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Original article

Association of physical activity and obesity status for individuals between the ages of 18-30 via bioelectrical impedance analysis device and metabolic holter measurements

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Summary. Obesity, according to its simplest definition, is excessive accumulation of fat in the body. Obesity is a health problem that is observed commonly in almost all societies and it is starting to become a global epidemic. In this study, physical activity and obesity statuses for individuals between the ages of 18-30 with different body types were tried to be associated via bioelectrical impedance analysis device and metabolic holter measurements. It was determined according to the results of the study that body fat ratio increases and number of steps decreases with increasing age, that there are statistically significant differences between gender and AEC, TEC, muscle weight and total body water and that this ratio is greater in men in comparison with women. Statistically significant differences ($P<0.05$) were determined between the muscle weight and total body water, BMI, waist/hip ratio, TEC, AEC; between total body water and BMI, waist/hip ratio, TEC and AEC; between the body mass index of individuals and their body fat ratio, waist/hip ratio, TEC and AEC; between body fat ratio and waist/hip ratio and TEC; betwen waist/hip ratio and TEC and BMR; total energy consumption and physical activity duration, AEC, number of steps, PAL, time spent with moderate intensity movement and time spent with very high intensity movement; physical activity levels and AEC, number of steps, PAL, time spent with moderate intensity movement and time spent with high intensity movement; between active energy consumption and number of steps, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement; number of steps and PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement; PAL values of individuals who participated in the study and the time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement.

Key words: obesity, physical activity, bioelectrical impedance analysis device, metabolic holter measurement

Introduction

The unbalance between calorie intake and burn and sedentary lifestyle results with obesity, a chronic disease which is characterized by over abundant or abnormal fat accumulation (1). The frequency and prevalence of obesity is continuously increasing all over the world thus becoming the most important health problem especially in developed and developing countries leading to many other health problems such as diabetes, hypertension, coronary artery disease, hyperlipidemia, hypertriglyceridemia, metabolic syndrome, cancer, osteoarthritis, paralysis, sleep apnea, hepatic lipidosis, asthma, respiratory failure, pregnancy complications, menstruation ir-

regularities, increase in surgical risks, mental problems, social disharmony, musculoskeletal disorders along with many other health issues (2-7). In Turkey, obesity is more common in women than in men and women are less active physically (8). World Health Organization has included obesity in the class of diseases to fight against. According to World Health Organization data in 2016, 1.9 billion of the world adult population was overweight and 650 million of the adults were obese, which means that by the year 2016, 39% of the adult population in the world was either (18 years and over; 39% of men and 40% of women) overweight. Furthermore, the data evidenced that obesity in the world had been tripled between 1975 and 2016 (1) (Tab. 1).

Physical activity is defined as all bodily movements generated by the skeletal muscles resulting in energy consumption (9). Tendency towards sports and physical activity continues to increase especially with the increase in welfare of societies and their awareness related with healthy living increases. It has been stated in studies that regular physical activity decreases risk factors for some diseases in addition to being closely related with the general health status, thus emphasizing that planned exercise programs enhance general health status while also preventing obesity in the long run which plays a fundamental role in the onset of many diseases (10, 11). The objective of this study was to measure the body mass index (BMI, kg/m^2), body fat ratio (%), waist/hip ratio, basal metabolic rate (BMR), muscle weight and total body water via bioelectrical impedance analysis in addition to measuring the total energy consumption (TEC), physical activity duration, active energy consumption (AEC), number of steps, sleep efficiency, physical activity level (PAL), time spent without movement, time spent with mild movement, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement via metabolic holter device thus associating the obesity and healthy living status of individuals according to these values.

Table 1. Obesity classification by WHO according to body mass index (5)

Body Mass	BMI (kg/m2)	Morbidity Risk
Thin	<18.5	Low (High Clinical Problems)
Acceptable	18.5-19.9	Moderate
Normal	20.0-24.9	Moderate
Pre-obese	25.0-29.9	Slightly High
Obese Class 1	30.0-34.9	Moderately High
Obese Class 2	35.0-39.9	Very High
Obese Class 3	≥40	Intensely High

Materials and Methods

The study was carried out with 25 male and 25 female volunteers for a total of 50 participants between the age of 18-30 who are continuing their education at Bitlis Eren University. Detailed information about the study was given to each of the students in the study group prior to the study and their signatures for the "Voluntary Consent Form" were taken. Continuous 24 hour measurements were carried out covering non-holiday periods during which the students did not carry out any extraordinary physical activity and they were asked to continue their regular lives during the measurements. The study was carried out after the necessary approvals were taken from the Bitlis Eren University Ethics Council.

