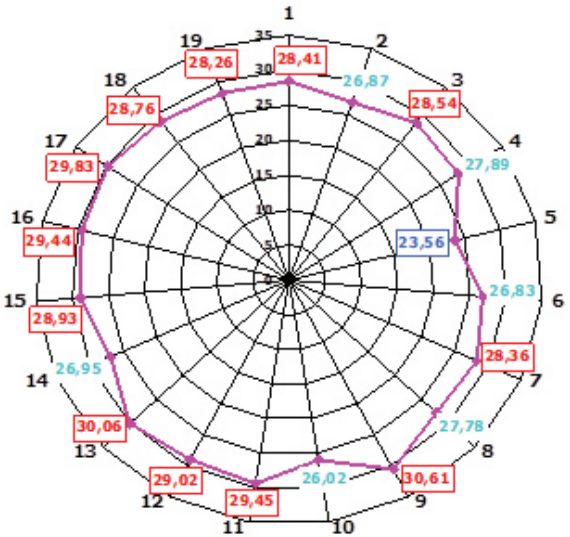

Fig.29. *Model characteristic of the specific working capacity of elite Greek handball players playing on the position "centre back"*

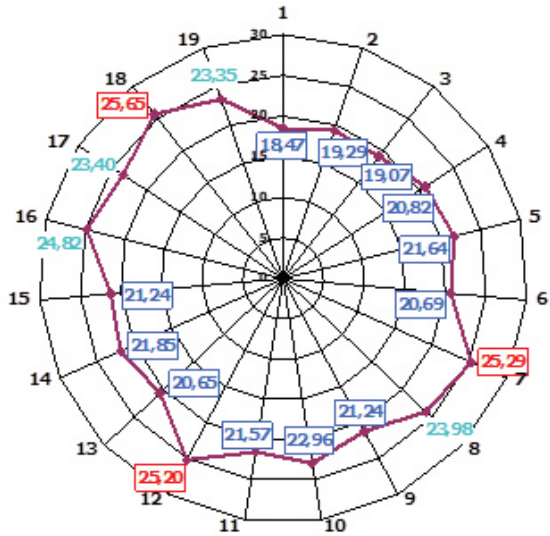

Fig.30. *Model characteristic of the specific working capacity of elite Greek handball players playing on the position "pivot"*

For the needs of the research, based on the T scores on all observed parameters of physical development and the specific working capacity, the so-called generalized score ($\overline{\sum T}$) are calculated, which can serve as an analogue of the special training of the competitors from the studied population (**Fig.31**). The analysis of the figures shows that the center backs have the most universal training ($\overline{\sum T}$ center backs = 28.97 points), followed by the backs ($\overline{\sum T}$ backs = 247.81 points), the wings ($\overline{\sum T}$ wings = 24.03 points), the pivots ($\overline{\sum T}$ pivot = 23, 08 points) and finally the goalkeepers ($\overline{\sum T}$ goalkeeper = 21.97 points).

It should be noted that in the Hellenic Republic there is no norm basis for assessing the specific working capacity of elite handball players. The construction of such a base is one of the most important conditions for optimizing sports training, as well as outlining

the parameters for identification and selection of future handball players. The sigma evaluation method was used in the development of our norm framework. The tables are presented in the dissertation.

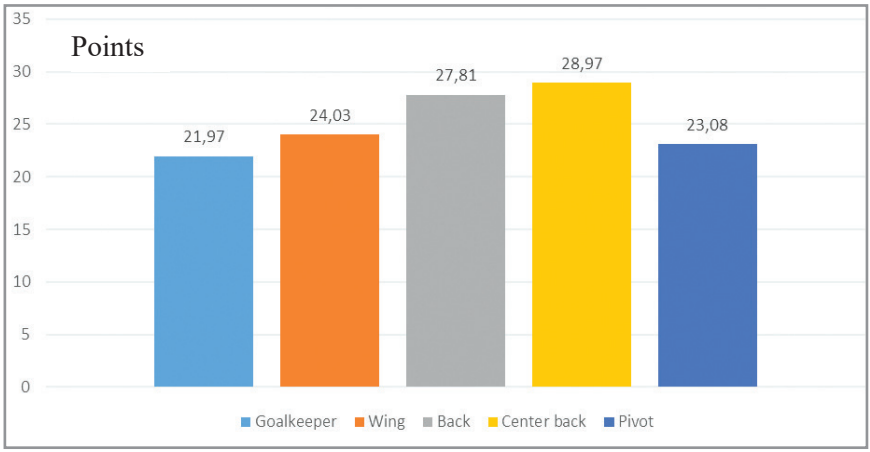

Fig. 31. *Summarized scores of the specific working capacity of elite Greek women handball players by game positions*

As an example, here we present two optimization models. The first is an optimization model of the physical fitness of a competitor who plays in the position – wing (**Fig. 32)**. This athlete has a relatively even development of the main parameters of physical fitness. The accents in the future training work with Ayşe should be focused mainly on the development of:

- ✓ the explosive force of the abdominal muscles.
- ✓ speed endurance.
- ✓ the explosive force of the lower limbs in the horizontal plane with coordination-complex exercises.
- ✓ the explosive force of the lower limbs in the vertical plane when jumping from a place.
- ✓ sprint abilities and special speed on the terrain with a change of direction.

