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Original Article

The association between resting metabolic rate and blood groups in overweight and obesity

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Abstract

Aim: Obesity is characterized as increase of fat tissue due to energy imbalance in the body. Resting metabolic rate shows the energy required for vital functions at resting state, and varies individually. Resting metabolic rate is affected by many factors. The aim of this study was to investigate whether resting metabolic rate changes depending on the blood groups.

Materials and Methods: A total of 185 females and 37 males aged between 17 and 72 years who were admitted to our outpatient clinic due to obesity were evaluated with bare feet in length. Weight, body mass index (BMI), fat percentage, fat mass, and fat free mass were determined by a bioimpedance device (Tanita-BC418). Resting metabolic rate was detected by a fitmate device. Calorimetric measurement method was used to measure resting metabolic rates (RMR). ABO and Rh blood groups were determined via Microplack method as Forward Reverse.

Results: There was not any significant difference according to ABO blood groups in terms of age, gender, body weight, fat percentage (F%), fat mass (FM) fat free mass (FFM), fat mass index (FMI) and fat free mass index (FFMI). There was not any statistically significant difference for RMR, RMR% measurements according to ABO blood groups and Rh factor ($p>0.05$).

Conclusion: Resting metabolic rate did not change according to the ABO blood groups and Rh factor in obese individuals. Since blood group antigens are variable parameters according to individuals, we did not find any meaningful finding in this study based on whether this variability has an effect on resting metabolic rate.

Keywords: ABO blood groups; obesity; resting metabolic rate, Rh factor

INTRODUCTION

Obesity is defined as increase of body fat tissue due to energy intake and consumption imbalance (1). Resting metabolic rate constitutes majority of the daily total calorie consumption (60 % to 75%) (2). Resting metabolic rate shows the energy required for vital functions at resting state and varies individually (3). It is acknowledged that age, gender, body weight, height, fat mass and muscle mass affect the resting metabolic rate (4). Various studies demonstrated that leptin (5), thyroid hormone (6), and growth hormone (7) affect the metabolic rate. Many studies indicated that energy consumption changes individually (8).

Although previous studies demonstrated that lower metabolic rate causes weight gain (9), recent studies indicated that weight gain is along with the metabolic rate increase (10). It was considered in such studies that the muscle mass reduction as a result of calorie restriction decelerates the resting metabolic rate (11), and this is caused by the muscle tissue which has a higher metabolism (12).

After first identification of the blood types in 1901, many studies were conducted to demonstrate the association with various diseases. These studies addressed the association of blood groups with some conditions such as gastric cancer (13) and malaria (14) as well as possible effects on homeostasis affected by serum total cholesterol and LDL cholesterol levels (15). Furthermore, studies investigating the relation between blood groups and obesity also exist (16). The association of resting metabolic rate with obesity remains unknown. The aim of the present study was to investigate whether resting metabolic rate changes depending on the blood groups.

MATERIALS and METHODS

Obese subjects between 17 and 72 years of age who referred to Sports Physiology department on outpatient basis were enrolled into the study. First, height was measured at a standing position without shoes through

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a stadiometer (Seca, 220, Germany). The fat mass as well as weight, body mass index, fat free mass analyses were performed by a bioimpedance device (Tanita-BC418). Afterwards, FMI (fat mass/ height m² and FFMI(fat free mass/ height m²) were calculated. Resting metabolic rate was measured by using a fitmate device. Calorimetric measurement method was used to measure resting metabolic rates (RMR). The patients were instructed to discontinue food intake at least before 12 hours in consideration of thermogenic energy of the foods to avoid false result during measurement. The patients were also reminded to avoid alcohol and nicotine intake at least 2 hours before, and caffeine at least 4 hours before, they were also instructed to be careful on having moderate physical activity and to discontinue heavy physical activity at least 14 hours before.

The measurements were taken in a physically adequate room at a room temperature between 20 °C and 25 °C. A specifically designed, soft mask was placed on patients' mouths and noses for metabolic rate measurement, and VO2 (oxygen consumption) and VE (volume expiration) levels were measured in each ventilation air for 15 minutes. Since the first 5 minutes was the stabilization period for the patient, the average of last 10-minute measurements was automatically measured by the device, and resting metabolic rate was calculated through Weir (Weir equity RMR = [3.9 (VO2)+1.1(VCO2)]1.44) (17).