Body composition measurements

Heights of the participants were measured using a stadiometer (ADE-GERMANY MZ10020) ultrasonic height measurment unit with a sensitivity of 0,1 cm with nothing on their heads that might affect the reliability of the measurement, with light clothing and with no shoes on and by measuring the distance between the head vertex and the feet. BMI, body fat ratio, waist/hip ratio, BMR, muscle weight and total body water measurements of the participants were carried out with no shoes and socks in the anatomical position using InBody230 (MW160) Bioelectrical Impedance Analysis Device. All metal objects on the participants were removed during the measurements. It was asked from the participants not to exercise at least 24 hours before the measurements and not to consume any nutrient 12 hours before the measurements. Total energy consumption (TEC), physical activity leval (PAL), active energy consumption (AEC), number of steps, sleep efficiency, physical activity level,

time spent without movement, time spent with mild movement, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very hith intensity movement; were measured via Metabolic Holter (Sense Wear Armband Body media Inc., Pittsburgh, PA, USA) device. TEC and AEC were measured using the Metabolic Holter device in kilojoule and were transformed into kilocalories using the 1 kcal = 4.184 kj equality. Physical activity duration, time spent without movement, time spent with mild movement, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very hith intensity movement were measured via Metabolic Holter device in hours and were transformed into minutes using the 1 hour = 60 minutes equality. Metabolic Holter measurements were carried out by placing the device on the right arms of the individuals in the middle of the distance between acromion and olecranon over the triceps muscle. Demographic data for the individuals such as age, height, gender, body weight, smoking status and dominant hand were loaded to the computer via Body Media Sense Wear 8.1 try software prior to placing the device on their arms and they were removed 24 hours after being placed on the arms after which the data on the device were uploaded to the computer via Body Media Sense Wear 8.1 try software.

Statistical analysis

Data acquired as a result of the study were evaluated using Statgraphics (Centurion XVI Version 16.2.04 trial version–Warrenton, VA) statistical software.

Table 2. Relationship between age, body fat ratio and number of steps (n:50)

	Body Fat Ratio (%)	Number of Steps
Age	0.2954 *	-0.3270 *

**P<0.05*

Results

The study was carried out with 25 male and 25 female volunteers for a total of 50 participants between the age of 18-30 who are continuing their education at Bitlis Eren University.

Age

Age average of the women who participated in the study was calculated as 21.92±2.30, whereas the age average for the men who participated in the study was calculated as 23.32±3.64. There was a statistically significant difference ($p<0.05$) between the age averages of the individuals and their body fat ratios and the number of steps they take and it was observed that body fat ratio increases with increasing age whereas the number of steps decreases (Tab. 2).

Gender

A statistically significant difference was determined between the genders of the individuals and AEC, TEC, muscle weight and total body water ($p<0.05$); it was observed that these ratios were higher in men in comparison with women. Similarly, a statistically significant difference was determined between the genders of the participants and sleep efficiency ($p<0.05$) with higher sleep efficiency in women in comparison with men (Tab. 3).

Muscle weight

A statistically significant differences ($p<0.05$) was determined between the muscle weights of the participants of the study and their total body water, BMI, waist/hip ratio, TEC, AEC (Tab. 4).

Table 3. Relationship of gender with AEC, TEC, muscle weight, total body water and sleep efficiency (n:50)

	AEC	TEC	Muscle Weight	Total Body Water	Sleep Efficiency
Gender	0.3405*	0.5927***	0.4631***	0.4253***	0.3971***

**P<0.05 , *** P<0.001*

Total body water

A statistically significant difference ($p<0.05$) was determined between the total body water and BMI, waist/hip ratio, TEC and AEC of individuals (Tab. 5).

Body Mass Index (BMI)

BMI average of the women who participated in the study was calculated as 23.33±4.41, whereas the BMI average of the men was calculated as 25.54±5.27. A statistically significant difference ($p<0.05$) was determined between the BMIs of individuals and their body fat ratio, waist/hip ratio, TEC and AEC. There was a statistically significant difference ($p<0.05$) between the BMIs and BMRs of the individuals and even if it was observed that the BMR of the individuals increased with increasing BMI, the BMR values were determined to be lower at statistically significant levels in comparison with those of the individuals at the same weight with ideal BMI values (Tab. 6).

