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Original article

Investigation of the relationship between basal metabolic rate and body composition in young adults using CHAID analysis

Irfan Yildirim[1], Ilkay Dogan[2], Ozkan Isik[3], Yunus Yildirim[1], Seniz Karagoz[4]

[1]Faculty of Sport Sciences, Mersin University, Mersin, Turkey - E-mail: iyildirim76@hotmail.com, [2]Department of Biostatistics, Faculty of Medicine, Gaziantep University, Gaziantep, Turkey; [3]Faculty of Sport Sciences, Balıkesir University, Balıkesir, Turkey; [4]Faculty of Sport Sciences, Afyon Kocatepe University, Afyonkarahisar, Turkey

Summary. *Study Objectives:* Basal metabolic rate (BMR) is the most important component of the individual's daily energy-consuming. Personal and environmental factors make a difference in BMR. Body composition is the most important variable for BMR, from these factors. In this context, the aim of this study was to examine the relationship between BMR and body components in young adults and to determine the most effective body component on BMR. *Methods:* The sample of this study consisted of 229 women and 123 men, a total of 349 young adult individuals. All measurements of the participants were carried out in the physiology laboratory of the School of Physical Education and Sports, Afyon Kocatepe University. Participants' height measurements were measured using Seca 213 (Germany) 1 mm precision portable stadiometer, body compositions (Body weight, Fat Mass, Free-Fat Mass, and Total Body Water) and BMR using a bioelectrical impedance analyzer. In the analysis of the obtained data, CHAID analysis was applied using the SPSS package program to explain the relationship between basal metabolic rate and body composition as well as descriptive statistics. *Results:* It was determined that the BMR of men and women differed statistically. It was determined that the most important body component affecting BMR in young adult women and men is free-fat mass. *Conclusion:* The BMR was predicted by 83.91% in young adult women and 70.39% in men by free-fat mass. Moreover, it was determined that BMR increased as the free-fat mass increased.

Key words: Basal Metabolic Rate, Obesity, Body Composition, CHAID Analysis

Introduction

Obesity is defined as the accumulation of fat in adipose tissues to the extent that it can impair human health. Obesity is a chronic health problem called the epidemic of our age, and its prevalence is gradually increasing. Many genetic, personal and environmental factors that play a role in the development of obesity cause degradation of the energy balance (1-4). The energy balance is the total received energy in a day is equal to the total consumed energy. The fact that the total received energy in a day is less than the total consumed energy is called the negative energy balance, and the total received energy in a day is more than the total consumed energy is called the positive energy balance. Degradation of the energy balance, and its transformation into chronic form change in body composition. While long-term negative energy balance creates body weight loss, positive energy balance causes body weight increase, and obesity (5,6). The total received energy in a day is consumed under the thermal effect of foods (10%), physical activity (15-30%), and BMR (60-65%). Basal metabolism is the lowest amount of energy required to maintain an individual's vital functions (7). BMR is the most important component of the individual's daily energy-consuming. However, some personal and environmental factors create a difference in BMR and affect the amount of energy-consuming per unit of time (5,8-13). Previous studies show that BMR is related to diet, physical activity, gender, age, height, body weight, body temperature, climate, some hormones, pregnancy, disease, etc. (8,14,15). Moreover, it is stated that the most important factors in BMR changes are body size and body composition (14,16). Body composition consists of the relative ratios of muscle, bone, fat, and other components to body weight (17-19). It is stated that lean mass (FFM), fat mass (FM) and total body water (TBW) in body composition are effective on the BMR (14,16-19). However, we think that they have a different effects on BMR. For this reason, it is important to identify the most effective body component in BMR.

In the literature, it has been observed that there are studies examining BMR changes in different populations and the components that are effective in BMR changes (6,20-23). However, studies examining the body composition components that are effective in BMR using the CHAID analysis technique in young adult individuals have not been encountered. In this context, the aim of this study was to examine the relationship between BMR and body components in young adults and to determine the most effective body component on the BMR using the CHAID analysis.

Material and Method

Participants

A total of 349 (226 women and 123 men) young adults participated in this study. Before the measurements, the participants were informed about the purpose of the study and the "Informed Volunteer Consent Forms" were obtained from participants. The participants were selected from healthy individuals between the ages of 18-30. However, disease, pregnancy, breastfeeding, and menstrual periods in women were determined as exclusion criteria.

Data Collection

All measurements were performed in the physiology laboratory of the School of Physical Education and Sports, Afyon Kocatepe University.

Height Measurements

Height measurements of the participants were measured with a portable stadiometer with Seca 213 (Germany) brand 1 mm precision. Length measurements were measured with barefoot in the anatomical position with a thin rod parallel to the floor that touched the head during deep inspiration with a sensitivity of 1 mm as the distance between the sole of the foot and the top of the head.

