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COMPARISON OF BODY COMPOSITION PARAMETERS IN CHILDREN AND ADOLESCENTS, USING SKİNFOLD AND BIOELECTRICAL IMPEDANCE METHODS

ÇOCUK VE ADÖLESANLARDA SKİNFOLD VE BİOELEKTRİK İMPEDANS METODLARI İLE VÜCUT KOMPOZİSYON PARAMETRELERİNİN KARŞILAŞTIRILMASI

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ABSTRACT

Background: Childhood and adolescent obesity is a seriously increasing cause of morbidity and mortality. The prevalence of childhood obesity and obesity-related metabolic syndrome increased during the past three decades. Unfortunately, the methods for the measurement of total fat ratio in childhood and adolescent period are still limited and diffucult.

Objective: The present study aims comparing the classical skinfold and the new bioelectrical impedance (BIA) methods to determine the body composition in childhood and adolescent periods.

Methods: 86 cases (45 boys and 41 girls) between 7-15 years of age were included in this study. The body mass index (BMI), fat percent (FAT%), fat mass (FM) and fat free mass (FFM) of all the cases were determined by both skinfold and BIA methods.

Results: When the body composition parameters were evaluated, a positive correlation was found between these two methods. When these two methods were compared, there was a statistically significant difference in all parameters of body composition in boys of 7-12 years of age.

Conclusion: This study suggest that the BIA method could be used in children over 12 years to determine the obesity, whereas further studies are needed for children below 12 years of age.

Key Words: Childhood, adolescent, bioelectrical impedance, skinfold method

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ÖZET

Giriş: Çocukluk çağı ve adölesan obezitesi ciddi bir şekilde artan morbidite ve mortalitede nedenidir. Ancak pediatrik yaş grubunda obezitenin tanımlanmasında kullanılan total yağ oranını ölçüm metodları halen sınırlı ve zordur. Bu çalışmada çocukluk çağında vücut kompozisyon parametrelerini belirlemede kullanılan klasik skinfold yöntemi ile yeni bioelektik impedans yöntemlerinin karşılaştırılması amaçlanmıştır.

Metodlar: Çalışmaya yaşları 7-15 yıl olan 86 olgu dahil edildi. Tüm olgularda skinfold ve BIA yöntemleriyle vücut kitle indeksi(VKİ),yağ yüzdesi (YY%),yağ kitlesi (YK), ve yağsız kitle(YK(-) oranları hesaplandı.

Sonuçlar: Vücut kompozisyon parametreleri değerlendirildiğinde her iki yöntem arasında pozitif korelasyon saptandı. İki metod vücut parametreleri yönünden karşılaştırıldığında 7-12 yaş erkek grupta anlamlı fark saptandı.

Yorum: Bu çalışma BIA metodunun 12 yaş üstü çocuklarda obezitenin belirlenmesinde kullanılabileceğini ancak 12 yaş altı çocuklarda daha ileri çalışmalar gerektiğini telkin etmektedir.

Anahtar Kelimeler: Çocukluk çağı, adölesan,bioelektrik impedans,skinfold yöntemi

BACKGROUND

Obesity is one of the main problem in this century, leading to severe morbidity and mortality. Several studies have shown that 60-80% of the obese children under the age of 3 years become obese adults if untreated or not treated sufficiently (1). For this reason, an early diagnosis of childhood obesity should be made. Although there are several techniques to define obesity, disadvantages of each technique make researchers look for new techniques. For this reason, the skinfold method, used in the evaluation of body composition and the bioelectrical impedance method, not yet studied sufficiently in childhood, have been used comparatively and the correlation between these methods has been investigated in this study.

PATIENTS AND METHODS

This study included 86 healthy children, aged between 7-15 years. All the cases were divided in to three groups (group 1; prepubertal, the other two groups pubertal; group 2, early adolescent and group 3 mid-late adolescent) The age, body weight, and height of all the cases were carefully measured. The descriptive criteria of all cases were used for the evaluation of clinically adiposity included body mass index (BMI). Body mass index was defined weight in kilograms divided by the square of the height in meters (kg/m^2) (2). Patients with diabetes mellitus, thyroid dysfunction, use of any medication, cushing syndrome, and dyslipidemia were excluded from this study.

Study participants and their parents gave informed consent before this study.

The measurements were repeated 3 times to minimize any likely errors.

The skinfold caliper was used in the measurement of subdermal fat thickness for every child (Figure 1).