Body fat ratio (%)

A statistically significant difference ($p<0.05$) was determined between the body fat ratios of individuals and their waist/hip ratio and TEC values. There was a statistically significant difference ($p<0.05$) between the body fat ratios of individuals and their BMR values; and even though the BMR values increased with increasing weight, they were determined to be lower at statistically significant levels in comparison with those of the individuals at the same weight with ideal BMI values (Tab. 7).

Waist/hip ratio

A statistically significant difference ($p<0.05$) was determined between the waist/hip ratio of individuals and their TEC and BMR values (Tab. 8).

Total Energy Consumption (TEC)

A statistically significant difference was determined between the TEC and physical activity dura-

Table 4. Relationship between muscle weight and total body water, BMI, Waist/hip ratio, TEC and AEC (n:50)

	Total Body Water	BMI	Waist/hip ratio	TEC	AEC
Muscle weight	0.8777 ***	0.7233***	0.4071**	0.7175***	0.4907***

***P<0.01 , *** P<0.001*

Table 5. Relationship of total body water with BMI, Waist/hip ratio, TEC and AEC (n:50)

	BMI	Waist/hip ratio	TEC	AEC
Total Body Water	0.6420 ***	0.2987 *	0.6692 ***	0.4900 ***

**P<0.05 , *** P<0.001*

Table 6. Relationship of BMI with body fat ratio, Waist/hip ratio, TEC, AEC and BMR (n:50)

	Body Fat Ratio	Waist/hip ratio	TEC	AEC	BMR
BMI	0.6999 ***	0.7566 ***	0.7155 ***	0.4147 **	-0.7089 ***

***P<0.01 *** P<0.001*

Table 7. Relationship of body fat ratio with Waist/hip ratio, TEC and BMR (n:50)

	Waist/hip ratio	TEC	BMR
Body Fat Ratio (%)	0.6645 ***	0.3635 ***	-0.8265 ***

**** P<0.001*

Table 8. Relationship of Waist/hip ratio with TEC and BMR (n:50)

	TEC	BMR
Waist/hip ratio	0.3811 **	-0.6593 ***

***P<0.01 , *** P<0.001*

Table 9. The relationship of TEC with physical activity duration, AEC, number of steps, time spent with moderate intensity movement, time spent with high intensity movement and sleep efficiency (n:50)

	Physical Activity Duration	AEC	Number of steps	Time Spent with Moderate Intensity Movement	Time Spent with High Intensity Movement	Sleep Efficiency
TEC	0.4791 ***	0.7766 ***	0.3593 **	0.4747 ***	0.3486 **	-0.3506 **

***P<0.01 *** P<0.001*

Table 10. Relationship of physical activity duration with AEC, number of steps, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (n:50)

	AEC	Number of steps	PAL	Time spent with moderate intensity movement	Time spent with high intensity movement	Time spent with very high intensity movement
Physical Activity Duration	0.8584 ***	0.7762 ***	0.7728 ***	0.9660 ***	0.4554 ***	0.3634 **

***P<0.01 , *** P<0.001*

Table 11. Relationship of AEC with number of steps, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (n:50)

	Number of steps	PAL	Time spent with moderate intensity movement	Time spent with high intensity movement	Time spent with very high intensity movement
AEC	0.7409 ***	0.8125 ***	0.8030 ***	0.4724 ***	0.5536 ***

**** P<0.001*

tion of individuals with AEC, number of steps, PAL, time spent with moderate intensity movement and time spent with high intensity movement ($p<0.05$). There was a statistically significant difference ($p<0.05$) between the TEC values of individuals and their sleep efficiencies and it was observed that sleep efficiency decreases with increasing TEC (Tab. 9).

Physical activity duration

There was a statistically significant difference ($p<0.05$) between the physical activity durations of individuals and their AEC, number of steps, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (Tab. 10).

Active Energy Consumption (AEC)

There was a statistically significant difference ($p<0.05$) and a positive correlation between the AEC of individuals and their number of steps, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (Tab. 11).

Number of steps

There was a statistically significant difference ($p<0.05$) and a positive correlation between the number of steps of individuals and their PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (Tab. 12).

