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BODY FAT DISTRIBUTION IN A SAMPLE OF YOUNG FEMALE VOLLEYBALL PLAYERS

Key words: children, sport, obesity, BIA, anthropometric indices.

ABSTRACT

There is an awareness about the prevalence of weight disorders among young people, even among populations classified as "active". The purpose of the present study was to describe fatness, leanness and regions of fat distribution in young volleyball players. 49 Polish girls (aged 10 years) playing volleyball were assessed. Several anthropometric measures were carried out. Anthropometric indices were used to evaluate body fat distribution. General level of body fat was measured by way of bioelectric impedance analysis (BIA). All girls were divided into three groups according to fat level (fat, normal, lean). The results showed a relationship between the percent of body fat content and fat distribution. Fatter children were more likely to deposit fat centrally, which is a significant factor in chronic diseases. On the other hand, lower fat mass was correlated with healthier fat distribution (more peripheral).

INTRODUCTION

As obesity is becoming a worldwide epidemic, there has been a growing interest in the study of body composition (overall and regional) to monitor the condition and delay the development of obesity-related diseases [5, 25]. There is also an increasing awareness about the prevalence of weight disorders among young people [38], even among populations classified as "active" [4]. In the case of athletes, overweight could be more linked with such medical conditions like musculoskeletal trauma, sudden cardiac arrest or heat stroke. Overweight in athletes appear especially in sports, in which body size and body mass are important, e.g. football, sumo, weight-lifting, and in which body components can affect physical performance, beyond body size and advancement level. Those factors have been identified as predictors of performance and selection in a number of sports [23]. Fat patterning reflects the sites in which the body has more amounts of adipose tissue, and it is different from the overall fat level. The health risk of obesity is associated more with central obesity than with total obesity [9]. The greater deposition of central fat is correlated with less favorable patterns of serum lipoprotein concentrations and blood pressure [6, 16].

According to a WHO report there are 400,000 more overweight children every year in Europe. In Poland, about 10-20% of children aged 7-11 years are overweight, and their number has increased dramatically in recent years [21].

In 1965, obesity was defined as excessive body fat [30, 31], but still there have been no definite agreement on cut-off values of body fat to define obesity in children. Many authors propose BMI cut-offs to assess obesity [2, 20]. Some

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authors use a single cut-off for the percentage of body fat: 25% for boys and 30% for girls, respectively, using Omron BF-300 measurements [24, 33]; while others [11] question the usefulness and accuracy of BMI in predicting obesity-related illness as it does not provide such data as body composition and fat distribution. In the present study BIA cut-off points were used.

The aim of the present study was to estimate some anthropometric indices for fat distribution assessment and to determine their relationship with the total fat level in a group of Polish 10-year-old female volleyball players.

METHODS

The study involved 49 pre-pubertal female volleyball players aged 10 years from Poznań, Poland. They participated in the weekly four hours of obligatory physical education at school and trained volleyball for six hours a week.

The study was approved by the local Human Ethics Research Committee of the Medical University in Poznań (Poland), and was carried out in November 2009 in the Department of Anthropology and Biometry of University School of Physical Education in Poznań, Poland. Parents and coaches of the children were informed of the nature and purpose of the study. Subjects took part in the measurements in the morning. They wore minimal clothing.

Anthropometric measurements included body height, body mass, skinfolds (subscapular, triceps, iliac and thigh) and circumferences (waist, hip, thigh). The children's body height was measured with a stadiometer to the nearest 0.1 cm. Body mass was calculated with the use of a platform digital scale (AXIS, B150 LM) to the nearest 0.1 kg. Skinfold measures were taken by the same operator using a Lange caliper (Cambridge Science Industries) on the left side of the body. Circumferences were measured with an anthropometric measuring tape in a horizontal plane. The anthropometric measurements were assessed with the use of standardized technique (Martin 1928).

Body composition was assessed using bioelectric impedance analysis (BIA 101, Akern Srl, Pontassieve-Florence, Italy), in accordance with the manufacturer's directions [22]. Subjects were measured while lying supine on a nonconductive surface, without socks, shoes and any metal jewelry.

