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The body composition and somatotype of 13-16 years old elite athletes (judo, volleyball, basketball) as a basis of selection and orientation of sports.

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Abstract This study aims to analyze the results of body composition and somatotype of elite athletes in the cadet category (13-16 years) (judo, basketball, volleyball) as a basis for sports selection. Accordingly, the study examined the significance of differences in body mass and somatotype components for the research samples. A descriptive survey study was conducted on a deliberately (purposely) selected sample, utilizing the anthropometric kit as a primary tool. Matica's equations and Heath-Carter's method were used to derive the results for body mass and somatotype components. Among the most significant findings of the study is the presence of substantial differences in body composition and somatotype components of the research samples. Based on these findings, the researchers recommend relying on published studies and research in the field of sports selection as a scientific foundation for guiding athletes toward the appropriate sports activity.

Keywords: Body composition, somatotype, selection, guidance.

1. INTRODUCTION

The record-breaking achievements and rapid breaking of world records, along with the remarkable improvement in sports performance levels, are clear evidence of the significant development witnessed in the sports field. Achieving such records and enhancing performance levels can be attributed to scientific and systematic sports selection, which is fundamentally an investment and economic process. Advanced nations rely on it to save effort, time, and money in crafting elite athletes. As noted by (Franz & Feresu, 2013), the process of sports selection and guidance is primarily an economic process aimed at optimizing effort and achieving the best results.

One of the main focuses of sports scientists in crafting elite athletes is the body composition of athletes. This is highlighted by (Costill & Wilmore, 2006): "In order to determine an individual's physical readiness and its impact on participating in sports activities, the growth and development of body structure and composition must first be described and understood" (Costill et Wilmore, 2006).

Somatotype is one of the most important determinants of selection due to its relative stability within the strategic system of crafting elite athletes (Abu El-Ela & Hassanin, 1997, 295). Selecting the right individual for the appropriate sport is the first step toward achieving championship levels. As stated by (Abdel Fattah & Hassanin, 1997), "For a player to succeed, they must be selected for a sport that suits their somatotype" (Abdel Fattah & Hassanin, 1997).

Additionally, many specialists agree that there is a relationship between an athlete's body composition and the potential to reach global sports performance levels (Houcine et al., 2014).

The Problem:

It is well known that crafting an elite athlete requires an appropriate body, intensive training programs, and consistent practice. Through the coach's skill in training and the athlete's appropriate somatotype for a specific activity, championship levels can be achieved.
Therefore, it is impossible to separate the coach's expertise from the athlete's

physical potential in ensuring the effectiveness of the training programs developed by the coach. As Hassanin (1998) cited Karpovich: "A wise coach does not waste their time and effort on a somatotype that shows no promise of success" (Hassanin, 1998).

From this, the research problem can be summarized in the researchers' observation of the absence of scientific foundations and the reliance on randomness and coincidental results in the process of selecting and guiding athletes toward sports activities, especially from a morphological perspective.

This observation stems from the researchers' involvement in training and teaching, which motivated us to conduct an analytical study of the body composition and somatotype of elite youth athletes in teams (judo, basketball, volleyball). The aim is to provide professionals in the field of selection with some scientific foundations and references to avoid randomness and coincidental results in crafting elite athletes.

Questions:

1. What are the specifications of body composition and somatotype for elite athletes (judo, basketball, volleyball) as a model for selecting and guiding athletes aged 13-16 years (males)?
2. Are there significant differences between elite teams (judo, basketball, volleyball) in body composition and somatotype components that distinguish each activity from the others?

Objectives:

1. To determine the body composition and somatotype of elite athletes (volleyball, basketball, judo) as a model for selecting and guiding male athletes aged 13-16 years.
2. To identify the significance of differences in body composition and somatotype components among elite teams (judo, basketball, volleyball) and how each activity stands out from the others.

Hypotheses:

1-1 Judo athletes are characterized by an increase in muscular and fat mass at the expense of bone mass, predominantly displaying a mesomorphic-endomorphic somatotype.

1-2 Basketball and volleyball players are characterized by an increase in bone and muscle mass at the expense of fat mass, predominantly displaying an ectomorphic-mesomorphic somatotype.

2- There are significant differences in body composition and somatotype components among the research samples.