Figure 1. The skinfold caliper

Measurements performed by holding dermal-subdermal fat by thumb and forefinger and pulling it to the natural skinfold and away from the muscles. Constant pressure was applied on the skin by the forceps of the tool. Double-layer skin thickness and subcutaneous fat tissue were read on the indicator. All the measurements were carried out by the same person to minimize the wrong results. The measurements were obtained from seven different regions. These regions were the breast, midaxillary, triceps, subscapular, abdominal, suprailiac, and leg. All the data were formulated to calculate each child's fat percentage (%FAT), fat mass (FM), free fat mass (FFM) and body density. Fat mass (kg) = (0.38 x weight) + (0.30 x triceps thickness) + (0.87 x female/male*) + (0.8 1x etnic**) - 9.42; (*for female 2 and for male 1;**for white 1 and for black 2) (3-5).

Bioelectrical impedance analysis (BIA) method was performed for all the cases. BIA is a technique to estimate body composition based on the difference in electrical conductive properties of various tissue and uses the principles of electric current flows (500-800 mA) through tissue with less resistance offered if the water content is high and the opposite if the water content is low like fat tissue.

Electrodes were applied to the body surface of cases and resistance was recorded. Environmental factors, individual features, the using formula to calculate free fat mass, and BIA device effect the sensitivity and specifity of BIA method (6,7). In our study, the bioelectric impedance analysis were determined by Tanita TBF 300 Body Composition (Figure 2). Analyser can calculate the body fat mass, total body water, free fat mass, and the basal metabolic rate (8). The sex, age, and height of each case were recorded by the researcher on the analyser. With the help of this analyser, each child's Body Mass Index (BMI), FAT %, Fat Mass, Free fat mass (FFM), Total Body Water (TBW) were calculated. All the measurements were repeated twice. Paired t-test and Pearson correlation coefficient were used in PC with SPSS software program for statistical analysis; $p< 0.05$ was accepted to be statistically significant.

Figure 2. Body composition analyser

RESULTS

Among all children included in this study; 45 were boys (52.3%) and 41 (47.7%), girls. Table 1 shows anthropometric

Table 1.General features all of the cases

n	*Case (86)*	*Boys(45)*	*Girls(41)*
Age (year)	10.18±0.26	10.15±0.25	10.46±1.12
Height(cm)	142.37±1.68	141.91±1.67	142.87±1.69
Weight (kg)	38.24±1.44	38.26±1.44	38.22±1.42
Body mass index(BMI)	18.53±0.34	18.39±0.31	18.68±0.37

Table 2. Comparison of body composition parameters with the skinfold and bioelectrical impedance methods in boys and girls

		BOYS			GIRLS		
Groups	**parameter**	**n (case)**	**mean**	**P**	**n (case)**	**mean**	**P**
Group1 (7-9year)	FATs FATb FFMs FFMb FMs FMb	19	9.15±5.01 19.30±7.44 25.62±3.82 22.97±2.68 2.80±1.98 5.92±3.35	<0.05* <0.05* <0.05** 	14	15.36±3.84 16.43±5.77 22.69±3.48 22.25±3.67 4.24±1.62 4.72±2.12	>0.05 >0.05 >0.05
Group 2 (10-12year)	FATs FATb FFMs FFMb FMs FMb	15	8.16±4.91 12.84±3.92 31.76±6.23 30.65±5.98 3.04±2.36 4.72±2.25	<0.05* <0.05* <0.05* 	20	23.29±5.57 22.55±7.34 32.77±6.38 33.32±5.54 10.54±4.86 10.56±5.71	>0.05 >0.05 >0.05
Group3 (13-15year)	FATs FATb FFMs FFMb FMs FMb	11	14.89±6.76 16.27±7.08 48.88±8.92 48.60±8.96 8.92±4.97 9.79±5.04	>0.05 >0.05 >0.05 	7	22.47±6.31 23.60±11.57 37.32±5.36 36.84±2.96 11.46±4.96 12.64±7.30	>0.05 >0.05 >0.05

FAT: fat percent (%); FFM: Fat free mass (kg); FM: fat mass (kg) ; s; skinfold method; b: BIA method

characteristics ofall the cases. In 86 cases, 33 were aged between 7-9 years (group 1), 35 between 10-12 years (group 2) and 18 between 13-15 years (group 3). There were 19 male in group 1, 15 males in group 2, and 11 males in group 3. Likewise there were 14 female in group 1, 20 in group 2, 7 in group 3.

Table 2 shows the measurements of body composition parameters with traditional method and the BIA method. These two methods were compared by paired t-test for three age groups of boys and girls.We compare all three age groups with each other for boys and girls. It seems that in group 1 and 2 the difference in body composition parameters of boys were statistically significant ($p<0.05$). However, there were no difference in the body composition parameters of girls assessed by two methods ($p>0.05$). There was a positive correlation between body composition parameters measured by the two methods (Pearson correlation analysis) (Table 3).