After collecting 2 ml of blood into EDTA from each patient, ABO and Rh blood groups were determined via Microplack method as Forward Reverse.

Statistical analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analyses. Descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, maximum) were used to evaluate the study data. Compliance of quantitative data to normal distribution was tested by Kolmogorov-Smirnov, Shapiro-Wilk test and graphical evaluations. Student t Test was used to compare quantitative data with normal distribution between two groups whereas Mann Whitney U test was utilized to compare the data without normal distribution. Comparison of three and more groups without normal distribution was performed by Kruskal Wallis test. Qualitative data comparison was performed through Pearson's Chi-Square test and Fisher's Exact test. The p level below 0.05 was considered as statistically significant.

RESULTS

The present study was carried out with 222 participants including 185 (83.3%) females and 37 (16.7%) males. The age average of the patients was 42.18 ± 10.42 years, ranging from 17 and 72 years. BMI measurements of the cases varied between 25.6 kg/m² and 77kg/m² with an average of 45.33 ± 9.57 kg/m² Other measurements taken and distribution of laboratory findings were shown in Table 1. Data of obesity groups according to BMI classification (Group 1; overweight, groups 2 and 3;obesity, group 4;morbid obesity) are also shown in Table 1. Among the cases enrolled into the study, 78 (35.1%) cases had blood group O, 106 (47.8%) cases had blood group A, 28 (12.6%) cases had blood group B, and 10 (4.5%) cases had blood group AB. Review of Rh factor revealed that 84.7% (n=188) of the participants were Rh-positive and 15.3% (n=34) of them were Rh-negative.

Table 1. Descriptive characteristics and distribution of the blood types

	Min-Max (Median)	Mean ± SD
Age (year)	17-72 (43)	42.2±10.4
Gender, n (%)		
Female	185	83.3
Male	37	16.7
Height (cm)	146-188 (161.5)	162.5 ± 7.9
Weight (kg)	60.9- 220 (119.6)	119.7± 27
BMI (kg/m²)	25.6-77 (44.9)	45.3±9.5
25.0-29.9 (Group1),n (%)	14	6.3
30.0-34.9 (Group 2), n (%)	17	7.7
35.0-39.9 (Group3), n (%)	30	13.5
≥ 40 (Group 4), n (%)	161	72.5
Fat %	4.8-57.1 (46.5)	45.3±7
FM (kg)	18-89.7 (55)	54.3±15.5
FFM (kg)	42-119.9 (61.5)	63.9±13
FMI (kg/m²)	5.8-37.6 (21.3)	20.8±6
FFMI (kg/m²)	10-37 (23.6)	24.±4
RMR (kcal/day)	890-3844 (1786)	1848.2±456.7
RMR (%)	56-154 (93)	93.5±15.8
ABO Blood Groups, n (%)		
O	78	35.1
A	106	47.8
B	28	12.6
AB	10	4.5
RH Blood Groups, n (%)		
Positive	188	84.7
Negative	34	15.3

There was not any significant difference according to ABO blood groups in terms of age, gender, body weight, fat percentage, fat mass, fat free mass, FMI and FFMI (p>0.05) (Table 2). Evaluation of the descriptive characteristics depending on Rh factor did not reveal any statistically significant difference on age and gender distribution of the cases (p>0.05). Body weight, BMI and fat measurements of the cases according to Rh factor did not any significant difference (p>0.05). FM, FFM, FMI and FFMI measurements of the cases according to Rh factor did not reveal any significant difference (p>0.05) (Table 3).

There was not any statistically significant difference for RMR, RMR% measurements according to the ABO blood groups (p>0.05) (Table 4) and Rh Factor (p>0.05) (Table 5). There was not any statistically significant difference between obesity groups and ABO blood groups as well as Rh factor depending on BMI classification (p>0.05) (Table 6).