Terms Used in the Study:

- **Body Composition:** Refers to the composition of the human body in terms of its three main components: muscles, fat, and bones (Hazaa, 1997, p. 87; Battinelli, 2007, p. 10).
- **Somatotype:** Refers to the morphology of the body, i.e., its structural and compositional form, expressed in three numbers: the first (right) indicates leanness, the second (center) indicates musculature, and the third (left) indicates fatness (Radwan, 1997, p. 29; Carter, 2002, p. 2).
- **Selection:** A process through which the best individuals are chosen from a large group based on specific criteria (Hamadeh, 1996).
- **Guidance:** A set of services aimed at helping an individual better understand themselves, their problems, and providing them with the necessary skills to utilize their potential, abilities, and readiness (Ikhlas, 2002, p. 13).

Similar Studies:

Study by Namouri and Abu Yousef, 2000: "The Somatotype and Side Profile Grid of National-Level Water Polo Players"

The study aimed to:

The body composition and somatotype of 13-16 years old elite athletes (judo, volleyball, basketball) as a basis of selection and orientation of sports.

1. Determine the physical and somatotype characteristics of water polo players (top teams and the Egyptian national team).
2. Design a side profile grid for water polo players (top teams and the Egyptian national team).
3. Compare the physical characteristics and somatotype in light of the side profile grid (top teams and the Egyptian national team).

The research sample included (33) players, who ranked first to third in the Egyptian International Water Polo Championship held at the Shooting Club from April 12 to 16, 1999, including 12 players from the Egyptian team and 7 players each from Hungary, Slovenia, and Bulgaria.

Data were analyzed using mean, standard deviation, and t-test.
The results showed:

1. Significant differences in most measurements in favor of top teams.
2. Top team players were characterized by a mesomorphic-endomorphic somatotype.
3. The Egyptian national team players were characterized by an endomorphic-mesomorphic somatotype.
4. A side profile grid was designed for top teams, which can be used in selecting and guiding young water polo players (Namouri and Abu Yousef, 2000, pp. 195–219).

Study by Duncan et al., 2006:
"Anthropometric and Physiological Characteristics of Elite Youth Volleyball Players"
The study aimed to:
Identify the anthropometric and physiological characteristics of elite youth volleyball players based on their playing positions.

The research sample included (25) elite youth volleyball players aged 16-19 from the English volleyball team, and the study was conducted during training camps in the summer of 2006.

Data were analyzed using ANOVA, and the results showed:

1. Setters displayed an ectomorphic-mesomorphic somatotype.
2. Attackers and defenders displayed a balanced somatotype.
3. Middle blockers displayed a mesomorphic-ectomorphic somatotype (Duncan et al., 2006, pp. 649–651).

Study by Sánchez-Muñoz et al., 2007: "Anthropometric Characteristics, Body Composition, and Somatotype of Elite Youth Tennis Players"
The study aimed to:

1. Describe the anthropometric characteristics, body composition, and somatotype of elite youth tennis players ranked in the top 12 and bottom 12.
2. Compare the anthropometric data, body composition, and somatotype of elite youth players ranked in the top 12 and bottom 12.
3. Develop an anthropometric profile for elite youth tennis players.

The research sample included (123) youth tennis players, consisting of (57) boys and (28) girls from (28) national teams participating in the 2005 and 2006 Davis Cup and Junior Fed Cup. The sample was divided into groups based on gender and ranking (top 12 and bottom 12, based on performance level).

The following were calculated:

- Body Mass Index (BMI)
- Somatotype using the Heath-Carter equation
- Fat mass percentage using Siri's equation, based on body density equation (Durnin & Womersley)
- Muscle mass percentage using Portman's equation

Data were analyzed using the mean, standard deviation, and range to describe research variables, as well as the Wilcoxon-Mann-Whitney U test and percentile ranking to develop the profile.

The body composition and somatotype of 13-16 years old elite athletes (judo, volleyball, basketball) as a basis of selection and orientation of sports.

The results revealed the following:

1. There were no significant differences between players ranked first and last in all research variables (body measurements, body composition, and somatotype).
2. Significant differences existed among female players ranked first and last, except in height and elbow and knee width (Sánchez-Muñoz et al., 2007, p. 793–799).