Efforts to develop the parameters with the highest scores will not lead to the same training effect.

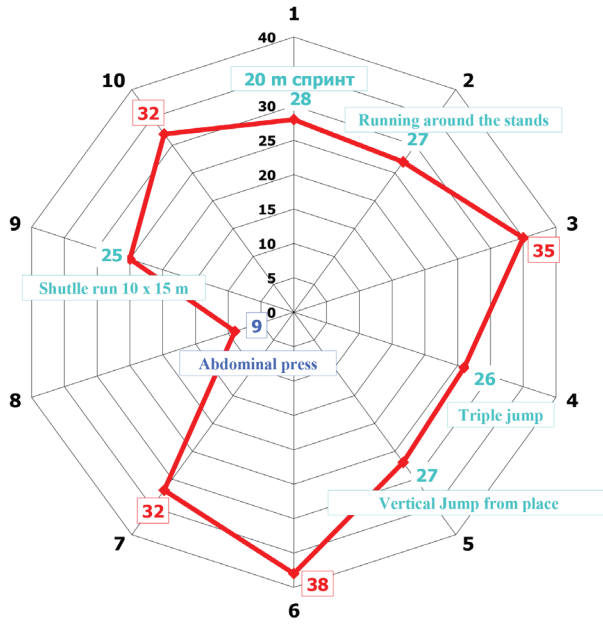

Fig. 32. *Individual optimization model of Aiche's physical fitness (wing)*

The second example model is the optimization model of the technical and tactical preparedness of the same competitor (wing) - **fig. 33**. The analysis of the figure gives

Reason to believe that the most significant improvement in the special technical and tactical preparedness Ayşe would achieve if in the future she focuses her efforts mainly on the development of:

- ✓ defensive play skills.
- ✓ the ability to move on the field with the ball at high speed and
- ✓ the speed of making tactical decisions and throwing the ball to the goal.

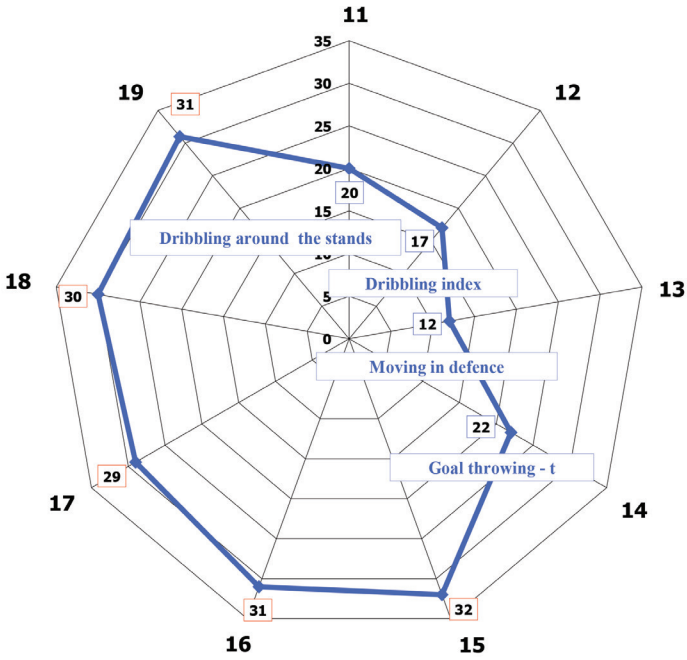

Fig. 33. *Individual optimization model of Aiche's physical fitness (wing)*

CONCLUSIONS AND RECOMMENDATIONS

The analysis of the literature sources, the conducted testing and the interpretation of the obtained results give us reasons to make the following more important conclusions and recommendations for the sports-pedagogical practice:

1. The comparative analysis of the average levels and the variability of the examined parameters shows that:

- ✓ in general, the studied set of elite Greek handball players is homogeneous in terms of parameters of physical development;
- ✓ inhomogeneity with the highest coefficient of variation is observed in anthropometric variables- respiratory difference, strength of the weak arm, Pine index, metabolic age and fat mass;
- ✓ in relation of specific performance and technical and tactical training, the studied handball women players are inhomogeneous in sprinting abilities and ball dribbling index, and relatively homogeneous for upper limb strength abilities, vertical jumping abilities and the ability to accurately throw the ball, as well as and throwing length.

