EVALUATION OF BODY FAT PERCENTAGE OF FEMALE UNIVERSITY STUDENTS ACCORDING TO THREE DIFFERENT METHODS

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Abstract

Purpose: In the present study, it was aimed to evaluate the body fat percentage of female university students according to three different methods.

Methods: This study was conducted on 282 healthy female students aged 20–25 years who attended at different faculties of Erciyes University and, also lived in female dormitories of General Directorate of Credit and Dormitories Agency. Body weight, height, body fat percentage (BF %) were measured by methods of skinfold thickness (SKF), circumference measurement (CM) and bioelectrical impedance analysis (BIA). Data were analyzed by *repeated measures analysis* of *variance.* Significance level was accepted as 0.05.

Results: Mean age was 21.07 ± 1.26 years while body weight and height of the participants were 57.48 ± 8.00 kg and 162.26 ± 5.97 cm, respectively. When BF % was compared according to three different methods, statistically significant difference was found ($p<0.001$). Range of BF % of three methods from minimum to maximum was found as CM, BIA and SKF, respectively. According to BIA and SKF methods, BF % was significantly different between physically active and less active students in other faculties ($p<0.001$). Significant difference was not found in physically less active students. According to CM, BF % was not significantly different among faculties.

Conclusion: It was known that a physically active lifestyle could decrease BF % and increase muscle mass. However according to SKF, BF % could give different results because of the researcher or different measurement formulas. It was thought that BIA could give both practical and accurate results by paying attention to measurement rules.

Key words: Body Fat Percentage, BIA, Skinfold Thickness, Circumference Measurements, Female Student.

Introduction

Currently, physical inactivity caused by industrialization and modern lifestyle has a negative impact on individuals in all age groups. A sedentary lifestyle causes many serious health problems with itself (F.F. Çolakoğlu, Ö. Şenel, 2003).

This lifestyle which grows due to more energy intake compared with energy expenditure occurs as a result of energy imbalance, is a serious public health problem which reduces quality and length of life (N. Şanlıer, 2005, E. Şanlı, 2008). In recent years, it was reported that obesity as a serious public health problem increased in both childhood and adulthood allover the world (B. Livingstone, 2000).

This study has once again pointed out the importance of the effects of overweight and obesity in our young population. Also, the present study conducted on female university students drew attention to decreasing fat mass, increasing fat free mass and total body water and providing suggestions on these anthropometric measurements to the exercise programmers.

Method

In the present study, 282 healthy female students aged 20–25 years who attended at different schools of Erciyes University, and also lived in female dormitory of General Directorate of Credit and Dormitories Agency participated voluntarily.Body weight, height, body fat percentage (BF %) by skinfold thickness (SKF), circumference measurement (CM) and bioelectrical impedance analysis (BIA) methods were measured.Informed consent was obtained from all subjects before the study begun. The study protocol and procedures were approved by the local ethical committee. This study was conducted in accordance with the Declaration of Helsinki or local laws depending on whichever afforded greater protection to the subjects.Codes of the Faculties or Colleges: Following codes in parenthesis were assigned to the faculties or colleges; Physical Education and Sport College (F1)**,** Faculty of Arts and Sciences (F2), Faculty of Engineering (F3), The Faculty of Economics and Administrative Sciences (F4)**,** The Faculty of Education (F5)**,** Faculty of Medicine (F6).

Body Weight and Height: A non–stretching measuring tape sensitive to 0.01 cm was used in height measurement. Height were measured in subjects with barefoot, in a plain standing position with strained knee and attached heels while body weight was measured by BIA with a sensitivity degree of 0.1 in participants with barefoot and minimum cloths.Subcutaneous Fat Mass (Skinfold Thickness Caliper Measurement): In measurement of subcutaneous fat mass, Holtain skinfold caliper which measures in sensitivity of ± 0.2 mm and pressures 10 g/mm² in every open space. Triceps, subscapula and subrailiac parts of the body were measured.Circumference Measurement: Circumferences of forearm, mid–upper arm, waist and thigh measurements were performed with a gullick

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band sensitive to 0.01 cm (K. Tamer, 2000).

Body Fat Percentage by Three Methods

Bioelectric Impedance Analysis (BIA): This measurement was done by Tanita–BC 418 MA (Tanita Corporation, Japan). This device was able to be used by 8 polar electrodes and to measure on high frequencies (50 kHz, 500A).

Skinfold Thickness (SKF): Durnin–Womersley's formula was performed for measuring body density according to the values measured by SKF. Body fat percentage was measured according to siri formula (K. Tamer, 2000, E. Zorba, MA. Ziyagil, 1995). Formula of Durnin–Womersley for adult female is the following;

Body Density: $1.1468 - 0.0740 (\log(X_1+X_2))$

BF % = ((4,95/D) – 4,5)*100 (K. Tamer, 2000).