Study by Boujemaa Beloufa, 2009: "Clarifying Morphological Requirements of Certain Body Composition Indicators (Somatotype, Quantitative Estimation) and Their Relation to the Type of Practiced Specialization"
The study aimed to:

1. Describe and clarify standard morphological models for sports specialization (judo) and organized games (football, volleyball, handball).
2. Determine the quantitative estimation of body composition components and anthropometric indicators for all research samples across age groups (16-17-18-19 years).
3. Draw a specific distribution map for the somatotype card and its quantitative estimation.
4. Identify differences and similarities in morphological indicators between sports specializations.

The research sample included 291 athletes participating in regional championships in the following disciplines: judo (70 athletes), football (91 athletes), volleyball (60 athletes), and handball (70 athletes).

The researcher utilized anthropometric measurements based on the Heath-Carter somatotype evaluation form and used Sheldon's somatotype distribution chart. Data were analyzed using the mean, standard deviation, and ANOVA.

Key findings:

1. A trend towards increased musculature and leanness, with a decline in fat component.
2. Somatotype distribution concentrated around the central area of the chart, with most leaning towards the mesomorphic somatotype.
3. Increased size and weight in judo specialization, with low fat levels attributed to the requirements of the sport.
4. Significant differences in somatotype and size between athletes in combat sports and organized games. (Beloufa Boujemaa, 2009, p. 184–192)

Research Methodology and Field Procedures:

Research Method:
The researchers relied on a descriptive survey approach to study the research problem.

Research Sample:
The study was conducted on a sample of 33 athletes from Algerian elite teams, comprising 7 judo players (from under 50 kg to over 90 kg), 14 basketball players, and 12 volleyball players (youth category, aged 13–16 years), selected intentionally.

Research Tools:
The primary tools used in this study included an anthropometric kit containing the following:

- Stadiometer for measuring heights
- Medical scale (Type: Trialo)
- Caliper
- Small sliding compass
- Measuring tape

Equations for Body Composition and Somatotype:

- **Body Composition:** Mateigka's equations (1921) were used to calculate the main components of body composition.
  - **Body Surface Area (BSA):** Sa=100+P+(stature−160)100Sa = \frac{{100 + P + (\text{{stature}} - 160)}}{100}Sa=100100+P+(stature−160) (Izakson, 1958).
  - **Fat Mass (FM):** MA=d·s·kMA = d \cdot s \cdot kMA=d·s·k.
  - **Muscle Mass (MM):** MM=l·r2·kMM = l \cdot r^2 \cdot kMM=l·r2·k.
  - **Bone Mass (BM):** MO=l·o2·kMO = l \cdot o^2 \cdot kMO=l·o2·k (Houcine et al., 2014).
- **Somatotype:** The researchers used the Heath-Carter anthropometric method to determine the somatotype.

Statistical Methods:

Data were analyzed using the SPSS statistical software to obtain the following statistical measures:

- Arithmetic mean
- Standard deviation
- Skewness coefficient
- ANOVA
- LSD test for mean differences significance

Presentation of Results:

Analysis of Body Composition Results:

Table No. (01) represents the significance of differences in fat mass for the research samples:

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	**Difference**
Within Groups	1273.74	30	42.45	5.75	3.32	Significant
Between Groups	488.59	2	244.29			

Means	Mean Differences			LSD Value	
	S1 =11.51	S2 =16.93	S3=7.07		
S1 =11.51	/	5.43	4.43	S1.S2 =3.68	Significant
S2 =16.93	/	/	9.86	S1.S3 =4.31	Significant
S3=7.07	/	/	/	S2.S3 =4.10	Significant

From the results in the table, it is clear that there are significant differences between the research samples, as indicated by the calculated F-value compared to the tabular F-value. The results of the LSD test also showed that the increase in absolute fat mass was in favor of basketball players, with S2=16.93S_2 = 16.93S2 =16.93 kg. Volleyball players ranked second, with S1=11.51S_1 = 11.51S1=11.51 kg, while judo players ranked last, with S3=7.07S_3 = 7.07S3=7.07 kg.

The researcher explains these results by noting that basketball coaches focus on developing speed and various types of strength more than general endurance. Additionally, basketball emphasizes skill-related aspects over physical aspects, which leads to a relative increase in fat mass among basketball players compared to volleyball and judo players. This is further supported by the fact that most tests applied in basketball aim to measure power, speed, and basic skills, such as the

Lilleshall Test, Johnson Test, Knoxon Test, and Liston Test (Montgomery et al., 2010).

