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Body Composition and Somatotype of Premenarchael and Menarchael Ballet School Female Dancers

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A B S T R A C T

The objective of this study was to describe the morphological characteristic taking into account somatotype and body composition in order to compare premenarcheal and menarcheal ballet school female dancers. The research material consisted of 24 female students from Ballet School in Poland aged 10–19. They were qualified to particular groups due to occurrence of menstruation. Twelve ballet dancers aged 12.13±1.9 years before menarche were included in group one (premenarcheal dancers). Group two consisted of 12 dancers aged 16.70±2.12 years who already menstruate (menarcheal dancers). To evaluate the body built type the Heath-Carter method based on Sheldon's classical concept of three body built components was employed. Body composition was assessed by BIA using the Tanita BC-418MA Segmental Body Composition Analyser. The main findings of this research are that premenarcheal ballet school students had balanced ectomorph somatotype profile and menarcheal ballet dancers had central somatotype profile. From these data it could be observed that there are no statistically significant differences between the group of premenarcheal and menarcheal ballet dancers for the following variables: supraspinale skinfold, endomorphy and ectomorphy components, somatotype and FAT%. Percentage value of the fat tissue in the body falls with age among the testees. Premenarcheal and menarcheal ballet dancers had slim body built and low content of fat tissue in the body but it doesn't threaten their health. Despite a big number of training hours and great pressure by the teachers to keep low body weight the tested ballet dancers develop correctly, what is shown by the BMI and FAT%.

Key words: *anthropometrics, somatotype, body composition, menarche, ballet*

Introduction

Ballet dance is a profession which is chosen at an early age and continues until retirement[1]. In Poland the recruitment to ballet schools starts at the age of 10 and since then the body undergoes a long and constant process of training. The path leading to performing on the stage is preceded by severe selection criteria and hard work. A dancer must have a slim figure, aesthetic look, perfect performance of technical elements and artistic expression[2–5]. Due to body built requirements and training specification, ballet dancers can be compared to aesthetic disciplines contestants.

Selection criteria in ballet schools contribute to students' mental and health problems. The willingness to keep slim figure at all cost cause eating, self-esteem and one's own body perception disorders[6]. The researches of Bettle et al. have shown that ballet dancers in all age groups aim at getting body mass below the 5th centile or below 82% of normal body mass[7].

Due to serious disturbance in eating behaviour there are weight-growth body proportions and composition disorders which can cause delayed menstruation and menstrual cycle irregularities. It was observed that menstrual dysfunction appear the most frequently among leanness sports female contestants (24.8% of checked in this group)[8]. Disturbances in menstrual function can appear as primary amenorrhea (defined as the absence of menstruation at the age of 16), secondary amenorrhea (defined as the absence on menses for three or more months in women who have reached menarche), or oligomenorrhoea (defined as menstrual cycle duration greater than 36 days)[9].

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Abnormal menstrual patterns had negative influence of bone mineralization, which can contribute to the appearance of breakages and osteoporosis[10,11]. Syndromes of disordered eating, amenorrhea and osteoporosis, which can be massively observed in sport disciplines in which a pressure to obtain and keep low body mass exists is called the »female athlete triad«[12–16]. There are publications describing professional dancers body built however few of them give information about young people who are being prepared to theater stage performances.

The observation of ballet school students' somatic features helps to select talents and prevent occurrence of eating disorders. Proper body built and composition provide better effects in the practice of classical ballet[17].

The objective of this study was to describe the morphological characteristic taking into account somatotype and body composition in order to compare premenarcheal and menarcheal ballet school female dancers.

Materials and Methods

The research material consisted of 24 female students from Ballet School in Poland aged 10–19. They were qualified to particular groups due to occurrence of menstruation. Twelve ballet dancers before menarche were included in group one (I) (premenarcheal dancers). Group two (II) consisted of 12 dancers who already menstruate (menarcheal dancers).