X_1 =Triceps X_2 = Subscapula (E. Zorba, MA. Ziyagil, 1995).

Circumference Measurement (CM): McArdle's formula for young women was performed (K. Tamer, 2000). Constant of waist circumference (cm) for Body Fat Percentage for Women (%) = Constant A + Constant B – Constant C – 19.6

Weight of the Fat Mass = Fat % / 100 x Body weight

Weight of the Fat Free Mass = Body Weight – Weight of the Fat Mass (K. Tamer, 2000).

women (constant A), of thigh circumference for women (constant B), of forearm circumference (cm) (constant C) were used in the following formula;

(SPSS) version 13.0. All results were given as mean, standard deviation. After testing the homogeneity of variances, variance analysis was performed according to different schools. ***Repeated measures analysis*** of ***variance*** was performed in order to compare BF % according to the three different methods. The level of significance was set at 0.05.

Statistical Analysis

In the present study, the data were analyzed by the statistical package program for social sciences

Results

Table 1. Characteristics of female students attending at different faculties and colleges of our university

Faculties	n	Age (year)	Body Height (cm)	Body Weight (kg)
		X±SD	X±SD	X±SD
F1	61	21.00 ± 1.24	164.07 ± 5.43[a]	55.86 ± 6.65
F2	58	21.19 ± 1.42	160.43 ± 5.38[b]	58.14 ± 7.93
F3	33	21.12 ± 1.24	161.39 ± 6.95[ab]	56.63 ± 9.44
F4	61	21.15 ± 1.19	162.80 ± 6.00[ab]	57.85 ± 8.36
F5	35	21.14 ± 1.31	162.14 ± 6.23[ab]	57.69 ± 5.69
F6	34	20.71 ± 1.06	162.09 ± 5.84[ab]	59.21 ± 10.02
TOTAL	282	21.07 ± 1.26	162.26 ± 5.97	57.48 ± 8.00
	F	0.792	2.521	1.001
	P	0.556[NS]	0.030[*]	0.418[NS]

ab: Significant difference was not found between groups which was shown as the same letter at the same column.
SD: Standard Deviation, NS: Not Significant, [*]p<0.05

Statistically significant difference was not found in mean age and body weight of the female students among faculties (p>0.05). Statistically significant difference in mean age of the female students was found between F1 and F2 (p<0.05). Significant differences were not found when the other schools compared with each other except for F1 (p>0.05). Ranking was as follows; "F2 < F3 < F6 < F5 < F4 < F1" (Table 1).

Table 2. Comparison of BF % of female students according to three different methods

	n	X ± SD (%)	F	P
BIA	282	24.03 ± 6.51[a]	184.75	**0.000**[***]
SKF	282	27.83 ± 5.00[b]		
CM	282	22.01 ± 5.01[c]		

abc: Significant difference was not found between groups which was shown as the same letter at the same column.
SD: Standard Deviation, NS: Not Significant, [***]p<0.001

When BF % of female students were measured according to BIA, SKF and CM methods, statistically significant difference was found among three different methods (p<0.001). Ranking was as follows; "CM < BIA< SKF (Table 2).

Table 3. Comparison of BF % of female students attending at different faculties and colleges of our university according to three different methods

Faculties	n	BIA	SKF	CM
		X ± SD	X ± SD	X ± SD
F1	61	19.25 ± 5.74[a]	23.76 ± 4.54[a]	22.07 ± 4.65
F2	58	25.81 ± 6.66[b]	29.02 ± 4.21[b]	22.92 ± 5.57
F3	33	24.89 ± 6.21[b]	28.79 ± 5.16[b]	21.59 ± 4.65
F4	61	24.87 ± 6.39[b]	28.43 ± 5.05[b]	21.33 ± 5.00
F5	35	25.02 ± 4.59[b]	28.80 ± 4.09[b]	21.22 ± 3.72
F6	34	26.19 ± 5.96[b]	30.09 ± 3.86[b]	22.80 ± 6.03
TOTAL	282	24.03 ± 6.51	27.83 ± 5.00	22.01 ± 5.01
	F	10.057	13.125	1.003
	P	0.000***	0.000***	0.416NS

ab: Significant difference was not found between groups which was shown as the same letter at the same column.
SD: Standard Deviation, NS: Not Significant, ***p<0.001

In statistical comparison of BF % of female students with BIA; while significant differences were found between F1 and F2, F3, F4, F5, F6 (p<0.001), significant difference was not found when other schools were compared with each other (p>0.05). Ranking was as follows; "F1 < F4 < F3 < F5 < F2 < F6". In statitistical comparison of BF % of female students with SKF; while significant differences were found among F1 and F2, F3, F4, F5, F6 (p<0.001), significant difference was not found when other schools were compared with each other (p>0.05). Ranking was as follows; "F1 < F4 < F3 < F5 < F2 < F6". Statistical comparison of BF % of female students with CM could not show significant difference between faculties (p>0.05), (Table 3).