Body composition and BMR Measurements

Body composition and BMR were measured in sedentary mode with the TANITA BC-418 (Tanita Corp., Tokyo, Japan) brand bioelectric impedance analyzer. All participants were informed about measurement protocols 72 hours before body composition measurements. They were informed about not drinking alcohol up to 48 hours before the measurements, not eating 4 hours in advance, not consuming tea, coffee and cola 12 hours before the measurement and not exercising. Body composition measurements were performed with light clothes, barefoot, without any metal objects on them, in the case of an empty stomach and an empty bladder.

Statistical Analysis

CHAID (Chi-Squared Automatic Interaction Detection) analysis is a method that can achieve similar results with regression analysis but does not take into account the assumptions of regression analysis. CHAID analysis is a method that determines statistically significant groups, can give results with clear and easily readable tree diagrams, classifies, or estimates observations. CHAID analysis examines the factors that significantly affect the change in estimated variables, and tries to identify the interactions and common level combinations of variables in the research model. CHAID analysis is a statistical method that divides the categorical dataset into detailed homogeneous sub-groups to describe the best dependent variable (24,25). In the analysis of the obtained data, CHAID analysis was applied using the SPSS program to explain the relationship between BMR and body composition, as well as descriptive statistics. Significance was determined as $p < .05$.

Results

In Table 1 some descriptive statistics related to body components for women was given. It was determined that the most important body component that affects BMR in women was FFM (Figure 1). FFM components for women were divided into 5 groups. When the FFM groups in Figure 1 were examined, ≤ 39.20 (n = 46), 39.20 < FFM ≤ 42.50 (n = 66), 42.50 < FFM ≤ 43.60 (n = 25), 43.60 < FFM ≤ 46.40 (n = 44), and BMR means for women in the FFM > 46.40 (n = 45) groups were 1189.67 Kcal, 1283.24 Kcal, 1348.88 Kcal, 1391.43 Kcal, and 1529.20 Kcal, respectively. As the FFM ratio increases for women, the BMR also increases. In addition, the determination coefficient of this model for women was determined as R^2 = 83.91%. In other words, approximately 84% of the change in BMR can be explained by FFM.

In Table 2 some descriptive statistics related to body components for men was given. It was determined that the most important body component that affects BMR in men was FFM (Figure 2). FFM components for men were divided into 3 groups. When the FFM groups in Figure 2 were examined, ≤54.00 (n = 26), 54.00<FFM≤60.50 (n = 35), and BMR means for men in the FFM >60.50 (n = 62) groups were 1493.92 Kcal, 1722.63 Kcal, and 1981.40 Kcal, respectively. As the FFM ratio increases for men, the BMR also increases. In addition, the determination coefficient of this model for men was determined as R^2 = 70.39%. In other words, approximately 70% of the change in BMR can be explained by FFM.

Discussion and Conclusion

In order to maintain the energy balance, all of the total received energy in a day must be spent. The most important component of energy-consuming is BMR. Because approximately 60-65% of the individual's daily energy consumption is spent on basal metabolism. However, the BMR varies individually (5,6,8-12,15). Body size and body composition are the most important factors estimating individual differences and changes in the BMR (10,11,14,16). In this context, in this study, the effects of body components on the BMR were investigated.

In the literature, it is stated that gender creates a difference in BMR, and women have a BMR of about

Table 1. Descriptive Statistics of Women Participants

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (Year)	226	18.00	29.00	20.88	1.77
Height (cm)	226	146.00	178.0	162.23	5.29
Body Weight (kg)	226	39.6	104.2	61.42	11.57
Body Mass Index (kg/m^2)	226	15.5	39.2	23.35	4.34
BMR (Kcal)	226	1070.0	1774.0	1341.50	125.89
Percentage of FM (%)	226	9.2	45.4	28.77	7.68
FM (kg)	226	3.6	47.2	18.45	8.11
FFM (kg)	226	32.9	57.5	42.99	4.29
TBW (kg)	226	24.1	42.1	31.47	3.14

Table 2. Descriptive Statistics of Men Participants

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (Year)	123	18.00	27.00	20.48	1.83
Height (cm)	123	156.00	194.00	176.02	6.36
Body Weight (kg)	123	45.90	117.80	71.39	13.49
Body Mass Index (kg/m^2)	123	16.10	36.10	22.99	3.78
BMR (Kcal)	123	1290.00	2578.00	1804.72	233.38
Percentage of FM (%)	123	2.80	32.70	14.07	7,.44
FM (kg)	123	1.90	34.60	10.76	7.46
FFM (kg)	123	43.00	83.20	60.48	7.63
TBW (kg)	123	31.50	60.90	44.17	5.77

10-15% lower than men (8,15). The results of this study showed that men's BMR was higher than women. It can be said that the difference between BMR of women and men is due to the ratio of body components. Therefore, BMR of women and men according to their body composition were evaluated separately in the CHAID analysis.

