



Anatomical and Morphofunctional Features of the Lower Extremities and their Individual Parts in Female Athletes, in A Number of Team Sports

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Abstract

The article presents the results of a study on the inversion of sex somatotypes obtained from female athletes adolescents engaged in four types of martial arts. 56 women participated in the research. It was found that in female athletes of adolescents engaged in single combat, in the values of the index of sexual dimorphism and in sexual somatotypes, the andromorphic and mesomorphic sexual somatotypes prevalent in 39 (69.64%) prevail. Ginekomorphic sexual somatotype is defined in 17 (30.36%) adolescents female athletes. In all four groups, 30 (53.57%) young female athletes have high enough values of mesomorphic sexual somatotype indicators as markers of somatic adaptive processes. The results obtained from the study suggest that the occurring somatic processes are adaptive changes in the body of young female athletes, under the influence of intense physical and psycho-emotional stresses on them.

Keywords: Female Athletes; Team Sports; Morphological and Functional Index Values; Bone Pelvis; Lower Limb

Introduction

Mass participation in various sports by women of different age groups has become a common occurrence today. Girls, starting from the prepubertal and pubertal periods, actively and en masse go to sports sections, which allows the coaching team with the participation of sports doctors to conduct a professional selection of candidates for a specific sports discipline [2,3]. When selecting for team sports such as basketball, volleyball and handball, there are also criteria for the selection of candidates, among which the morphological features of the upper and lower limb girdle are of great importance [8,9]. It is well known that the body length of female athletes is of primary importance in team sports such as volleyball and handball, and especially basketball.

These sports are dominated by tall athletes [4,8-10]. The length, circumference of the athlete's thigh and shin, the length and width of the foot, the pushing right and/or left leg are important in the

technique of performing a number of specific techniques in each of these sports. Also, according to a number of researchers, the relationship between each part of the athlete's body, including the upper and lower limbs, is of great morphofunctional importance, which stabilizes around 14-16 years of age as puberty occurs, growth and maturation of the bone structures of the skeleton, including the bony pelvis and limbs [4,11-13].

Serving the ball, building a block, throwing into the basket or at the opponent's goal - this is only a small part of the game "work" that female athletes perform during the game of basketball, volleyball and handball. Thus, in basketball, such an anthropometric parameter as body height, including the lower and upper limbs, is of decisive importance for the sports role of the athlete and her place on the field - center, in defense or in attack [5,6,9,14]. In connection with the above, the study of medical and biological and anatomical and morphofunctional features of the bone pelvis and lower limb

girdle in female athletes in these team, game sports is very relevant and in demand, both in sports morphology and in a number of other related medical and biological disciplines.

Aim of Study

The purpose of this article is to present the data obtained as a result of the conducted research and their analysis concerning the study of morphofunctional and anatomical features of the lower limb girdle in female athletes involved in basketball, volleyball and handball.

Hypothesis of the study

During the preparation of this study, its author put forward a working hypothesis, the essence of which was as follows: with long-term and intensive physical and psycho-emotional loads, in female athletes, in a number of game sports, such as volleyball, basketball and handball, during the training and competition period, adaptive somatic and psychological changes are formed in the bodies of female athletes and, in particular, the belt of their lower limbs, and their individual parts, with their anatomical and morphofunctional changes, including the developing adaptive inversions of their sexual somatotypes, which leads to a significant improvement in their athletic performance, both due to the ongoing masculinization and hyperandrogenism of female athletes.

Research objectives

To achieve the stated objective of the study, its tasks were developed, namely:

- To recruit reliably similar groups of female athletes in the sports under study, both in terms of sport type, sports experience and qualifications, and age, who have expressed their voluntary desire to participate in it;
- To select a set of anatomical and anthropometric studies and groups of special morphofunctional index values for this study, as well as, in addition to anthropometric measurements, to take pelvimetric measurements for all participants in the study using Martin's calipers and a centimeter tape.
- To find similar scientific articles and research articles that are close and/or similar to the study. To conduct a literary-critical analysis of them.
- To subject all digital indicators and values obtained as a result of the study to mathematical statistics and critical analysis.