Discussion and conclusion

Mean age of the female students was not statistically significant between faculties. Body fat percentages of female students according to CM, BIA and SKF from minimum to maximum was found as 22.01 %, 24.03 % and 27.83 %, respectively. Significant difference was found among three different methods (BF % with; CM < BIA < SKF). In a study with 17–22 years old female members in the USA Army BF % values were found as 28.70 % (Kyle et al, 2004). In another study conducted on 409 female university students aged 19–23 years, BIA result was 20.73 % (H. Kaya, O. Özçelik, 2009). In the present study, female students of our university had 3.3 % more body fat according to SKF. A hundred and eight sedentary college students aged 19–20 years in the USA were found to have BF % as 28.33±7.93 % and 38.33±5.84 % according to SKF and BIA, respectively (Bowden et al, 2005). It was obvious that different methods could give different results. The results in the other studies were higher than of our study. Minimum and maximum BF % of the students according to BIA was found in faculties coded F1 and F6, respectively. Significant difference was found between F1 and the other faculties and was not found among other faculties except for F1.

In the study which active athletes and students of physical education and sports college of Cumhuriyet University participated, BF % was found as 15.11 % (G. Sınırkavak, U. Dal, Ö. Çetinkaya, 2004). Students of Faculty of Medicine and Physical Education and Sport College were found to have BF % as 32.78 % and 25.55 %, respectively. Significant difference was found between the two faculties which was similar to our study (S. Karakaş et al, 2005). Lowest BF % of female students according to SKF method was found at F1 which was 23.76 %, while the highest was determined at F6 and F2 (30.09 % and 29.02 %, respectively). According to BIA, significant difference was found between F1 and the other faculties and was not found at the other faculties except for F1. In a study conducted with female university students, it was reported that BF % were 31.30 % by SKF method (N. Şanlıer, 2005) which was similar in our study.

Although BF % of the faculties was significantly different according to CM method, it was not valid enough for our young population. The reason may be the female subjects of our population with a tendency of increasing fat in their hip area. Although significant difference was found between faculties according to BIA and SKF, ranking in BF % of these methods were same ("F1 < F4 < F3 < F5 < F2 < F6"). In a 9 week regular endurance and strength training healthy people were able to have decreased BF % (F. Toraman et al, 2002). An 8 week regular aerobic exercise programme was found to decrease BF % of middle aged sedentary women (FF. Çolakoğlu, Ö. Şenel, 2003). Exercise and physically active lifestyle were accepted as having positive impact on BF % (Y. Bektaş et al, 2007)

Female Slovenian army members aged 24.82 years old had 28.50 % body fat by SKF method (Tomazo – Ravnik and Jezernik (2008). Body fat percentages of our participants were lower. Statistically significant differences in BF % with BIA in 19–29 years old female students of faculty of medicine and physical education and sport college were determined (S. Karakaş et al, 2005) which was also similar our study.

Various methods were performed in order to measure BF %. Various factors should be considered for evaluating the data. Because these methods had not only positive benefits but also missing aspects, it was possible to use different methods together (E. Güney, et al, 2003). Currently, BIA has entered to clinics because

of its ease of use and reliability of results. On the other hand, there were studies suggesting contrary findings (AC. Utter et al, 1999). Many studies showed that BIA was an effective way for evaluating the body composition of children, young and old people (LB. Houtkooper et al, 1996, LG. Bandini et al, 1997). Measuring body composition by BIA could give reliable results especially in clinical and health assessments (H. Kaya, O. Özcelik 2009).

Measuremets in body composition by BIA were reported to be affected by changes in nutritional habits, by conditions influencing total body water and concentration of electrolytes such as dehydration, exercise, menstruation and by hot and cold environments which affect skin temperature (K. Üçok et al, 2008). Although SKF method was used for assessing obesity, it was not used in common because of problems in terms of measurement techniques. However, measurements which were done by one observer could give results compatible with reference methods (E. Güney et al, 2003).

Circumference measurement was another method for evaluating body composition which had advantages and limitations. It was especially preferred to SKF for measuring BF % of obese people. The reason may be that skinfold thickness could promote the maximum level of thickness of caliper. Besides, CM method requires less technical abilities. There has been found less difference in circumferences when the differences among experts were measured. However, CM method was able to give racial differences (E. Zorba, 2006). Measuring BF % by using SKF method, different formulas were performed. Each formula was used for different values from different parts of the body. That was the reason why SKF method could give different results even in the same group.

In conclusion, significant difference was not found in the age, body weight and BF % values of other faculties except for F1. It was known that physically active lifestyle could decrease BF % and increase muscle mass. According to SKF method, BF % could give different results because of the researcher or due to different measurement formulas. We thought that BIA could give both practical and accurate results by paying attention to measurement rules.