PAL

PAL average of the women who participated in the study was calculated as 1.64±0.20, whereas the PAL average for men was calculated as 1.62±0.24. A statistically significant difference ($p<0.05$) and a positive correlation were observed between the PAL values of individuals and time

Table 12. Relationship of number of steps with PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (n:50)

	PAL	Time spent with moderate intensity movement	Time spent with high intensity movement	Time spent with very high intensity movement
Number of steps	0.7865 ***	0.7552 ***	0.5090 ***	0.4856 ***

*** *P<0.001*

Table 13. Relationship of PAL with time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement (n:50)

	Time spent with moderate intensity movement	Time spent with high intensity movement	Time spent with very high intensity movement
PAL	0.6879 ***	0.4286 **	0.5118 ***

***P<0.01 *** P<0.001*

spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement.

Discussion

It was observed in our study that the number of steps of individuals decreased with increasing age and that as a result there is a tendency for a sedentary lifestye. It was determined that body fat ratio increased with increasing age resulting in an increase in BMI, waist/hip ratio and total energy consumption as well. It was recorded in our study that the active energy consumptions, muscle mass and total body waters of male individuals were greated; whereas it was also recorded that sleep efficiency was higher in women. It was observed in previous studies that sleep efficiency of men was greater (12), that gender does not affect sleep quality (13, 14) or that sleep quality of women is better than that of men (12). According to the results of this study, there was a statistically significant difference was detected between muscle mass and total body water and it was recorded. Whereas there was a statistically significant increase in BMI, waist/hip ratio, total energy consumption and active energy consumption depending on an increase in muscle mass and body water; there was a statistically significant decrease in the time spent with light movement during these periods. According to the results of our study, it has been observed that body fat ratio increases significantly as time spent with mild movement increases and in individuals with a sedentary lifestyle. It has been put forth in studies carried out that body fat mass decreases and physical strength increases in individuals who carry out regular physical activities. In addition; it is also known that a sedentary (inactive) lifestyle leads to energy imbalance and thus increase in obesity. Thus, the results of our study support the results of relevant studies in this field (16, 17). Even though there is an increase in BMI with increasing muscle mass, this is not an indication of obesity. Even though it has been put forth in similar studies that the body mass indexes of participants are slightly above limits, this may be due to excessive muscle mass and that body mass index is missing in the definition of obesity (18, 19). Increases in body fat ratio and waist/hip ratio have been observed in the participants of this study parallel to an increase in BMI. It has been put forth in many studies carried out that the obesity disease which is characterized with excessive increases in body fat ratios is becoming a significant public health problem in many countries of the world and especially in developed countries.

In the present study, a statistically significant increase was detected in the total energy consumption and active energy consumption of individuals parallel with increasing BMI. It has also been recorded that BMR has increased, however this increase was lower than expected. There was a parallel increase in the total energy consumption of individuals, physical activity durations, active energy consumption, PAL, time spent with moderate intensity movement, time spent with high intensity movement and time spent with very high intensity movement; sleep efficiency was determined to decrease depending on the increase in total energy consumption. Spiegel et. al. (2004) carried out a study in which they put forth that sleep limitations cause changes in metabolic hormones that play significant roles in the arrangement of neuroendocrine and energy balances. So it can be stated that sleep efficiency might depend on sleep limitation in which case time spent for food intake may increase thus resulting in an increase in total en-

ergy consumed due to physical activity (20). Even though the obesity states of the individuals who participated in this study increased with BMI, body fat ratio and muscle mass, obesity depends only on high fat ratio according to the obesity definition by the World Health Organization. In this case, it was observed that BMI is missing in the definition of obesity and that bioelectrical impedance body analysis devices are important for the determination of the bodily components of individuals and the nutritional treatment that will be provided accordingly. Even though it was observed that the number of steps decreased with increasing age and that the individuals tended more towards a sedentary lifestyle, the fact that the age interval of the individuals is close and limited prevents gaining accurage information about the clarity of this issue. It was determined in our study that male individuals spent more active and total energy. Accordingly, sleep limitation was imposed and it can be stated to lead to a decrease in sleep efficiency. Even though there is an increase in the basal metabolic rates of individuals with increasing BMI and weight; it can be stated that it is lower in comparison with individuals at the same weight with ideal BMI and that depending on BMI increase, basal metabolic rate is lower than it should be. Total and active energy consumption values of individuals increased with increasing number of steps, times spent with moderate, high and very high intensity movement.