The specification of ballet schools cause small number of students on particular levels of education and a tight schedule. While taking measurements difficulties connected with the access to the research group aged 13 and 16–17 occurred. In some classes the girls didn't agree to take part in the research in fear of results disclosure to the teachers and due to negative perception of their own figure and body mass.

After the explanation of the goals and procedures of the study, parents of the subjects who accepted to participate in the research signed the free and informed consent form. During the recruitment the dancers were asked to fill out a simple questionnaire on their training experience, number of weekly dancing hours and menstrual cycle. The tests were conducted in the morning hours before the first meal. The measured dancers wore underwear.

To evaluate the body built type the Heath-Carter method based on Sheldon's classical concept of three body built components was employed. Somatotype evaluation is based on the direct measurements, done on the right side of the body and re-counting the data of the particular component to the points. Anthropometric measurements were done according to the indications of the method authors[18] employing the following measurement tools: Alumet standard anthropometric caliper, Baseline's brand Saehan metal skinfold caliper, Alumet small sliping caliper, a flexible fiberglass tape measure. The body mass measurement was done by the device Tanita BC-418MA.

We define the somatotype by numbers describing the point values of three body built components: endomorphy which is the fatness measurement, mesomorphy which informs about body massiveness and a component of ectomorphy which evaluates its slenderness. In order to calculate thoroughly particular components and apply somatotypes to the somatochart one used a computer program Somatotype – Calculation and Analysis[18,19]. Additionally one checked if height correction in the endomorphy component for children and youths were taken into consideration in the system. No differences between the program results and our own calculations of fatness factor were found. Somatotype – Calculation and Analysis V1.1 (Australia) also calculates average somatotypes of research groups and applies them to the somatochart.

Somatotypes which are placed in the centre of the somatochart have the same participation of all components in body built. The closer to any of the vertexes and farther from the centre of the somatochart the greater participation of the component in creating somatotype. Somatotype profile is defined according to the Category Chart Key (Figure 1).

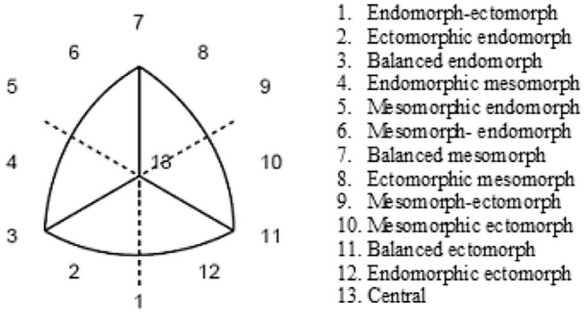

Fig. 1. Category Chart Key according to the program Somatotype – Calculation and Analysis V1.1.

Body composition was assessed by BIA using the Tanita BC-418MA Segmental Body Composition Analyser (Tanita Corporation). The BIA measurements were made adhering to the manufacturer's guidelines and at a measurement frequency of 50 kHz.

Height, sex and age were entered manually, while weight was recorded automatically using 0.0 kg as an adjustment for clothing weight in all subjects. Due to the varied aged of the testers the standard mode was chosen. Excess of dirt was removed from the soles of the feet and device's metal surfaces with moist antiseptic towels. The Tanita software uses inbuilt prediction equations to produce an output specifying. The assessed parameters are: body mass indicator (BMI), the percentage of total body weight that is fat (FAT%); total weight of fat mass (in kg lb) in the body (FAT MASS); Fat Free Mass is comprised of muscle, bone, tissue, water, and all other fat free mass in the body (FFM); Total Body Water is the amount of water (expressed as lb, kg) retained in the body (TBW)[20].