Material and Methods

To conduct this study, we used the following methods: literary-critical analysis of available, both domestic and foreign research and scientific-methodological materials, on the issue under study, anthropometry with determination of body length and weight; determination of the length of the lower limb, both right and left, shoulder width, length and girth of each part of the lower limb - thigh and shin, length, width and size of the foot, determination of the width of the pelvis (intercensal diameter); determination of the Soloviev index - the girth of the radio-wrist joint in cm; method of mathematical statistics.

To achieve the goal of the study, we used anthropometric methods such as determining the shoulder width (SW) and the pelvic width (PW), which are necessary to determine such a morphological index value as the sexual dimorphism index (SDI) according to J. Tanner. A number of additional morphofunctional index values were also determined, such as the leg (lower limb) length index (LLLI), which was determined as the percentage ratio of the total length of the lower limb to the result obtained by subtracting the sitting body length from the body length, in cm); Pelvic bone index (the sum of three transverse and one longitudinal dimensions of the pelvic bone (IT)); pelvic bone maturity index (PMI), according to the method of N.I. Kovtyuk; IRFL-TL; index ratio of femur length to tibia length; trochanteric index (TrI), as the ratio of body length in cm to the length of the lower limb; pelvic index (IT), as the sum of three transverse dimensions of the pelvis (intertubercular, intercrestal and trochanteric size, plus the size of the external conjugate - all in cm); sexual dimorphism index, according to the method proposed by J. Tanner (1996, 2010) with subsequent determination of sexual somatotypes in each group of female athletes; body mass index - according to the classical method; shoulder width index, as a percentage of shoulder width to body length; body mass index (BMI).

All female athletes, from various team sports, gave their voluntary, both oral and written, consent to participate in the study.

Abbreviation

- SI - Soloviev index;
- SW - Shoulder width;
- PW - Pelvic width;

- SDI - Index of sexual dimorphism, according to the method of J. Tanner and W. Marshall, as modified by E.P. Sharaikina;
- LLLI - (Lower limb) length index;
- RPWI - Relative Pelvic Width Index;
- MS - Master of Sports;
- CMS - Candidate Master of Sports.
- PBI - Pelvic bone (PBI), according to the method of N.I. Kovtyuk;
- PI - Pelvic index (PI), as the sum of three transverse dimensions of the pelvis (intertubercular, intercrestal and trochanteric size, plus the size of the external conjugate - all in cm);
- TrI - Trochanteric inde, as the ratio of body length in cm to the length of the lower limb;
- IRFL-TL - Index ratio of femur length to tibia length;
- TSLR - Thigh to shin length ratio;
- BMI - Body mass index, kg/cm²;
- ANP - Anatomically narrow pelvis.

Results and Discussion

Methodology of the study. The study involved 72 female athletes actively involved in such game and team sports as basketball (23 female athletes); volleyball (25 female athletes); and handball (24 female athletes). Their average age was, respectively, 22.73 ± 1.12 years; 23.07 ± 1.14 years; and 21.97 ± 1.34 years. The duration of training in these sports was from 4.5 to 10 years. The level of sports qualification was from the 1st sports category - 29 female athletes (40.28%) of the total number of athletes; candidates for master of sports (CMS) - 27 (37.5%) and masters of sports - 16 (22.22%). The frequency of training was 5-6 times a week, for 2-2.5 hours. This study was conducted in a number of sports sections and clubs in the Nikolaev and Kherson regions of Ukraine, on the condition of absolute voluntariness, both on the part of the athletes themselves, and with the consent and active support of the coaching teams. After conducting the anthropometric measurements necessary for this study, which were carried out using the classical method, the indicators were obtained, which are presented in Table 1, at p < 0.05.

Name of the indicator	Sportswomen-Basketball players (n = 23)	Sportswomen-Volleyball players (n = 25)	Sportswomen- Handball players (n = 24)
Body length (standing), cm	192,77 ± 1,36	179,35 ± 1,13	177,03 ± 1,11
Body weight, kg	82,03 ± 0,74	73,23 ± 1,08	71,54 ± 1,29
Shoulder width, cm	36,43 ± 1,04	35,53 ± 1,27	35,67 ± 1,14
Length of lower limb, cm	105,37 ± 1,93	102,17 ± 1,71	93,83 ± 1,86
Thigh length, cm	62,17 ± 1,14	61,87 ± 1,33	56,08 ± 1,21
Hip circumference at rest, cm	52,89 ± 1,13	51,67 ± 1,88	53,86 ± 1,14
Length of shin, cm	43,47 ± 1,66	40,47 ± 1,54	37,93 ± 1,68
Calf circumference, cm	35,47 ± 1,09	33,67 ± 1,16	34,97 ± 1,28
Foot length, cm	28,57 ± 1,45	29,81 ± 1,68	27,85 ± 1,54
Foot width, cm	8,56 ± 1,37	9,47 ± 1,08	8,23 ± 1,36