References

1. http://search.who.int/search?q=2015+obesity+report&ie=utf8&site=who&client=_en_r&proxystylesheet=_en_r&output=xml_no_dtd&oe=utf8&getfields=doctype. (Access Date 21.11.2017)
2. Leggio M, Lombardi M, Caldarone E, Severi P, D'Emidio S, Armeni M, Bravi V, Bendini MG, Mazza A. The relationship between obesity and hypertension: an updated comprehensive overview on vicious twins. Hypertens Res. 2017; 5.
3. Ortega FB, Lavie CJ, Blair SN. Obesity and Cardiovascular Disease. Circ Res. 2016; 27: 1752-70.
4. Reynolds RM, Allan KM, Raja EA, Bhattacharya S, McNeill G, Hannaford PC, Sarwar N, Lee AJ, Bhattacharya S, Norman JE.Maternal obesity during pregnancy and premature mortality from cardiovascular event in adult offspring: follow-up of 1 323 275 person years. BMJ. 2013; 13: 347-447.
5. Forno E, Han YY, Libman IM, Muzumdar RH, Celedón JC. Adiposity and Asthma in a Nationwide Study of Children and Adults in the United States. Ann Am Thorac Soc. 2017; 16.
6. Ackerman SE, Blackburn OA, Marchildon F, Cohen P. Insights into the Link Between Obesity and Cancer. Curr Obes Rep. 2017; 6(2): 195-203.
7. Russell-Mayhew S, McVey G, Bardick A, Ireland A.Mental Health, Wellness, and Childhood Overweight/Obesity. J Obes. 2012; 2012: 281801.
8. Erem C. Prevalence of overweight and obesity in Turkey. IJC Metabolic & Endocrine. 2015; 8: 38-41.
9. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C. Physical activity and public health. JAMA. 1995; 273: 402-407.
10. Franklin BA, Whaley MH, Howley ET. Benefits and Risk Associated with Exercise. In: Franklin BA, Whaley MH, Howley ET, editors. ACSM's Guidelines for Exercise Testing and Prescription. 6th ed. Philadelphia: LWW; 2000. p.3-21.
11. Warburton DE, Nicol CW, Bredin SSCMAJ. Health benefits of physical activity: the evidence. 2006;14: 801-9.
12. Krishnan V, Collop NA. Gender differences in sleep disorders. Curr Opin Pulm Med. 2006; 12: 383–389.
13. Buysse DJ, Reynolds CF, Monk TH, Hoch CC, Yeager AL, Kupfer DJ. Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI). Sleep.1991; 14(4): 331-8.
14. Şenol V, Soyuer F, Pekşen AR, Argun M. Adolesanlarda uyku kalitesi ve etkileyen faktörler. Kocatepe Tıp Dergisi. 2012; 14: 93-102.
15. Liu X, Zhao Z, Jia C, Buysse DJ. Sleep patterns and problems among Chinese adolescents. Pediatrics. 2008; 121: 1165–1173.
16. Goodpaster BH, Chomentowski P, Ward BK, Rossi A, Glynn NW, Delmonico MJ, Kritchevsky SB, Pahor M, Newman AB. Effects of physical activity on strength and skeletal muscle fat infiltration in older adults: a randomized controlled trial. J Appl Physiol. 2008; 105(5): 1498-503.
17. Pietiläinen KH, Kaprio J, Borg P, Plasqui G, Yki-Järvinen H, Kujala UM, Rose RJ, Westerterp KR, Rissanen A. Physical inactivity and obesity: a vicious circle. Obesity (Silver Spring). 2008; 16(2): 409-14.
18. Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, Allison TG, Batsis JA, Sert-Kuniyoshi FH, Lopez-Jimenez F. Accuracy of body mass index in diagnosing obesity in the adult general population. Int J Obes (Lond). 2008; 32(6): 959-66.
19. Rothman KJ. BMI-related errors in the measurement of obesity.Int J Obes (Lond). 2008; 32: 56-9.
20. Spiegel K, Leproult R, L'hermite-Balériaux M, Copinschi G, Penev PD, Van Cauter E. Leptin levels are dependent on sleep duration: relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. J Clin Endocrinol Metab. 2004; 89 (11): 5762-71.

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