Table 2. Distribution of the anthropometric data by blood types

ABO Blood Groups	O (n=78)	A (n=106)	B (n=28)	AB (n=10)	P Value
Age (Year)					
Min-Max (M)	21-61(42.5)	17-66 (43.5)	20-72(43.5)	23-50(44)	a 0.941
Mean ± SD	41.7±9.4	42.4±11	42.9±11.6	40.8±8.2	
Gender, n (%)					
Female	66 (35.7)	85 (45.9)	27 (14.6)	7 (3.8)	b 0.089
Male	12 (32.4)	21 (56.8)	1 (2.7)	3 (8.1)	
Weight (kg)					
Min-Max (M)	60.9-200(125.2)	63.9-220(117)	73.6- 162.5(109.4)	102.1- 162.5(129.5)	c 0.056
Mean ± SD	123.2±27.4	118.2±28	111.8±23.2	130.8±17.3	
BMI (kg/m^2)					
Min-Max (M)	26-70(47)	25.6-77(43.7)	27-63.3(44.2)	40.8-61.2(45.9)	a 0.171
Mean ± SD	46.5±9	44.9±10.3	42.9±8.8	47.8±6.5	
Fat %					
Min-Max (M)	4.8-56(46.5)	22.7-57.1(46.3)	26.7-55.2 (46.4)	35.3-52.7 (49.4)	a 0.895
Mean ± SD	45.4±7.3	45±7	45.8±6.6	46.5±6.4	
FM (kg)					
Min-Max (M)	18-84.6 (56.6)	20.2-89.2 (53.7)	26.5-89.7(51.2)	41.6-85.6(63.5)	a 0.296
Mean ± SD	55.7±15.1	53.2±15.6	52.3±17.1	60.1±12.7	
FFM(kg)					
Min-Max (M)	42.9-96.3 (62.1)	42-119.9 (60.5)	44.9-77.4 (59.3)	53.9-88.1(66.1)	a 0.075
Mean ± SD	65.6±13.8	63.3±13.8	59.6±8.5	69.8±11.1	
FMI (kg/m^2)					
Min-Max (M)	5.8-33.3 (22)	6.1-37.6 (20.8)	9.7-34.8 (19.4)	15.6-32.3 (23)	a 0.369
Mean ± SD	21.1±6	20.5±6.2	20±6.4	23.3±4.4	
FFMI (kg/m^2)					
Min-Max (M)	10-36.9 (24.6)	16.1-37 (22.9)	17.3-32.6 (23.4)	20.5-32.3 (24.4)	a 0.252
Mean ± SD	24.5±4.6	23.9±3.8	22.9±3.7	25.3±3.7	

No significant difference was detected according to ABO blood groups in terms of age, gender, body weight, fat percentage, fat mass, fat free mass, FMI and FFMI (p>0.05)

Table 3. Distribution of anthropometric data by Rh factor

Rh Factor	Positive	Negative	P value
Age (Year)			
Min-Max (M)	17-72 (43.5)	20-64 (43)	c 0.616
Mean ± SD	42.3±10.3	41.3±11.3	
Gender, n (%)			
Female	157 (84.9)	28 (15.1)	d 0.868
Male	31 (83.8)	6 (16.2)	
Weight (kg)			
Min-Max (M)	60.9-220 (119)	65.1-171.6(126.1)	c 0.251
Mean ± SD	118.9±27.3	124.7±25.3	
BMI (kg/m^2)			
Min-Max (M)	25.6-77 (44.7)	26.4-65.9 (45.8)	c 0.458
Mean ± SD	45.1±9.6	46.4±9.2	
Fat %			
Min-Max (M)	22.7-56 (46.3)	4.8-57.1 (47.7)	e 0.210
Mean ± SD	45.4±6.5	45.9±9.7	
FM			
Min-Max (M)	18-85.6 (54.8)	23.1-89.7 (56.1)	c 0.271
Mean ± SD	53.9±15.2	57.2±17.2	
FFM			
Min-Max (M)	42.2-119.9 (61.4)	42-94.7 (63.8)	e 0.538
Mean ± SD	63.9±13.6	63.9±11.3	
FMI			
Min-Max (M)	5.8-34.8 (21.2)	9.3-37.6 (21.7)	c 0.382
Mean ± SD	20.6±5.9	21.7±6.6	
FFMI			
Min-Max (M)	10-37 (23.4)	17-36.9 (23.8)	c 0.984
Mean ± SD	24±4.2	24±3.8	

