Assessment of the Relationship between University Students' Food Consumption and Anthropometric Measurements and Phase Angle

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ABSTRACT

Purpose: This study was carried out to assess the relationship between university students' food consumption and anthropometric measurements, and phase angle (PA).

Methods: The study was conducted with a total of 240 students between the ages of 18-25 studying at the Department of Nutrition and Dietetics at Agri Ibrahim Cecen University Health School. Research data were collected using a questionnaire that included about demographic information and questions about physical activity levels and three-day food consumption record was taken. Lastly, anthropometric measurements of the students were performed by the researcher in person.

Results: The study's findings revealed that the students' energy intake was lower than their energy expenditures. The body mass indexes (BMI), and waist circumferences of female and male students were calculated as 21.8 ± 3.2 kg/m^2 and 23 ± 3.4 kg/m^2, and 75.2 ± 8.1 cm and 85 ± 10 cm, respectively. The PA was $5.7 \pm 0.5°$ in female students and $6.7 \pm 0.5°$ in male students ($p<0.05$).

Conclusion: The study's findings revealed that male students had significantly higher PA values. The PA values of female students were found to have increased with BMI, waist circumference, and body muscle mass values. There was also no significant relationship between students' PA values and and food consumption levels regardless of gender.

Keywords: Bioelectrical impedance, body mass index, food intake

Üniversite Öğrencilerinin Besin Tüketimleri ve Antropometrik Ölçümleri ile Faz Açısı Arasındaki İlişkinin Değerlendirilmesi

ÖZET

Amaç: Araştırma, üniversite öğrencilerinin besin tüketimleri ve antropometrik ölçümleri ile faz açısı arasındaki ilişkinin değerlendirilmesi amacı ile yapılmıştır.

Yöntem: Çalışma Ağrı İbrahim Çeçen Üniversitesi Sağlık Yüksekokulu Beslenme ve Diyetetik bölümünde öğrenim gören 18-25 yaş aralığındaki toplam 240 öğrenci ile yapılmıştır. Çalışmaya katılan öğrencilerin demografik bilgileri, fiziksel aktivite kayıt düzeyleri sorgulanarak üç günlük besin tüketim kaydı alınmıştır. Katılımcıların antropometrik ölçümleri araştırmacı tarafından birebir ölçülerek alınmıştır.

Bulgular: Öğrencilerin enerji alımlarının enerji harcamasından düşük olduğu bulunmuştur. Beden kütle indeksi (BKİ) kız öğrencilerde $21,8 \pm 3,2$ kg/m^2 erkek öğrencilerde $23 \pm 3,4$ kg/m^2, bel çevresi kız öğrencilerde $75,2 \pm 8,1$ cm erkek öğrencilerde 85 ± 10 cm'dir. Faz açısı erkek öğrencilerde $6,7 \pm 0,5°$ kız öğrencilerde $5,7 \pm 0,5°$ olduğu saptanmıştır ($p<0,05$).

Sonuç: Çalışmaya katılan erkek öğrencilerin daha yüksek faz açısı değerine sahip olduğu görülmüştür. Kız öğrencilerin PA değerlerinin BKİ, bel çevresi ve vücut kas kütlesi değerleri ile arttığı bulunmuştur. Öğrencilerin besin tüketimleri ile faz açısı arasında bir ilişki bulunmamıştır.

Anahtar kelimeler: Beden kütle indeksi, besin alımı, biyoelektrik empedans

Contributions of dietary fat, carbohydrate, and protein to energy intake were reported to be associated with body weight and obesity prevalence (1). Diets low in fibers and high in fats have been associated with the most significant increases in the risk of becoming overweight and obese (2,3).

Anthropometric measurements are essential in determining the nutritional levels of individuals as they are indicators of the proteins and fats stored in the body (4). Bioelectrical impedance analysis (BIA) evaluates body composition by the correlation between body water content and impedance (5).

BIA measures the whole-body impedance along with the two components of impedance, that is, reactance (Xc) and resistance (R) (6). The PA, the direct index of the BIA device, is derived from the relationship between the Xc and R measurements in order to obtain more valid assessments that directly reflect tissue hydration and integrity. The PA is calculated by the formula (arctan (Xc/R) $\times$(180/π) (7).