To assess body fat distribution, the regional indices were used:

WHR = waist / hip circumference ratio
WTR = waist / thigh circumference ratio
SFR = subscapular / triceps skinfold
CPR (central-peripheral skinfold ratio) = (subscapular skinfold + suprailiac skinfold) / (triceps skinfold + thigh skinfold)
AVI (abdominal volume index) = [2*(waist circumference)^2 + 0,7 (waist circumference – hip circumference)^2] / 100

All participants were divided into three groups according to their body fat level. Since BMI, which is the most popular index in obesity assessment in populations of different ages, can misclassify large numbers of children with a high body fat content (Reilly et al. 2000) and is unable to distinguish between fat-free mass and fat mass (McCarthy 2006), BIA cutoff points were used (Bodystat LTD norms for children):

fat	% FAT > 25
normal	% FAT 18 – 25
lean	% FAT < 18

The studied morphological parameters were tested for normality using the Shapiro-Wilk test. The level of statistical significance was set at $p<0.05$. The following descriptive statistics were calculated for the analyzed parameters: mean ($\bar{x}$), standard deviation (SD). In order to evaluate the influence of fat index on the distribution of fatty tissue in different anatomical regions in girls, analysis of variance was implemented. Homogeneity of variance between groups was tested with Levene's test (homogeneity of unequal variance at $p<0.05$). Significance of differences between selected three studied groups (fat, normal, lean) for parameters with normal distribution and homogenous variance was tested with parametric analysis of variance (ANOVA). The Tukey-Kramer test was used to examine differences between mean values. The significance of differences between mean values in three groups for parameters with skewed distribution or inhomogeneous variance was tested with non-parametric post-hoc Kruskal-Wallis test of variance analysis. For parameters with skewed distribution (at least one of the parameters had distribution different from normal) Spearman's rank correlation coefficient was calculated. All statistical analyses were performed using STATISTICA 8.0 PL.

RESULTS

Table 1 presents differences in the mean anthropometric characteristics and ratios among three groups of girls divided according to total body fat level into fat, lean and normal.

When the girls were stratified by the percent of body fat, 13 of them (26.5%) were fat, 22 (44.9%) lean and only 14 (28.6%) were assessed as normal (healthy).

Table 1. Anthropometric characteristics and ratios between three groups of girls

Characteristic	All girls	Fat	Lean	Normal	p
n	49	13	22	14	
stature (cm)	147.51 ± 8.33	148.8 ± 6.89	145.9 ± 7.94	148.9 ± 10.13	ns
weight (kg)	39.56 ± 8.99	48.8 ± 8.99	34.5 ± 6.06	39.0 ± 5.92	**
FAT %	20,00 ± 7,00	30.0 ± 3.00	14.0 ± 3.0	21.0 ± 2.0	**
WHR	0.79 ± 0.04	0.82 ± 0.04	0.77 ± 0.03	0.77 ± 0.03	*
WTR	1.37 ± 0.11	1.43 ± 0.18	1,37 ± 0.07	1.33 ± 0.05	ns
SFR	0.74 ± 0.30	0.98 ± 0.44	0.63 ± 0.17	0.68 ± 0.18	**
CPR	1.03 ± 0.38	1.41 ± 0.43	0.81 ± 0.25	1.01 ± 0.22	**
AVI	77.57 ± 18.87	100.84 ± 18.30	65.78 ± 9.74	74.48 ± 8.09	**

All girls had body stature of 147.51 (SD = 8.33), mean body weight of 39.56 (SD = 8.99), percent of body fat of 20.00 (SD = 7.00), WHR of 0.79 (SD = 0.04), WTR of 1.37 (SD = 0.11), SFR of 0.74 (SD = 0.30), CPR of 1.03 (SD = 0.38) and AVI of 77.57 (SD = 18.87). The volleyball players had significantly different body fat distribution according to some indices (ANOVA) in relation to their overall fat level (Tab. 2). Lean girls were the lightest, shortest and had the lowest values of all indexes in comparison to the fat and normal groups. The fat children had different fat distribution that that of two other groups (Fig. 1, 2).

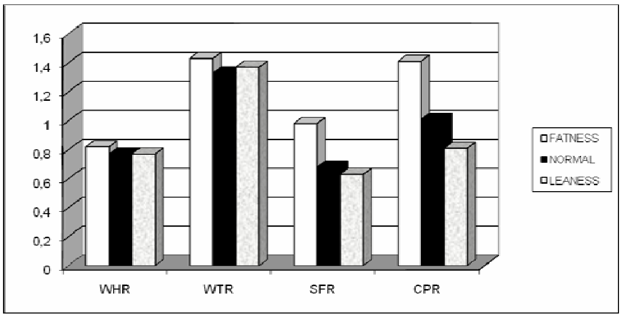

Figure 1. Body fat distribution in three groups of girls

Table 2. Comparison of anthropometrical indexes between three groups of girls (t-test)

CHARACTERISTIC	I - II	I - III	II - III
stature (cm)	–	–	–
weight (kg)	**	**	–
FAT %	**	**	**
WHR	*	*	–
WTR	–	–	–
SFR	*	–	–
CPR	*	–	–
AVI	**	*	–