The STATISTICA 10 software package was used for the statistical analysis of the results. Data was pooled into

two groups dependent on having menstruation. Initially, descriptive analysis was used as a mean and standard deviation to characterize the study subjects with regard to anthropometric variables, body composition and somatotype. To assess the normality of data, the Shapiro-Wilks' test was used. If data did not show normal distribution, the Mann-Whitney U test (U M – W) was applied to identify differences between groups of premenarcheal and menarcheal dancers in the variables studies. Due to obtaining untypical results concerning fat tissue in both research groups, the Spearman's rank correlation coefficient was used to check for any correlations between FAT% and age. In the group II one also analyzed the influence of age, FAT% and training experience on the menstruation regularity. The level of statistical significance was set at: $p<0.05$; $p<0.01$; $p<0.001$.

Results

The number of weekly training hours varies a great deal on different levels. Female ballet dancers trained from ten 45-minute lessons in the youngest classes to thirty lessons a week in the oldest classes. The number of dancing hours systematically increased together with the training experience and the age of students. The dancers were gradually being prepared to greater physical effort. The training experience of the first group of dancers was 2.92±1.92, and the second – 6.67±2.10 years.

Figure 2 shows the location of premenarcheal ballet dancers' somatotype on the somatochart. Somatotype of premenarcheal ballet dancers together with the average somatotype (3.04-2.23-4.05) is localized in the ectomorphic part of the somatochart, what indicates a considerable participation of the slenderness component in creating the somatotype. It was observed that 50% of premenarcheal ballet dancers had a balanced ectomorph somatotype profile (Figure 2).

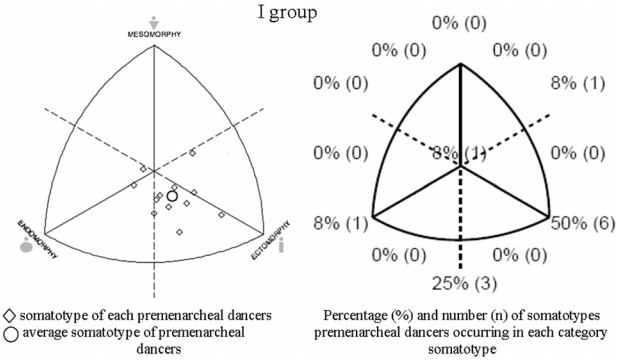

Fig. 2. Localization of premenarcheal ballet students' somatotypes on the somatochart.

Figure 3 shows the localization of menarcheal ballet dancers' somatotypes on the somatochart. The somatotype of female ballet dancers who have reached the age of menarche (group II) characterize with bigger differentiation.

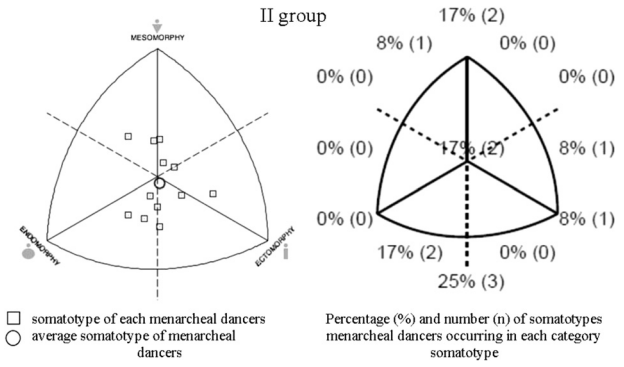

Fig. 3. The location of menarcheal ballet students' somatotype on the somatochart.

The individual and average somatotypes (3.65-3.40-3.75) of the group II are localized closer to the central part of the somatochart (Figure 3).

Table 1 shows the mean values related to anthropometric characteristics, body composition and somatotype of ballet dancers. The values of particular parameters together with the standard deviation of the whole research group and the division between premenarcheal and menarcheal dancers were taken into consideration. The differences and similarities which were significant for the statistics between the group I and II were demonstrated.

Premenarcheal dancers had significantly lower values compared to those of menarcheal dancers for the following variables: age; height; body mass; BMI; skinfolds: triceps, subscapular and sum of 3 skinfolds; breadth of the humerus and femur; arm and calf girth.