Rh factor did not reveal any statistically significant difference on age, gender , body weight, BMI, %F, FM, FFM, FMI, FFMI(p>0.05)

Table 4. Distribution of RMR AND RMR% data by ABO blood types

ABO Blood Groups	O (n=78)	A (n=106)	B (n=28)	AB (n=10)	P Value
RMR (kcal/day)					
Min-Max (M)	890-3844(1778.5)	995-1830(1784)	1224-2468 (1751)	1133-3123 (1988)	a 0.96
Mean ± SD	1864.4±527.8	1830.5±417.5	1811.3±342.4	2031.5±568.3	
RMR (%)					
Min-Max (M)	56-133 (92.5)	56-132 (90.5)	75-130 (99.5)	58-154 (86)	a 0.180
Mean ± SD	92.2±15.6	92.9±15.4	98.7±12.8	94.9±26.7	

a Kruskal Wallis Test
No statistically significant difference was detected for RMR, RMR% according to ABO blood groups (p>0.05)

Table 5. Distribution of RMR and RMR% data by Rh factor

Rh Factor	Positive (n=188)	Negative (n=34)	P Value
RMR (kcal/day)			
Min-Max (M)	995-3844(1784)	890-2837 (1842)	c 0.755
Mean ± SD	1844.2±456.6	1870.8±463.9	
RMR (%)			
Min-Max (M)	56-154 (93)	58-124 (89)	c 0.548
Mean ± SD	93.8±15.9	92±15.4	

c Student t Test e Mann Whitney U Test
No statistically significant difference was detected for RMR, RMR% according to the Rh factor (p>0.05)

Table 6. The association of obesity groups (by BMI) with ABO blood groups and Rh factor

	0group (n=78)	A group (n=106)	B group (n=28)	AB group (n=10)	p	Pozitive (n=188)	Negative (n=34)	p
BMI								
Group1	4 (5.1)	85 (7.5)	2 (7.1)	0	b 0.841	13 (6.9)	1 (2.9)	d 0.728
Group2	5 (6.4)	8 (7.5)	4 (14.3)	0		14 (7.4)	3 (8.8)	
Group3	12 (15.4)	15 (14.2)	3 (10.7)	0		27 (14.4)	3 (8.8)	
Group4	57 (73.1)	75 (70.8)	19 (67.9)	10 (100)		134 (71.3)	27 (79.4)	

b Fisher-Freeman-Halton Exact Test
There was not any statistically significant difference between obesity performed by BMI classification and ABO blood groups and Rh factor.(p>0.05)

DISCUSSION

In the present study, we detected that resting metabolic rate did not change according to the ABO blood groups and Rh factor in obese individuals.

Previous studies have shown that resting metabolic rate decreases by age, because ageing decelerates the resting metabolic rate due to decrease of the muscle mass and increase of the fat mass (18). There are studies on resting metabolic rate which changes by weight and BMI. Although some studies suggest that resting metabolic rate increases by weight gain (19), some also assert lower metabolic rate as a cause of weight gain (20). It was shown that metabolic rate increases by the increase of muscle tissue (21). The decrease of energy consumption per muscle weight along with the increase of body weight was demonstrated; however, the opposite was also shown. This was considered to be related whether the muscle is metabolically active (22).