2. The analysis of variance revealed that:

- ✓ there are statistically significant differences in terms of physical development and body composition of the studied athletes playing in different playing positions, the most significant being in relation of height, body circumference, body weight and BMI;

- ✓ The results of the study show that the elite Greek women handball players differ significantly, according to their playing position as regards speed and dynamic strength abilities, followed by specific speed endurance. The results also reveal that women handball players playing center backs are better at running, explosiveness of the upper limbs when throwing, explosiveness of the lower limbs (jumps) and flexibility compared to athletes playing in other positions, while the leading factor for backs is speed endurance.

2. The discriminant analysis confirmed the findings of the analysis of variance, namely that the elite Greek women handball players differ according to their position, mainly as regards:

- ✓ speed and dynamic power abilities, as well as specific speed endurance;
- ✓ The center backs re better in running speed, the explosiveness of the upper limbs when throwing, the explosiveness of the lower limbs (rebound) and the flexibility in comparison with the competitors in the other playing positions, while the backs are better in the speed endurance;
- ✓ The wings and backs determine the organization of the game in a quick attack, as well as the pivots and center backs, and the goalkeepers direct the game in attack.

3. The overall assessment of the somatotypes showed that in relation of game functions, the competitors were relatively homogeneous, with the dominance of the endomorphic somatotype. However, the somatotype should not be considered as the only determining factor for effective sports performance, but only as an important prerequisite in the identification and selection of future handball players.

4. The established correlation coefficients show that the structure of the anthropometric profile, the specific motor performance and technical-tactical training of elite Greek women handball players is very specific. Probably, the specialization in positions influences the connections between the individual studied parameters.

5. The factor structure of the physical development of the elite Greek women handball players is determined by 4 main factors, which explain a high percentage of the initial variance of the studied phenomenon, with the highest factor weight being the indicators of body and structural composition of the body.

6. The factor structure of the specific motor performance and technical-tactical preparedness of elite Greek handball players is determined by 3 main factors and two additional factors that explain a relatively high percentage of the initial variance of the studied phenomenon. The most significant contribution to the specific performance is the ability to quickly perform various throws to the opponent's goal, associated with the specific speed and power abilities of the upper limbs, which is a key feature of the game and determines its speed and strength.

7. The developed normative base for control and optimization models for game positions of special motor and specific technical-tactical preparedness of elite Greek women handball players is a reliable basis for ongoing monitoring of the preparedness of Greek handball players, a particularly important factor for success in elite women's handball.

Recommendations:

1. To increase the criteria for the selection of Greek handball players for inclusion in the representative teams of the first and second divisions. This recommendation stems from the fact that the determining somatotype is the endomorphic, atypical according to experts for modern dynamic handball.

2. To take serious measures (increasing the parameters of training loads and optimizing the diet) to reduce the body weight of athletes, most of whom have deviations from the norm.

3. The revealed model characteristics by game positions to serve as a starting point for improving the system of identification and selection of adolescent handball players in the Republic of Greece.

4. The developed normative base for control and assessment of the specific working capacity of elite Greek women handball players to be proposed to the Greek Handball Federation for implementation in practice.

Publications in connection with the dissertation

1. **Giannakou I.**, S. Tsanev, M Blachava. «Comparative analysis of the physical fitness of the elite Greek female handball players playing in different positions», 27-та международна конференция по физическо възпитание и спорт, 10-12 май 2019 г., Комотини.

2. **Giannakou, I.**, S. Chanev. «Anthropometric performance characteristics of female Greek handball players» International Scientific Congress "Applied Sports Sciences" Balkan Scientific Congress "Physical Education, Sports, Health" 15 - 16 November 2019.

3. Chanev, S., **I. Giannakou**. «Factor structure of the technical-tactical preparedness of the elite female Greek handball players» International Scientific Congress "Applied Sports Sciences" Balkan Scientific Congress "Physical Education, Sports, Health" 15 - 16 November 2019.

4. Μασαδησ, Γ., Φιλιππου, Φ., Μπεμπετσοσ, Ε., Κουλη, Ο., Πιτση, Α., Μαυριδησ, Γ., Σαμαρα, Ε., Σιαρενου, Δ., Πετανιδησ, Δ., **Giannakou I.**, «The impact of different teaching methods of Greek traditional dance on the motivational climate of elementary school student», 28-миМеждународна конференция по физическо възпитание и спорт, 12-14 юни 2020 г., Комотини.

5. Skandalis V., Chatzimanouil D., Stavropoulos N., Sykaras EV., Mavromatis G., **Giannakou I.,** Chanev, S. „The importance of evaluating lower limbs 'asymmetry in high – level handball players after an injury „, 28-ма Международна конференция по физическо възпитание и спорт, 12-14 юни 2020 г., Комотини.

6. **Giannakou, I**., S. Chanev, V. Skandalis, D. Hatzimanouil «Anthropometry of elite female Greek handball players according to the playing positions», 28-ми Международна конференция по физическо възпитание и спорт, 12-14 юни 2020 г., Комотини.