The somatotype of ballet dancers who already menstruate had lower participation of ectomorphy component for mesomorphy component in comparison to the somatotype of ballet dancers who don't menstruate yet. Statistically significant differences ($p>0.05$) among the testees were observed in the mesomorphy component.

Menarcheal dancers had significant higher values compared to those of premenarcheal dancers for the following variables of body composition: FAT MASS [kg], FFM, TBW.

From this data, it could be observed that there are no statistically significant differences between the group premenarcheal and menarcheal ballet dancers for the following variables: supraspinale skinfold, endomorphy and ectomorphy components, somatotype and FAT% (Table 1).

Due to the similarity between the groups despite the age difference ($p<0.001$) in parameters in which the participation of fat tissue plays an important role, it was decided to analyze the correlation of testees' age and FAT%.

Figure 4 shows negative correlation of FAT% with the age taking into consideration all the testees (n=24). It was determined that the older the ballet dancers are the smaller content of the fat issue in their bodies they have. This interdependence is particularly high in the group II menarcheal ballet students ($r=-0.922$) (Figure 4). Half of them had menstrual irregularities. Four girls declared second-

TABLE 1
AGE, ANTHROPOMETRIC CHARACTERISTICS, BODY COMPOSITION AND SOMATOTYPE OF BALLET SCHOOL FEMALE STUDENTS

Variables	Participants			U M-W
	All(N=24) X±SD	I group(N=12) X±SD	II group(N=12) X±SD	p-value (I–II)
Age [years]	14.31±3.05	12.13±1.90	16.70±2.12	<0.001***
Body Mass [kg]	43.01±10.37	34.88±7.67	51.13±4.67	<0.001***
Height [cm]	154.72±12.50	145.67±11.57	163.77±3.81	<0.001***
BMI [kg/m^2]	17.60±1.90	16.25±1.28	18.94±1.41	<0.001***
		Skinfolds		
Triceps [mm]	10.75±3.31	9.33±.23	12.17±4.13	0.014*
Subscapular [mm]	10.83±2.79	9.42±2.02	12.25±2.80	0.024*
Supraspinale [mm]	8.63±3.54	7.08±2.97	10.17±3.49	0.060
Sum 3 skinfolds [mm]	30.21±8.76	25.83±5.11	34.58±9.61	0.020*
		Breadths		
Humerus [cm]	5.53±0.49	5.29±0.45	5.76±0.42	0.024*
Femur [cm]	7.94±1.78	6.83±1.85	9.04±0.94	0.002**
		Girths		
Arm flexed [cm]	22.19±2.59	20.21±1.70	24.17±1.60	<0.001***
Calf [cm]	30.96±3.86	28.13±2.85	33.79±2.35	<0.001***
		Somatotype components		
Endomorphy	3.34±0.87	3.04±0.64	3.65±0.99	0.198
Mesomorphy	2.82±1.09	2.23±0.72	3.40±1.09	0.005**
Ectomorphy	3.90±0.86	4.05±0.96	3.75±0.77	0.442
		Body composition		
FAT [%]	18.90±4.00	20.00±2.29	17.80±5.04	0.379
FAT MASS [kg]	7.97±2.26	6.98±1.73	8.98±2.34	0.024*
FFM [kg]	35.06±9.30	27.93±6.20	42.19±5.59	<0.001***
TBW [kg]	25.70±6.85	20.46±4.53	30.94±4.19	<0.001***

X – mean, SD – standard deviation, BMI – body mass indicator, FAT – the percentage of total body weight that is fat, FAT MASS – total weight of fat mass in the body, FFM – fat free mass, TBW – total body water, * – significant differences by variable between premenarcheal and menarcheal ballet school female students ($p<0.05$) according to the Mann-Whitney U test, ** – $p<0.01$, *** – $p<0.001$