I – Fat, II – Lean, III – Normal

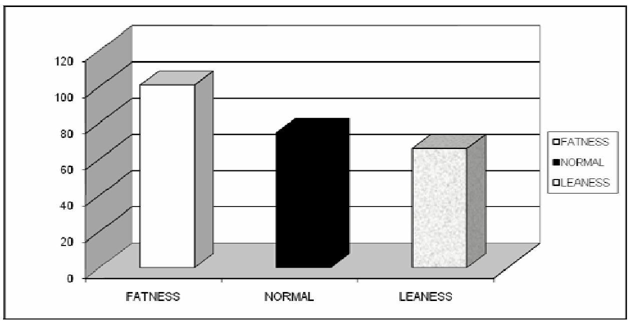

Figure 2. Abdominal volume index (AVI) in three groups of girls

The most significant differences were observed between the two extreme groups, i.e. fat and lean, in most parameters. Between the lean and the normal group, differences in indexes were not large. There were non-significant differences in two characteristics: body stature and WTR. Also percentage body fat by BIA was not correlated with WTR. The correlation between estimates of % fat and waist-hip ratio (WHR) was significant at $p<0.05$, while all other ratios were significant at $p<0.01$.

DISCUSSION

Subcutaneous fat thickness varies with regard to body location. There have been multiple studies dealing with visceral fat accumulation in adults; however, studies on children have been rarely conducted. The first investigators who examined intra-abdominal fat deposition in children were De Ridder et al. [8] and Fox et al. [13]. They noted that visceral fat found in children varied between individuals and that subcutaneous abdominal adipose tissue was more predominant in children than abdominal adipose tissue. As Huang et al. indicated [18] intra-abdominally fat accumulating in children is partly related to the biology of adipose tissue growth.

In the present study a relationship between % BF content and a tendency to fat distribution was noted. The children's healthy constitution – lower level of fat mass – was correlated with healthier fat distribution (more peripheral). The % BF was correlated with WHR, SFR, CPR and AVI using correlation analysis. Only WTR did not differ between the three groups of girls.

According to our research children with greater amounts of body fat were likely to be taller and heavier. It was also confirmed by other authors [10, 12]. Trunk fat accumulation occurred in the fat group by SFR, WHR, CPR and AVI. The lean and normal groups were very similar in most ratios. It is worth noticing that there were many girls who had problems with body weight in the present research. In the case of overweight girls it is particularly unsetting because of their participation in volleyball training they were more active than their peers. In our study there were also lean girls, and the problem lies not only in overweight but also in underweight.

Another important aspect to be taken into consideration is that obese children get tired very easily and quickly during physical exercise (training) and they need twice as much energy than their slim peers [28]. This could derive from the short time of participation in sport but also from genetic factors or nutrition habits. Moreover, overweight children are more likely to be injured in sport as compared with their non-overweight counterparts [26], due to biomechanical inefficiency or other factors [19]. That is why early observation of children, longitudinal monitoring and relatively quick prevention of weight problems are necessary.

The results of the present study demonstrated that when overall body fat is assessed also fat distribution should be taken into account. It confirmed quite a strong relationship between the body fat level and fat accumulation in some regions of the body. Fat patterning is very important at each stage of life. When a child displays an unhealthy tendency to accumulate fat, he or she could have problems with many diseases in the future. It has been indicated that also youngsters are developing "diseases of old age" such as type 2 diabetes.

The ratios presented in this study, e.g. SFR and CPR, reflect the distribution of subcutaneous fat and are related to cardiovascular diseases in adults [7, 14, 15, 17]. Body fat distribution could be helpful in identifying children who are likely to have adverse blood concentrations of insulin and lipids [27]. Adiposity and cardiovascular risk factors should tracked from childhood to adulthood since identification of children with high central adiposity is highly important [29, 34, 36, 37]. Styne [35] stated that about 50-80% of obese children would grow up to become obese adults. As indicated, 30% of obese adults began to be so before adolescence [1]. Moreover, as some researchers revealed [3], weight status (and body fat level) could have a significant influence on sport performance. Obese children, according to that research, gained lower scores in sprint performance than their leaner counterparts.

Obesity is a consequence of poor nutritional choices and limited physical activity. Presumably, some girls from our research could have been obese because of unhealthy eating patterns rather than lack of physical activity.

In conclusion, it has been demonstrated that there was a big diversity in the overall fat level among the studied girls. Also fat patterning assessed by several ratios was different and dependent on the absolute fat level. Fat mass reduction was connected with healthier fat distribution. It was also noted that fat children were more likely to deposit fat centrally, which is a significant factor for chronic diseases, so they should be particularly benefited by losing excess fat and dieting. Further studies of children involved in sport are necessary to verify our insights.

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