Moreover, Dr. Beloufa's study demonstrated that judo athletes are characterized by lower fat mass compared to other team sports (football, volleyball, handball). This difference is attributed to the specific demands of the sport (Beloufa Boujemaa, 2009, p. 190).

Table No. (02) Represents the Significance of Differences in Muscle Mass for the Research Samples

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	Difference
(Within Groups)	804.60	30	26.82	2.19	3.32	Not Significant
(Between Groups)	117.98	2	58.99			

The results of Table No. (02) indicate that there are no significant differences between the research samples, as the calculated F-value is less than the tabular F-value.

The researcher attributes this to the fact that strength in its various forms is a necessary attribute in all three activities and is a requirement for every coach. This is evident through the dominance of muscle mass in the body composition of the research samples compared to fat and bone mass. As noted by Franchini et al. (2011), "Muscular strength significantly influences the development of other physical attributes."

Additionally, Hazza (1997, p. 115) emphasizes that "there is a direct correlation between muscular strength and the cross-sectional area of the muscle."

The researcher also attributes the increase in muscle mass in the research samples to the physiological characteristics of the age group (13–16 years), which is characterized by gaining most of the muscle mass, as testosterone secretion during

this stage is 10 times higher than in earlier stages (Costill & Wilmore, 2006, p. 430).

Table No. (03) Represents the Significance of Differences in Bone Mass for the Research Samples

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	Difference
(Within Groups)	64.84	30	2.16	4.33	3.32	Significant
(Between Groups)	18.71	2	9.37			

Means	Mean Differences			LSD Value	
	S1 =12.54	S2 =12.58	S3 =10.67		
S1 =12.54	/	0.13	1.77	S1.S2=0.83	Not Significant
S2 =12.58	/	/	1.9	S1.S3=0.97	Significant
S3 =10.67	/	/	/	S2.S3=0.92	Significant

The results of the table show that there are significant differences between the research samples, as the calculated F-value is greater than the tabular F-value. Using the LSD test for mean differences, it was found that the volleyball and

basketball samples are equivalent in absolute bone mass, unlike the judo sample, which has lower bone mass compared to the volleyball and basketball samples.

The researcher attributes the equivalence of the basketball and volleyball samples and their superiority over the judo sample in bone mass differences to the specific nature of each activity. As Hazza (1997, p. 95) states, "The type of activity plays a role in stimulating bone density. Activities that involve body weight-bearing, such as running and jumping, are essential for the motor performance of basketball and

volleyball." For example, the spiking skill in volleyball depends on jumping, and the approach steps for performing this skill involve running. Similarly, the jump shot skill in basketball contributes to increasing bone density.

In contrast, judo relies on bringing the body's center of gravity closer to the ground to enhance balance. Physiological factors also play a significant role in increasing bone density, as growth hormone secreted by the pituitary gland greatly impacts skeletal and physical maturation during growth stages (Tavio & Jook, 2002, p. 2).

Table No. (04) Represents the Significance of Differences in the Obesity Component for the Research Samples

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	Difference
(Within Groups)	36.94	30	1.23	8.79	3.32	Significant
(Between Groups)	22.1	2	11.05			

Means	Mean Differences			LSD Value	
	S1=2.21	S2=3.71	S3=1.85		
S1=2.21	/	0.35	1.51	S1.S2 =0.62	Significant
S2=3.71	/	/	1.86	S1.S3 =0.73	Not Significant
S3=1.85	/	/	/	S2.S3 =0.69	Significant

Table No. (05) Represents the Significance of Differences in the Muscle Component for the Research Samples

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	Difference
(Within Groups)	41.72	30	41.72	8.92	3.32	Significant
(Between Groups)	24.82	2	12.41			

Means	Mean Differences			LSD Value	
	S1=2.42	S2=3.25	S3=4.78		
S1=2.42	/	0.83	2.73	S1.S2 =0.74	Significant
S2=3.25	/	/	1.54	S1.S3 =0.78	Significant
S3=4.78	/	/	/	S2.S3 =0.66	Significant

Table No. (06) Represents the Significance of Differences in the Thinness Component for the Research Samples

	Sum of Squares	Degrees of Freedom	Mean Squares	F (Calculated)	F (Tabular)	Difference
(Within Groups)	58	30	1.94	1.91	3.32	Not Significant
(Between Groups)	7.47	2	3.73			