The PA is considered an indicator of body cell mass and nutritional level (8). Low PA values indicate cell death or decreased cell membrane integrity and decreased cell function. In contrast, high PA values indicate better cell membrane integrity, cell function, and body cell mass. PA values vary between 5° and 7° in healthy individuals (9).

In the light of the above considerations, this study was carried out to assess the relationship between university students' food consumption and anthropometric measurements, and PA.

MATERIAL and METHODS

Study Group and Design
The study group of this study comprised a total of 240 students aged between 18-25, who were studying at the Department of Nutrition and Dietetics at Agri Ibrahim Cecen University School of Health and volunteered to participate in the study. Research data were collected using a questionnaire that included questions about demographic information, physical activity levels and three-day food consumption records were taken. Lastly, anthropometric measurements of the students were performed by the researcher in person.

Assessment of Physical Activity Levels
The physical activity levels of the study students were evaluated through a one-day physical activity record form. To this end, first, the physical activities were classified according to their categories, and secondly, the duration of the physical activities was multiplied by the energy cost coefficient. The products have been added and then divided by 24 hours to determine the physical activity level (Pal) for each study participant (10).

Assessment of Food Consumption
Students' daily energy and nutrient intake were evaluated based on their three-day food consumption record. Serving size training was provided to the study students based on the 'Food and Food Photo Catalogue' (11).

Assessment of Anthropometric Measurements
Students' waist circumferences were measured from the midpoint between the lowest rib and the lateral iliac crest while standing using a rigid tape measure (12). Students' heights were measured while standing on the Frankfort horizontal plane using a commercial stadiometer, a Tartı brand telescopic height gauge. Students' body weights were measured on bare feet and while they had light clothing on using a Tanita MC 780 brand BIA device. Additionally, students body fat percentage (%), body fat mass (kg), body muscle mass (kg), and PA were determined according to age and gender using BIA.

The students' body mass indexes (BMI) were assessed according to the BMI criteria published by the World Health Organization (13). Basal metabolic rates (BMR) of the students included in the study were calculated using the Harris-Benedict equation based on whether they were classified as underweight, normal, or slightly overweight according to the BMI criteria (14). In addition, BMRs of the students who were classified as obese according to the BMI criteria were calculated using the Mifflin-St Jeor equation (15). Total energy requirements of the students were found by multiplying their BMR and physical activity level (Pal) values (14). The PA value commonly varies between 5° and 7° in healthy students (9).

Statistical Analysis
SPSS (IBM Statistical Package for Social Sciences for Windows, version 23.0, Chicago, IL, USA) software package was used to analyze the research data. Descriptive statistics were expressed as numbers (n) and percentages (%), mean (Ẋ) ± standard deviation (SD), median, maximum and minimum values. Independent samples t-test was used to research data determined to conform to normal distribution. The Mann-Whitney U test was used to of non-parametric research data. Pearson's and Spearman's

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correlation tests were used to assess the linear relationship between variables in the case of the normally and non-normally distributed research data, respectively. $p<0.05$ was considered statistically significant.

RESULTS

A total of 240 university students, of whom 195 were female and 45 were male, participated in the study. The mean ages of male students 21.7 ± 1.6 years female were calculated as 20.8 ± 1.3 years. It was determined that 60.5% and 39.5% of the female students have been taking day and night classes, respectively, as compared to 55.6% and 44.4% of the male students who were determined to have been taking day and night classes, respectively. In addition, 90.3% of the female students and 73.3% of the male students were determined to have been living in dormitories (Table 1).

Based on the three-day food consumption records of the students, it was determined that mean daily energy intake through diet, mean intake of carbohydrate, protein, fat, saturated fatty acid, monounsaturated fatty acids, polyunsaturated fatty acids, omega 3, omega 6, cholesterol, fiber, water-soluble fiber, and water-insoluble fiber were significantly higher in male students than in female students ($p<0.05$). Additionally, the percentage of energy coming from fats was found to be significantly higher in female students than in male students ($p<0.05$) (Table 2).

The mean body weight, height, BMI, waist circumference, body muscle mass, BMR, Pal values, and total energy expenditures of male students were found to be significantly higher than female students ($p<0.05$). On the other hand, the mean body fat mass and body fat percentage of female students were found to be significantly higher than male students ($p<0,05$). Male and female students' mean PA values were found as 6.7 ± 0.5º and 5.7 ± 0.5º, respectively, and significantly differed between the genders ($p<0.05$) (Table 3).