Table 1: Anthropometric indicators of female athletes in the study groups.

The analysis of the obtained results of the conducted anthropometry showed that according to the body length indicators, female basketball players can be classified as very tall athletes, and female volleyball players can be classified as tall athletes [4,6,7,13]. The greatest body mass was also observed in female basketball players, followed by female volleyball players and female handball players. The shoulder width of the athletes in all groups is approximately the same, but again, the broadest shouldered are the female basketball players, followed by female volleyball play-

ers and female handball players. The length of the lower limb of female basketball players is the greatest, exceeding the length of the lower limbs of female volleyball players and female handball players. In all three groups of athletes, the length of the thighs exceeds the length of the shin, with the smallest thigh length value being observed in female handball players, and the greatest length being observed in female basketball players, followed by female volleyball players. The thigh girth at rest and the shin girth are greatest

in female basketball players and female handball players, while the results for female volleyball players and female handball players are almost identical. In all three groups of female athletes, the average thigh length exceeded the shin length.

The largest values of foot length and width are in female volleyball players, then in female basketball players, the smallest are in female handball players. In female athletes of all three groups,

the pelvis width values are less than the generally accepted, standard for this age group, equal to 28-29 cm [2,7,12]. The ratio of the existing shoulder width and pelvis width indicates a masculine body type of female athletes - with broad shoulders and a narrow pelvis [2,7,12]. We also conducted pelviometry, carried out according to the classical method, using Martin's calipers. The obtained results of measurements of 3 transverse and 2 longitudinal, external dimensions of the bony pelvis of female athletes are presented in Table 2, at $p < 0.05$.

Name of the indicator	Sportswomen-Basketball players (n = 23)	Sportswomen-Volleyball players (n = 25)	Sportswomen- Handball players (n = 24)
Interspinous diameter (d. spinarum), cm	25,01 ± 0,24	24,81 ± 0,27	24,37 ± 0,33
Intercrestal diameter (pelvic width), d. cristarum, cm	27,14 ± 0,67	27,56 ± 0,38	27,51 ± 0,11
Trochanteric size (d. trochanterica), cm	31,35 ± 0,74	31,22 ± 0,61	31,17 ± 0,88
External conjugate (c. externa), cm	20,03 ± 0,74	19,87 ± 0,21	19,31 ± 0,77
True conjugate (c. vera), cm	10,89 ± 0,67	10,45 ± 0,49	10,23 ± 0,66

Table 2: Results of pelviometry in the studied groups of female athletes.

The analysis of the obtained pelviometry results showed that the athletes of all three examined groups have clinical manifestations of an anatomically narrow pelvis. This is convincingly evidenced by all transverse and longitudinal dimensions of the bony pelvis, reduced in comparison with the norm. Thus, for example, d. spinarum in the norm (for this age group) should correspond to 25-26 cm; d. cristarum - 28-29 cm; d. trochanterica - 30-32 cm; c. external - 20-21 cm; c. vera - 11 cm [2,7,12]. After receiving the

anthropometric indicators necessary for this study and their analysis, we carried out mathematical recalculations of six morphofunctional index values used in our study: body mass index; Soloviev index; sexual dimorphism index; lower limb length index [1]; pelvic index; index of relative pelvic width; pelvic bone index; trochanteric index; index value of thigh length, cm/shin length, cm. The obtained results of nine morphofunctional index values are presented in Table 3, at $p < 0.05$.