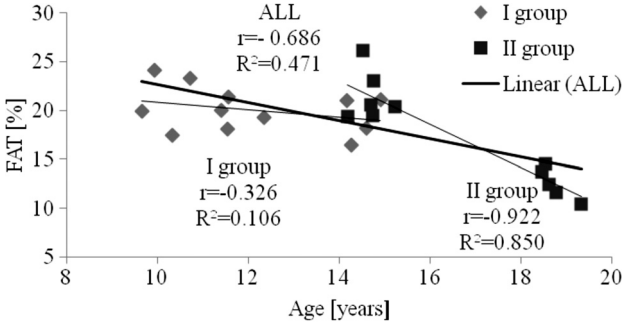

Fig. 4. Simple linear regression determines the relationship between age and FAT% of ballet school dancers. r – Spearman correlation coefficients, R^2 – coefficient of determination, FAT – the percentage of total body weight that is fat.

ary amenorrhea and oligomenorrhoea occurred in two of them. The average age at menarche in this group was 13.50±0.67 years. Statistical analysis of the research results showed no influence of age, FAT% and training experience on menstruation regularity.

Discussion

Premenarcheal ballet dancers had balanced ectomorph somatotype profile. In the research of Claessens et al. the somatotypes of the girls in ballet school aged on average 12.7 were localized in the endo-ectomorph and meso-ectomorph areas[21]. This research was done 30 years ago but one could see a tendency of body built in the direction of ectomorphy among young ballet dancers.

In relation to BMI norm section for girls aged 12: 15.62–26.7 kg/m^2 based on two publications of Cole et al.[22,23] the average BMI value indicator of premenarcheal ballet students (16.25±1.28 kg/m^2) was localized in the

lower limit of normal. Overweight and obesity were defined based on the BMI cut-off points in accordance with the international definition of obesity for children and youths[23], whereas underweight was defined based on BMI cut-off points offered by Cole et al.[22], indicated with the centile curve crossing BMI 18.5 (WHO classification[24]) at the age of 18.

Menarcheal ballet dancers had a central somatotype profile. In the Ferrari et al. research ballet dancers characterized with a balanced ectomorph somatotype profile and lower participation of endomorphy component (2.8) and mesomorphy component (2.6) in creating the somatotype than the control group[17].

In relation to BMI norm section for girls aged 17: 18.25–29.7 kg/m^2, set similarly like for the youngest dancers based on two publications by Cole et al.[22,23], the average BMI indicator value for premenarcheal students (18.94±1.41 kg/m^2) were also localized in the lower limits of the normal.

By analyzing the obtained BMI indicator values one can conclude that despite ballet schools students' slim body built they develop correctly. Steinberg et al. indicated the similarity in built and proportions of dancers aged 8–16 in comparison with the control group. Both groups had similar speed of growing. They decided that the fear of delayed growth and maturation is baseless[25]. However the girls taking part in their research presented various dance styles. Liive et al. proved that ballet dancers in comparison with other dancers had the lowest body FAT%, weight and BMI values[26]. It is striking that the analysis of research results didn't show statistically significant differences for the following variables: supraspinale skinfold, endomorphy and ectomorphy components, somatotype. Additionally the premenarcheal group (20.00±2.29) had the greater FAT% value than menarcheal ballet dancers (17.80 ± 5.04). It results from researches of other scientists that the typical body FAT values for professional ballerinas range from 16 to 18%[27, 28]. Ferrari et al. showed that among ballet dancers aged 18.9±1.3 body FAT percentage is 17.9±2.6 while among ordinary students of the same age – 31.3±4.6[17]. Yannakoulia et al. testing the Greek female dancers proved it was a group of lean women with a mean body fat of 19.4%[29]. These values obtained by the authors of this work and other scientists running researches of the ballet dancers tissue composition fall within the range of 17–23% body fat which was proposed by Chmelar and Fitt as an optimum body composition for University adult female dancers[30]. In general, most female athletes experience greater performance benefits at body fat percentage between 10–25% depending on the sport[31].