When the literature was examined, it was reported that the percentage of FM, FM, and FFM was effective in BMR (14,16,20-22). While Lührmann et al. (2001) stated that the resting metabolic rate (RMR) is not only dependent on FFM, and also is affected by FM and FM distribution in the body (21), Molnar and Schutz (1997) reported that the main determinant of RMR is FFM (22). In studies conducted at different ages and groups in the literature, it was seen that there was no consensus regarding the effect of body compositions on BMR. In this study, according to the results of CHAID analysis using FFM, FM, percentage of FM, and TBW, it was determined that the most important component estimating BMR for women (figure 1) and men (figure 2) was FFM. It was seen that the FFM component was divided into 5 groups in women and 3 groups in men. For both women and men, BMR increased as FFM increased. Approximately 60% of human body weight consists of water. Water is 78% in muscle mass and 18% in FM. According to these ratios, as the muscle mass increases in the body increases the water ratio and decreases the fat ratio. This study was planned considering that per unit changes in the body composition of FFM, FM, and TBW components would change the effective rates on BMR. As a matter of fact, according to our hypothesis, FFM has been found to be the most important component affecting BMR. We also estimated that the BMR difference between men and women was due to body compositions. This situation may be due to the lower TBW and FFM ratios of women and higher FM than men.

In this study, changes in BMR can be explained by approximately 83.91% for women (figure 1) and 70.39% (figure 2) for men by the FFM. In the current study, considering the most important change in BMR may be due to body composition, only FFM, FM, TBW, and FM percentage were included in the CHAID analysis model. However, it is stated in the literature that BMR is affected as well as body composition and gender by many factors such as age, hormones, current general health status, stress, diet, disease, environmental temperature, pregnancy, etc. Stress, post-workout, pregnancy, breastfeeding, growth era, increased muscle mass in the body, febrile diseases, cancer-derived diseases, low environmental temperature, excess protein in the diet, and excess of thyroid hormone increase the BMR. Depending on age, the BMR decreases in low thyroid hormone (8,15). In this study, women and men were evaluated separately, the participants were selected from healthy individuals, and it was paid attention not to have women participants during pregnancy, breastfeeding, and menstrual periods. In addition, BMR changes in young adults were examined, paying attention that the participants