As for the relationship between PA and anthropometric measurements, statistically significant and positive relationships were found between PA and the anthropometric measurements, i.e., body muscle mass, waist circumference, and BMI values (r=0.264, $p<0.001$; r=0.186, $p=0.009$; and r=0.323, $p<0,001$; respectively) in female students, whereas no significant relationship was found between PA and any anthropometric measurement in male students ($p>0,05$). In addition, male and female students no significant relationship was found between the PA values and mean daily energy, carbohydrate, protein, and fat intake through diet ($p>0,05$) (Table 4).

DISCUSSION

Adults should get 45-60% of their daily energy from carbohydrates, 20-35% from fats, and 10-20% from proteins (16). In comparison, in this study, it was determined that students' energy intake ratios from carbohydrates, fats, and proteins were within the recommended value range indicated above; however, that their energy intakes were lower than their energy expenditures (Table 2).

It was reported in the studies conducted with university students that the mean body weight, BMI, and body muscle mass values of male students were significantly higher than female students, whereas that the mean body fat percentage and body fat mass values of female students were significantly higher than male students (17–19). Similarly, in this study, the mean body weight, BMI, and body muscle mass values of male students were found to be significantly higher than female students, and the mean body fat percentage and body fat mass values of female students were found to be significantly higher than male students. Additionally, in this study, it was determined that 17.8% and 13.8% of the male and female students were overweight, respectively, and that 4.4% and 2.1% of the male and female students were obese, respectively (Table 3).

In healthy individuals, the PA value commonly varies between 5° and 7°. Low PA values indicate cell death or decreased cell membrane integrity and cell function. In contrast, high PA values indicate better cell membrane integrity and cell function, and body cell mass (9,20). The results of the studies available in the literature indicate that PA values below the range of 4.4° to 5.4° are associated with malnutrition and low survival rates (20,21). In a study conducted with 75 female students between the ages of 20-65 in Turkey, the mean PA of the students was found as 5.9±0.8º (22). In comparison, in this study, the mean PA values of the male and female students were found as 6.7 ± 0.5º and 5.7 ± 0.5º, respectively (Table 3). Accordingly, it was determined that the PA values, the indicator of the health status featuring cell health and cell membrane integrity, were within the normal range in male and female students.

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Table 1. Demographic characteristics of the study students			
		Gender	
	Overall (n=240)	**Female (n=195)**	**Male (n=45)**
Age Ẋ ± SD	21 ± 1.4	20.8 ± 1.3	21.7 ± 1.6
Education type, n (%)			
Formal education	143 (59.6)	118 (60.5)	25 (55.6)
Secondary education	97 (40.4)	77 (39.5)	20 (44.4)
Housing status, n (%)			
I live in a state dormitory	209 (87.1)	176 (90.3)	33 (73.3)
I live with my family	13 (5.4)	11 (5.6)	2 (4.4)
I'm staying in a rented house with my friends	18 (7.5)	8 (4.1)	10 (22.2)
Working status, n (%)			
I'm working	11 (4.6)	9 (4.6)	2 (4.4)
I am not working	229 (95.4)	186 (95.4)	43 (95.6)
Smoking status, n (%)			
Yes	37 (15.4)	16 (8.2)	21 (46.7)
No	193 (80.4)	175 (89.7)	18 (40)
I do not use it anymore	10 (4.2)	4 (2.1)	6 (13.3)
Alcohol drinking status, n (%)			
Yes	7 (2.9)	2 (1)	5 (11.1)
No	224 (93.3)	188 (96.4)	36 (80)
Sometimes	9 (3.8)	5 (2.6)	4 (8.9)