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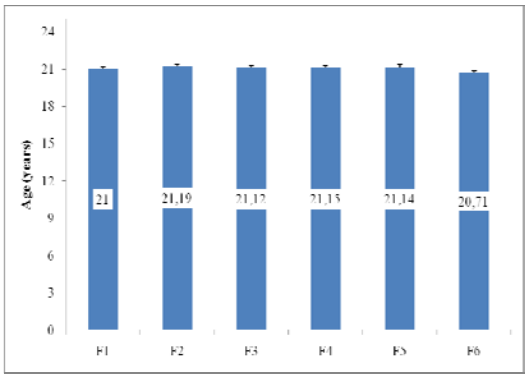

Figure 1. Age of female students attending at different faculties and colleges of our university. Results were presented as means ± SEM. One way ANOVA was performed according to different faculties. Statistically significant difference was not found in terms of age among faculties.

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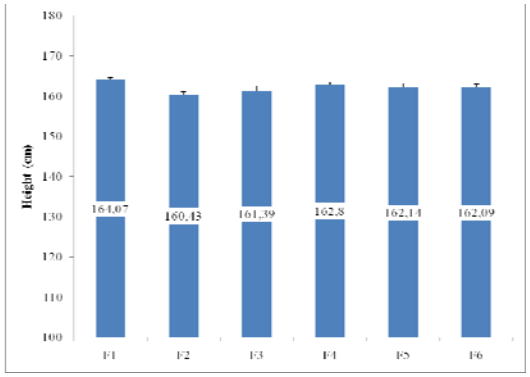

Figure 2. Height of the female students attending at different faculties and colleges of our university. Results were presented as means ± SEM. One way ANOVA was performed according to different faculties. Statistically significant difference was found between F1–F2 ($p<0.05$). Significant difference was not found when the other schools were compared with each other except for F1 ($p>0.05$).

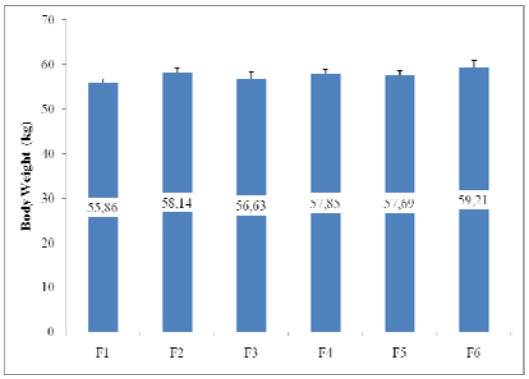

Figure 3. Body weight of female students attending at different faculties and colleges of our university. Results were presented as means ± SEM. One way ANOVA was performed according to different faculties. Significant difference was not found in body weight among faculties.

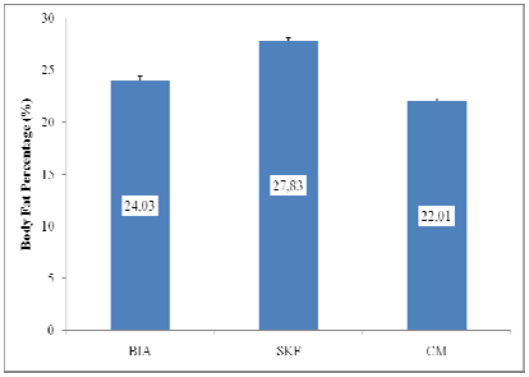

Figure 4. Comparison of BF % of female students according to three different methods. Results were presented as means ± SEM. ***Repeated measures analysis*** of ***variance*** was performed. When BF % of female students were measured according to BIA, SKF and CM, statistically significant difference was found among three different methods ($p<0.001$).

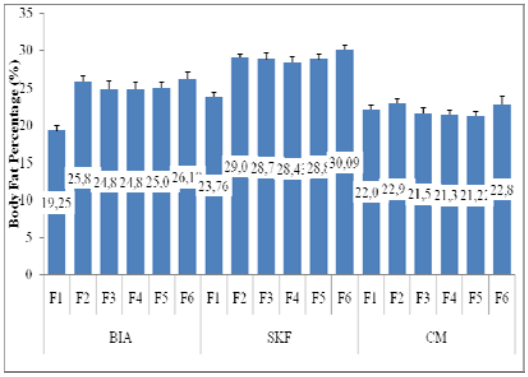

Figure 5. Comparison of BF % of female students attending at different faculties and colleges of our university according to three different methods. Results were presented as means ± SEM. ***Repeated measures analysis*** of ***variance*** was performed. While statistically significant difference was found among F1 and other faculties according to SKF and BIA method, significant difference was not found among faculties according to CM method.