Table 3. A positive correlation among three parameters between two methods in boys and girls

		BOYS			GIRLS		
Groups	**Parameters**	**Case**	**Correlation**	**p**	**Case**	**Correlation**	**P**
1	FATs-FATb	19	+0.802	*<0.05**	14	+0.767	*<0.05**
	FFMs-FFMb	19	+0.902	*<0.05**	14	+0.891	*<0.05**
	FMs-FMb	19	+0.916	*<0.05**	14	+0.881	*<0.05**
2	FATs-FATb	15	+0.900	*<0.05**	20	+0.868	*<0.05**
	FFMs-FFMb	15	+0.991	*<0.05**	20	+0.972	*<0.05**
	FMs-FMb	15	+0.938	*<0.05**	20	+0.969	*<0.05**
3	FATs-FATb	11	+0.876	*<0.05**	7	+0.962	*<0.05**
	FFMs-FFMb	11	+0.970	*<0.05**	7	+0.950	*<0.05**
	FMs-FMb	11	+0.909	*<0.05**	7	+0.981	*<0.05**

FAT: fat percent (%); FFM: Fat free mass (kg); FM: fat mass (kg) ; s; skinfold method; b: BIA method

DISCUSSION

Body composition assesment is a useful procedure for the study of nutritional status and water distrubition both in pediatric and adult subjects. On the other hand, body fat dispersion is the most accurate method in defining obesity. Body fatness is associated with risk factors for cardiovascular diseases (especially left ventricular hypertrophy) and hypertension (9). In determination of the body fatness, the most reliable way of body fatness calculation is underwater weighing (9). However this method is not practical and easy to apply. For this reason, anthropometric measurements were generally used in fat percent, fat weight, bodyweight without fat, and body density measurements. Especially subcutaneous fat thickness (skinfold) measurements are mostly used in childhood as they are so reliable in body composition measurements. Skin folds are measured at well defined sites using a skin fold calliper. Possible locations include triceps, biceps, the subscapular and supra-iliac position, front thigh and medial calf (9). On the other hand, the skinfold method has also some disadvantages. Applying this method on children is hard, needs time and experience. Results can vary from researcher to researcher. Fat mass measurement by this method show difficulties in especially little children, because they are active. The rate of metabolism can not be determined by skinfold method. Caliper can cause pain for children. As a result, new methods have been investigatedin assesing body composition in children,In recent years, researchers have been interested in the bioelectric impedance method (10). The system using the low resistance flows holding the body components has not been investigated sufficiently in children (10). The BIA is a non-invasive, non-time consuming and non-personal result change method. It does not also affect the child's movements and is easy to use. The metabolic rate can be measured. The BIA method has recently been used widely in determining overweight and obese children (11). On the other hand, measurement of visceral fat accumulation is essential for diagnosis of metabolic syndrome in obese cases and BIA is most suiatable for this measurement. Because, visceral fat accumulation is known as a significant risk factor for cardiovascular events (12).

Frankfield et al. informed that the BIA method is an easy method in measuring Free fat mass and body fat in 2001 (13). They also reported that children with BMI less than 30 kg/m^2 can easily be recognised as obese by the BIA method. In 2000, Lohman et al measured body fat mass by skinfold and BIA in 98 children and found a statistical significance in BIA fat percentage (14). Lohman et al. Also showed that BIA has a perfect predictable value (14). Our study results are in conformity with those of

Lohman et al. These results suggested that BIA is a sensitive method. Gillis et al. showed that the BIA method is a quick method, enablesweight control in overweight and obese children (15). Nevest and co-workers found a strong positive correlation when they measured the body composition parameters by anthropometry and BIA methods (16). Their findings were in consistence with those of our study.

De Lorenzo et al. used the BIA and Dual- energy X-ray Absorbsiometry (DEXA) in body fat mass and free fat measurements and they found a positive correlation between both methods (17). DEXA is one of the most accurate methods in determining body composition (17). However, it is hard to use, time consuming, and needs special training and it is also very expensive. As a result, it seems not appopriate for rapid clinical use. Pietrobelli et al. used the impedance index, ZI (height2/impedance) in a 75 normal children. DEXA was chosen as reference method. They found ZI values were highly correlated with FFM measured by DEXA Thus, BIA alone can be used to measure FFM in children (17).

In our study, a statistically significant difference was found between the skinfold and BIA methods in body composition parameters of boys. There were no differences in the girls. We believe that the statistically significant difference between two methods in the boy group (<12 years group) is due to the restless of the boys and the diffuculty of using skinfold method.

Obesity is an increase of body weight dependent increase of body fat. Body weight can also be dependent on the increase of muscle mass. For calculating distribution and mass of body fat we can use subcutaneous fat thickness (skinfold) measurements, BIA, DEXA or MRI (magnetic resonance imaging)(18). Instead of these methods, using BMI is preferable.

As a result, the bioelectric impedance method is a promising method for determining the overweight and obese cases in childhood and adolescent period. However, more studies are needed for the impedance method on the low age group of children.

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