We could not detect any difference between body weight, BMI, fat percent, fat mass and fat free mass according to ABO blood groups and Rh factor in the participants. However, we observed that blood group A revealed the most in our study (47.8%). Similarly, another study also demonstrated that blood group A is more in obese individuals (16), the eating behaviour defined as conscious restriction was more in blood group A than group O (23). It was detected in a previous study that the individuals with blood group B are more vulnerable to obesity (24). There are conflicting results obtained from the studies investigating the association between obesity and blood groups. It is well-known that along with existence of antigens A and B specifically in red blood cells, they are expressed by endodermal epithelial systems including epithelial cells, salivary glands, gastrointestinal system, bronchopulmonary system, urogenital system, and various parenchymal systems including the kidney (25,26). However, they were not detected in the muscle, bone and connective tissue (27). Although blood group antigens are well known as immunological ligands for proteins and germs, the underlying mechanism was not clarified yet (26). The direct association between resting metabolic rate and muscle tissue is well-known. However, we could not obtain a significant result in the present

study which was conducted to see whether blood group antigens in the muscle tissue affect the metabolic rate. We believe that more detailed studies perhaps at molecular level are needed.

In recent studies, rheumatoid arthritis which is an inflammatory disease, were shown to be more common in blood group A and Rh positive individuals (28). Since inflammatory rheumatic diseases are known to be affected by genetic factors, blood groups are determined genetically and do not change with environmental factors, it is thought to have an effect on diseases (29). In a study conducted in elder women and men, the relationship between osteoporosis and osteopenia with blood groups and Rh factor was not shown (30). Another study conducted in postmenopausal women reported that osteoporosis was less common in non-O blood group individuals. It was concluded that the ABO blood group plays an important role in bone mineralization and bone resorption during postmenopausal period. (31).The bone mineral density decreases in osteoporosis by aging, and this is a chronic process (32). However, there is not any data on whether it has an effect on metabolic rate. Further studies with larger patients series are needed on this subject.

In the study conducted on patients with type II diabetes, blood group B was found to be more frequent and no association with the Rh factor was shown (33). In recent years, genome-wide studies show that the ABO blood group antigen affects the inflammatory state in the body. Nucleotide polymorphisms at locus ABO are known to be associated with inflammatory markers such as TNF-α and soluble intercellular adhesion molecule-1 (34). Inflammation was considered to play an important role in insulin resistance, and the relationship between ABO blood group and diabetes may be explained by immunological and genetic factors (33). It is known that ABO antigens in the complex carbohydrate structure have structural variability and act as a potential receptor for pathogenic and non-pathogenic microorganisms, therefore, they can be involved in the pathogenesis of diseases (35). Resting metabolic rates have not been demonstrated in these studies, furthermore, it is unknown whether inflammation affects resting metabolic rate. Moreover, the association between resting metabolic rate and blood groups is unknown. Obesity is a low-grade chronic inflammatory disease (36), previous studies showed the association between obesity and blood group A (16). Although the importance of resting metabolic rate is known in obesity, literature information on the relationship between the metabolic rate and any other inflammatory diseases is very limited. In addition, although there is a relationship between blood groups and inflammatory disease, there is insufficient literature knowledge about its effect on resting metabolic rate.

We also analyzed the association between Rh factor and resting metabolic rate. Carbohydrate structure of ABO antigens and protein structure of Rh antigens are well-recognized (37). Previous studies showed that cancers of skin, esophagus, breast and lung are more in Rh-negative individuals (38). It was demonstrated in a study that obesity is more in Rh-positive individuals (16), and there was an association between opioid addiction and Rh-negative blood group (39). Studies on clinical importance of Rh factor are ongoing, it was found in our study that Rh factor is not effective on resting metabolic rate in obesity.

LIMITATIONS

Inclusion of obese individuals only without any control group is limitation of the present study.

CONCLUSION

The results obtained from the studies about effect of resting metabolic rate on obesity indicate multifactorial pattern of obesity. Although former studies addressed that decrease of resting metabolic rate is a factor on weight gain, recent studies showed the increase of metabolic rate by weight increase; this fact points out the necessity of further studies on this topic. We could not obtain any significant finding in the present study which was planned to detect whether the variability of blood groups is effective on resting metabolic rate. We designed this study on obese patients only, therefore, we consider to develop the study by adding a control group. We believe that more detailed and probably molecular studies are needed.

Conflict of interest : The authors declare that they have no competing interest.

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Ethical approval: The approval of Human Ethics Committee of Marmara University (Decision number: 09.2018.357) was obtained.

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