Name of the indicator	Sportswomen-Basketball players (n = 23)	Sportswomen-Volleyball players (n = 25)	Sportswomen- Handball players (n = 24)
Soloviev index, cm	15,77 ± 1,13	15,12 ± 0,96	14,33 ± 0,54
Relative lower limb length index (RLLLI)	55,27 ± 0,41	57,56 ± 0,53	53,72 ± 0,29
Relative Pelvic Width Index (RPWI)	14,33 ± 0,18	15,48 ± 0,47	15,52 ± 0,34
Pelvic Index (PI)	105,92 ± 0,23	104,93 ± 0,27	104,45 ± 0,41
Индекс костей таза (ИКТ)	43,14 ± 0,93	42,68 ± 0,33	41,68 ± 0,33
Trochanteric Index (TRI)	1,81 ± 1,03	1,74 ± 0,66	1,86 ± 0,53
Body mass index, kg/cm ²	22,01 ± 0,97	22,94 ± 0,67	24,61 ± 0,73
Sexual dimorphism index	84,61 ± 0,13	82,46 ± 0,21	82,81 ± 0,22
Thigh to shin length ratio	1,41 ± 0,08	1,52 ± 0,12	1,45 ± 0,41

Table 3: Morphofunctional indicators in female athletes of the studied groups.

The analysis of the obtained morphofunctional index values convincingly demonstrates the adaptive somatic changes present in all three groups of female athletes. In particular, the Soloviev index values are the highest in female basketball and volleyball players, exceeding the norm (14-15 cm). The obtained result indicates thickening of the tubular bones of the limbs [2,7,12]. The lowest values, although within the norm, were determined in female basketball and volleyball players. In female handball players, the body mass index on average for the group is slightly above the upper limit of the normative indicators, at 24.5 kg/cm² [2,7,12]. The pelvic index values indicate that the pelvises of female athletes, despite isolated cases of normal pelvic sizes, are smaller than the normative indicators by 107-109. Thus, in all three study groups, the pelvic index values indicate that the athletes have anatomically narrow pelvises (ANP) [2,7].

The values of the index of the relative width of the pelvis (IRWP) - its average value for all three groups, less than the permissible, from 16.0 to 17.9 [2,7]. The indicators of the trochanteric index, in average values by groups, reliably indicate that the handball players have a dysevolutionary type of constitution, and volleyball and basketball players - a pathological type of constitutional development [2,7]. Reliably, the obtained data indicate stenopyelia - a narrow pelvis, while the value of this morphofunctional index value is the lowest in basketball players. Thus, with their very tall stature, broad shoulders, narrow pelvis and long lower limbs, we can say that they have a giant body type [2,7]. In handball and volleyball players, a geynoid body type was determined [2,7].

The average group values of the relative lower limb length index (RLLLI), are as follows: in female basketball players - metroskeliya (from 55.0 to 56.9); in female volleyball players - macroskeliya - 57.0 and higher (long leg); in female handball players - brachioskeliya (short leg) - up to 54.9 [4,5,14]. These values are confirmed by the values of the index relationships between the femur length and the shin length [4,5,14]. The values of the sexual dimorphism index (average by group) in female basketball and volleyball players indicate a reliable presence of these athletes as representatives of the inverse, andromorphic sexual somatotype, with the presence in each of these groups of a small number of female athletes with a transitional, mesomorphic sexual somatotype - 3 (13.04%) and 4 (16.00%) athletes, respectively. In female handball players, on average for the group, the values of andromorphism were ob-

tained, but slightly higher than the upper limit of the mesomorphic sexual somatotype, equal to 82.1. This is due to the fact that in this group, there are 9 (37.5%) athletes with a mesomorphic sexual somatotype. In none of the three examined groups was the physiological for women, gynecomorphic sexual somatotype determined [2,7,12].

Conclusions

- The results of the conducted study showed that female basketball players differ significantly in anthropometric parameters (primarily in the length of the lower limb and its components) and in the indicators of a number of morphofunctional index values (Soloviev index, index of relative length of the lower limb, index of relative width of the pelvis, trochanteric index, index of sexual dimorphism), depending on their playing role.
- Volleyball players have more moderate values of the pelvis and lower limbs, and then handball players.
- The revealed anatomical and morphofunctional features in the athletes of the studied groups, in our opinion, can be due to both the previously conducted selection of athletes by the coaching team, and the result of adaptive processes caused by long-term (many years) and intense physical activity.

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