Table No. (07) Represents the Quantitative Estimation of Body Type for the Research Samples

Specialization / Component Type	Obesity Component	Muscle Component	Obesity Component	Determining Coordinates (y, x)
Volleyball	3.92	2.42	2.21	x=1.71
	Balanced Thin			y=−1.29
Basketball	3.11	3.25	3.71	x=−0.6
	Central Pattern			y=−0.32
Judo	2.71	4.78	1.85	x=0.86
	Muscular Thin			y=5

Table No. (07) clearly indicates that each sport activity among the three has its specific body type. Volleyball players are distinguished by a balanced thin body type with a quantitative estimation of (3.92–4.42–2.21). Basketball players are characterized by a central body type with a quantitative estimation of (3.11–3.25–3.71). Meanwhile, judo players are distinguished by a muscular thin body type with a total quantitative estimation of (2.71–4.78–1.85).

The results of Tables No. (04), (05), and (06) confirm the uniqueness of each sport activity. From the results of the "F" test in Table No. (04), it was found that there are statistically significant differences in the obesity component. Using the LSD test, it became clear that the difference was in favor of the basketball sample, with equivalence in this component between the judo and volleyball samples.

Table No. (05) shows that there are statistically significant differences in the muscle component, as indicated by the results of the "F" test. Through the LSD test for the significance of mean differences, it was found that the difference was in favor of the judo sample, followed by basketball, and finally volleyball.

As for Table No. (06), it indicates, through the results of the "F" test, that there are no significant differences in the thinness component, as the calculated "F" value is less than the tabular "F" value.

The researcher interprets the differences in body type results (thin, muscular, obese) among the research samples (judo, basketball, volleyball) as evidence that each sport activity has a suitable body type that distinguishes it. This was confirmed by (Abdel Daim and Hassanien, 1999), who stated that an athlete

must possess a body type suitable for the sport they practice. Arnott and Janis, in their book "Sports Selection," stated that "body type is beneficial and useful in describing the great diversity of body structure requirements across all types of sports. Based on this, children and adults are directed towards sports suitable for them" (Abdel Daim & Hassanien, 1999, p. 194).

Researchers explain the differences in the significance of body type components (thin, muscular, obese) among the research samples compared to body mass components (fat, muscle, bone) as being due to the fact that body type grades are more influenced by genetics than by training and nutrition factors. Meanwhile, body masses are affected by intensive training programs, nutrition, illnesses, and other factors. This explains why athletes are constrained by their genetic inheritance.

Carter and Heath proved that the increase in muscle component and the decrease in obesity component among some athletes result from intensive training programs without any change in the type of body type (muscular obese). Sheldon also points out that body type represents the path and course taken by an organism under normal nutrition conditions and in the absence of severe pathological disturbances (Hassanien, 1995, pp. 100–101).

In this study, the variables of illness and malnutrition were controlled, as the sample consisted of elite athletes.

Conclusions:

- Significant differences were found between the research samples in height, favoring the volleyball sample, followed by basketball, and finally judo.
- Significant differences were found in fat mass, favoring the basketball sample, followed by volleyball, and then judo.

- No significant differences were found in muscle mass among the research samples.
- Significant differences were found in bone mass, favoring the basketball and volleyball samples, followed by judo.
- Significant differences were found in the obesity component, favoring the basketball sample, with equivalence between the volleyball and judo samples.
- Statistically significant differences were found in the muscle component, favoring the judo sample, followed by basketball, and then volleyball.
- No significant differences were found in the thinness component among the research samples.
- Elite volleyball players were characterized by a balanced thin body type, elite basketball players by a central body type, and elite judo wrestlers by a muscular thin body type, with a noticeable increase in muscle component.
- Some differences were found between the results of body mass tables (fat, muscle, bone) and body type components (thin, muscular, obese).

Recommendations:

- Conduct training courses for coaches and physical education teachers on measurement and evaluation methods.
- Focus on directing school students towards appropriate sports activities.
- Avoid separating morphological aspects from skill and physical aspects in admission tests within sports clubs.
- Rely on certain morphological indicators such as weight, body mass, muscle circumferences, and skinfold thickness as indicators to evaluate training sessions.
- Consider genetic factors such as body type, expected height, and other factors in sports selection processes.
- Base athlete selection and direction towards suitable sports activities on published research and studies in the field of sports selection.

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