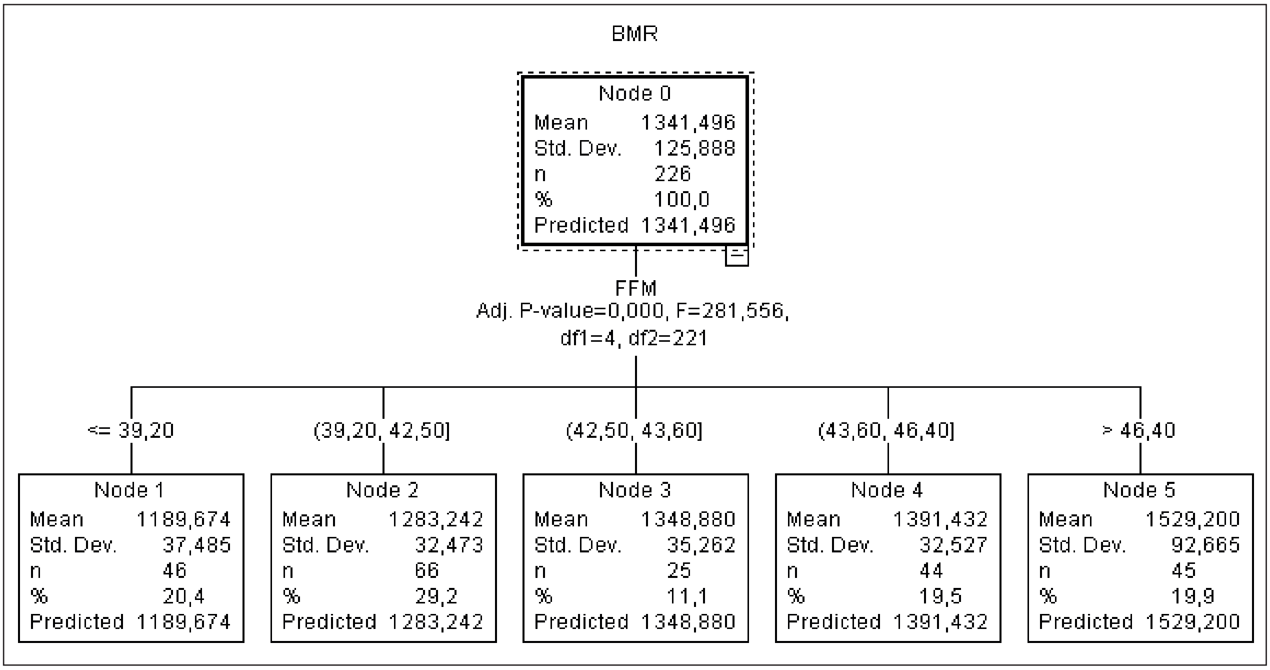

Figure 1. CHAID analysis results for women

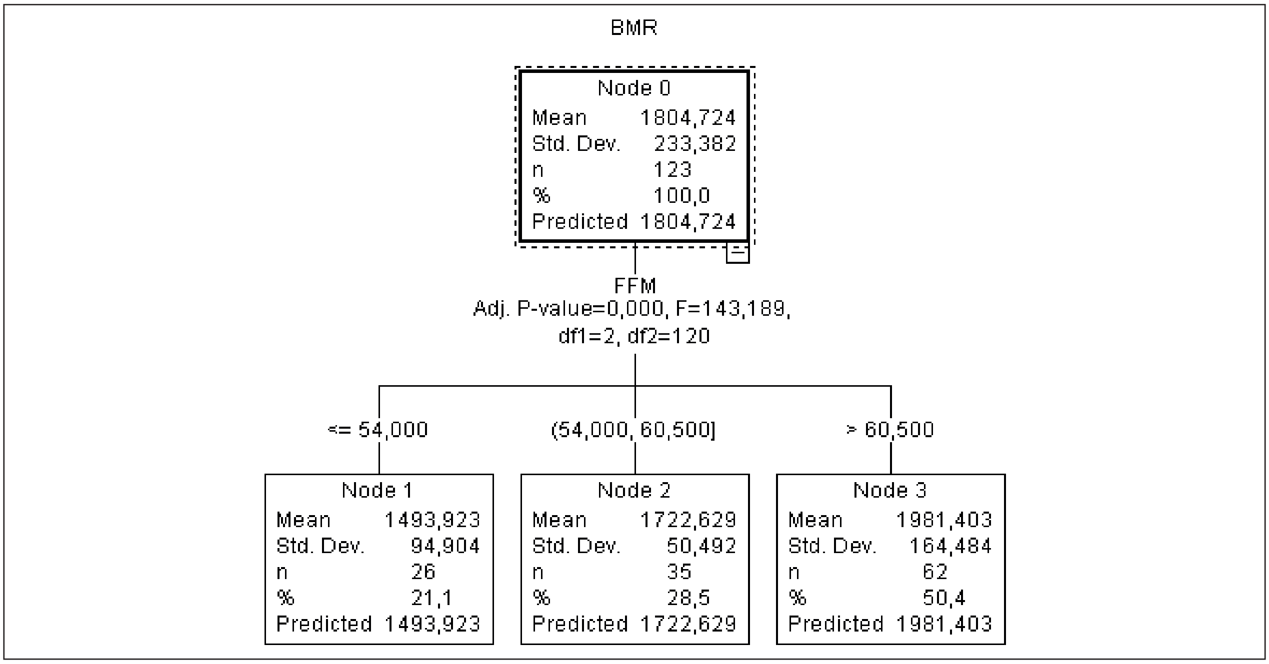

Figure 2. CHAID analysis results for men

were between the ages of 18-30. Thus, individual and environmental factors that may affect the BMR were brought under control. However, the stress, diet, and thyroid hormones that we cannot control can also cause changes in the BMR of the participants. Therefore, it can be said that the unexplained percentages of BMR changes in the model are caused by stress, diet, and thyroid hormone levels.

As a result, it was determined that the most important component affecting BMR in young adult women and men was FFM. It was determined that the BMR increased as the FFM ratio in the body increased. 83.91% of BMR changes in women and 70.39% of men were explained through FFM. In future researches, the examination of the levels of stress, diet, and thyroid hormones and the effect of body components on the BMR using CHAID analysis will contribute to the sports and health field.

Conflict of interest

The authors declare that there is no conflict of interest in this manuscript.

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Correspondence:
Irfan YILDIRIM
Faculty of Sport Sciences, Mersin University, Mersin, Turkey
Mobile phone: +905326833220
E-mail: iyildirim76@hotmail.com