By analyzing the results of body built and composition of premenarcheal and menarcheal ballet dancers it can be observed that the testees had a small contents of fat tissue in the body but it doesn't threaten their health. Moreover, there was no influence of FAT% on menstruation regularity in the research group. However it is worrying that tour own research results analysis showed that the percentage content of fat tissue falls with age, especially among the older ballet dancers. For women from the age of 8 subcutaneous fat should rise progressively, except for a noticeable dip at about the time of the growth spurt at about the age of 11–12 until the age of 60[32].

Conclusion

This study can be used in future research with this population and assist in the detection of talents to the practice of classical ballet. The main findings of this research are that premenarcheal ballet school students had balanced ectomorph somatotype profile and menarcheal ballet dancers had central somatotype profile. Premenarcheal dancers had significant lower values compared to those of menarcheal dancers for the following variables: age; height; body mass; BMI; skinfolds: triceps, subscapular and sum of 3 skinfolds; breadth of the humerus and femur; arm and calf girth, mesomorphy, FAT MASS, FFM, TBW. From these data it could be observed that there are no statistically significant differences between the group of premenarcheal and menarcheal ballet dancers for the following variables: supraspinale skinfold, endomorphy and ectomorphy components, somatotype and FAT%. Percentage value of the fat tissue in the body falls with age among the testees. This dependence is particularly visible among menarcheal ballet students. Statistical analysis of the research results proved no influence of age, FAT% and training experience on menstruation regularity. Premenarcheal and menarcheal ballet dancers had slim body built and low content of fat tissue in the body but it doesn't threaten their health. Despite a big number of training hours and great pressure by the teachers to keep low body weight the tested ballet dancers develop correctly, what is shown by the BMI and FAT%. Nevertheless, body built and composition of ballet dancers at any age should be permanently controlled in order to prevent an excessive dip of FAT% (especially among menarcheal dancers) and the »female athlete triad« occurrence.

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TJELESNI SASTAV I SOMATOTIPOVI PREDMENARHALNIH I MENARHALNIH PLESAČICA BALETNE ŠKOLE

S A Ž E T A K

Cilj ovog istraživanja bio je opisati morfološke karakteristike uzimajući u obzir somatotipove i sastave tijela kako bi se usporedile predmenarhalnih i menarhalnih plesačica baletne škole. Istraživački uzorak se sastojao od 24 studentice iz baletne škole u Poljskoj u dobi od 10–19. One su bile kvalificirane za pojedine skupine zbog pojave menstruacije. Dvanaest baletanki u dobi 12.13 ± 1,9 godina prije menarhe su bile uključene u skupinu broj jedan (predmanrhalne plesačice). Grupa dva sastojala se od 12 plesačica u dobi od 16,70 ± 2,12 godina, koje jsu već dobile menstruaciju (menarhalne plesačice). Za procjenu tipa tjelesne građe korištena je Heath-Carter metoda koja je utemeljena na Sheldonovom klasičnom konceptu tri tijelesne komponente. Sastav tijela je procijenjen s BIA-om pomoću TANITA BC-418MA, segmentalnog analizatora sastav tijela. Glavni rezultati ovog istraživanja su da predmenarhalne plesačice imaju uravnotežen ektomorfni profil somatotipa, dok menarhalne plesaćice imaju središnji profil somatotipa. Iz tih podataka može se vidjeti da ne postoje statistički značajne razlike između skupine premenarhalnih i menarhalnih baletnki za sljedeće varijable: supraspinalno nabiranje kože, endomorfne i ektomorfne komponente, somatotipove i postotak tjelesne masnoće. Postotak vrijednosti masnog tkiva u tijelu opada s godinama među ispitanicima. Premenarhalne i menarhalne plesačice su imale tijela vitke građe i niskog sadržaja masnog tkiva, ali to ne ugrožava njihovo zdravlje. Unatoč velikom broju sati obuke i velikom pritisku od strane nastavnika da zadrže niske tjelesne težine, testirani plesačice se pravilno razvijaju, što je prikazano od strane BMI-a i postotka masnoća u tijelu.