Table 2. Students' mean energy and macronutrients intake through diet					
	Female (n=195)		**Male (n=45)**		**p**
	Ẋ ± SD	**Median (Min-Max)**	**Ẋ ± SD**	**Median (Min-Max)**	
Energy (kcal)	1339.5 ± 356.5	1296.4 (517.2 – 2835.7)	1747.4 ± 393.5	1742.4 (737.1 – 2767.6)	**<0.001**
Carbohydrate (g)	160.2 ± 49.1	156.9 (55.4 – 336.5)	211.0 ± 50.2	214.1 (106.3 – 354.5)	**<0.001**
Carbohydrate %	48.8 ± 6.4	49 (24 – 73)	49.4 ± 4.5	49 (40 – 62)	0.446
Protein (g)	53.6 ± 14.1	52.7 (15.6 – 106.1)	73.8 ± 17.6	73.6 (31.9 – 113.4)	**<0.001**
Protein %	16.5 ± 2.3	17 (9 – 24)	17.3 ± 2.5	17 (12 – 26)	0.061
Fat (g)	51.9 ± 16.4	50.2 (8.1 – 136)	65.4 ± 18.2	61.8 (19.2 – 120)	**<0.001**
Fat %	34.5 ± 5.6	35 (14 – 55)	33.1 ± 4.1	33 (23 – 42)	**0.049**
SFA (g)	21.0 ± 6.7	20.8 (3.7 – 49.6)	25.0± 6.4	25.2 (6.7 – 42.1)	**<0.001**
MUFA (g)	17.1 ± 5.4	16.6 (2.9 – 37.8)	21.5 ± 6.9	20.7 (5.9 – 44.9)	**<0.001**
PUFA (g)	9.5 ± 4.7	8.3 (1.7 – 39)	13.1 ± 5.8	11.9 (4.5 – 33.7)	**<0.001**
Omega 3 (g)	1.1 ± 0.7	0.9 (0.4 – 6.4)	1.4 ± 0.7	1.2 (0.5 – 4.1)	**<0.001**
Omega 6 (g)	7.9 ± 4.0	7.1 (1.2 – 32.4)	11.0 ± 5.2	9.8 (3.7 – 30.6)	**<0.001**
Cholesterol (mg)	255.3 ± 120.9	239.5 (15.3 – 760.1)	326.2 ± 115.3	319.1 (127.8 – 572.8)	**<0.001**
Fiber (g)	14.9 ± 4.9	14.2 (4.3 – 31)	17.4 ± 5.4	16.7 (8.7 – 31.2)	**0.004**
Water soluble fiber (g)	4.9 ± 1.7	4.6 (1.6 – 13)	5.8 ± 1.8	5.7 (2.7 – 12.4)	**0.003**
Water insoluble fiber (g)	9.0 ± 3.1	8.6 (2.8 – 22)	10.9 ± 3.8	10.6 (5.3 – 20.5)	**0.002**
SFA: Saturated fatty acids MUFA: Monounsaturated fatty acids PUFA : polyunsaturated fatty acids					

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Table 3. Students' anthropometric measurements, physical activity levels and energy expenditures					
	Female (n=195)		Male (n=45)		p
	$\dot{X} \pm SD$	Median (Min-Max)	$\dot{X} \pm SD$	Median (Min-Max)	
Body weight (kg)	57.2 ± 9.8	55.2 (38.1 – 94.8)	71.7 ± 11.8	69.6 (49.2 – 104.1)	<0.001
Height (cm)	161.7 ± 5.3	162 (149 – 173)	176.3 ± 5.5	175 (166 – 190)	<0.001
BMI (kg/m²)	21.8 ± 3.2	21.2 (14.9 – 33.6)	23 ± 3.4	23.2 (16.4 – 32.1)	0.013
Waist circumference (cm)	75.2 ± 8.1	74 (60 – 102)	85 ± 10	84 (69 – 112)	<0.001
Body muscle (kg)	41 ± 4.5	40.2 (30.4 – 58.9)	57.2 ± 5.9	56.9 (45.1 – 74.6)	<0.001
Body fat (%)	23.7 ± 6.1	23.1 (11.1 – 43.6)	15.1 ± 6.7	15.6 (3.5 – 28.8)	<0.001
Body fat (kg)	14.1 ± 6.1	12.8 (5 – 39.4)	11.5 ± 6.7	11.2 (1.7 – 30)	0.004
Phase angle °	5.7 ± 0.5	5.6 (4.1 – 8.9)	6.7 ± 0.5	6.7 (5.8 – 7.8)	<0.001
BMI (kcal)	1409.4 ± 118.5	1385.6 (1217.2 – 1739.2)	1779.1 ± 159.1	1763.5 (1475.7 – 2200)	0.001
Pal	1.6 ± 0.2	1.6 (1.3 – 2.7)	1.7 ± 0.2	1.7 (1.3 – 2.4)	0.006
Energy expenditure (kcal)	2302.6 ± 255.2	2286.7 (1809.6 – 3586.7)	3075.7 ± 441.6	3084.8 (2173.5 – 4383.4)	<0.001
BMI: body mass index					

Table 4. The relationship between students' phase angle values and daily energy and macronutrient intakes, and anthropometric measurements				
	Phase Angle °			
	Female		Male	
	r	p	r	p
BMI (kg/m²)	0.323	<0.001	0.234	0.122
Waist circumference (cm)	0.186	0.009	0.016	0.918
Body muscle (kg)	0.264	<0.001	0.041	0.79
Body fat (%)	0.01	0.887	0.104	0.497
Body fat (kg)	0.077	0.287	0.107	0.483
Pal	0.038	0.595	-0.141	0.356
Energy (kcal)	-0.052	0.467	-0.038	0.804
Carbohydrate (g)	-0.073	0.309	-0.048	0.756
Carbohydrate (%)	-0.045	0.534	-0.185	0.224
Protein (g)	0.021	0.774	0.148	0.333
Protein (%)	0.059	0.412	0.132	0.387
Fat (g)	-0.019	0.792	-0.027	0.858
Fat (%)	0.027	0.709	-0.051	0.739
BMI: body mass index				

In healthy individuals, gender, age, lean body mass, BMI, and body fluid distribution are considered as essential determinants of PA (5,23,24). Since males have more body muscle mass relative to their body weight as compared to females, they also have higher PA values than females due to the decrease in resistance (25). In parallel, in this study, the mean body muscle mass, thus the mean PA value of ale students were found to be significantly higher than female students (p<0.05) (Table 3).

The results of the studies conducted on PA indicated a negative correlation between the PA and body fat ratio and a positive correlation between the PA and the body muscle mass. Furthermore, the results of the relevant studies available in the literature have revealed that the PA values increase with increasing BMI values due to the increased number of muscle and fat cells (5,23). In comparison, in this study, there was a statistically significant and positive relationship between the PA and body muscle mass, waist circumference, and BMI values in female students; however, there was no statistically significant relationship between the PA and anthropometric measurements in male students (Table 4).

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The absence of a significant relationship between the PA and anthropometric measurements in male students in this study was attributed to the fact that the sample size of the male students, which was smaller compared to the sample size of female students, might not have been enough to reveal the effect of anthropometric measurements on the PA.

A study conducted with female students in Turkey reported a significantly positive relationship between the PA and the BMI and body muscle mass values. However, in the same study, no statistically significant relationship was found between the PA and the physical activity levels and macronutrient intake (22). In comparison, in this study, no significant relationship was found between the PA and the daily energy and macronutrient intake through diet and Pal values (Table 4).

CONCLUSION

The results of this study indicated that the students who participated in the study energy intake was lower than their energy expenditure. Additionally, it was observed that the PA values of the female and male students participating in the study were within the normal range and were found to have significantly differed between genders in favor of male students. The PA of female students were found to have increased with BMI, waist circumference, and body muscle mass values. In contrast, there was no significant relationship between the PA values and anthropometric measurements in male students. There was also no significant relationship between students' PA values and the physical activity and food consumption levels regardless of gender. Taking into consideration that PA is used as one of the anthropometric indicators to determine the body cell mass and nutritional status, it should be further investigated in larger populations of different age groups in Turkish society.

DECLARATIONS

Ethics Approval

The study's research design was approved by the Acibadem Mehmet Ali Aydinlar University Medical Research Evaluation Committee with the ethics committee approval numbered 2020-02/42. In addition, written permission of the Directorate of Agri Ibrahim Cecen University School of Health, as the venue where the study is to be conducted, was obtained. Lastly, the written consent of all students who participated in the study was obtained after they were orally informed about the study.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Availability of Data and Material

All data is available

Authors' Contributions

Concept: ME, GAÇ; Study Design: ME, GAÇ; Data Collection: ME; Data Analysis: ME, GAÇ; Literature Search: ME; Writing Manuscript: ME; Critical Review: GAÇ

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