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Evaluation of Bone and Body Mineral Profile in Association with Protein Content, Fat, Fat-Free, Skeletal Muscle Tissues According to Obesity Classification among Adult Men

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Abstract**—**Obesity is associated with increased fat mass as well as fat percentage. Minerals are the elements, which are of vital importance. In this study, the relationships between body as well as bone mineral profile and the percentage as well as mass values of fat, fat-free portion, protein, skeletal muscle were evaluated in adult men with normal body mass index (N-BMI), and those classified according to different stages of obesity. A total of 103 adult men classified into five groups participated in this study. Ages were within 19-79 years range. Groups were N-BMI (Group 1), overweight (OW) (Group 2), first level of obesity (FLO) (Group 3), second level of obesity (SLO) (Group 4) and third level of obesity (TLO) (Group 5). Anthropometric measurements were performed. BMI values were calculated. Obesity degree, total body fat mass, fat percentage, basal metabolic rate (BMR), visceral adiposity, body mineral mass, body mineral percentage, bone mineral mass, bone mineral percentage, fat-free mass, fat-free percentage, protein mass, protein percentage, skeletal muscle mass and skeletal muscle percentage were determined by TANITA body composition monitor using bioelectrical impedance analysis technology. Statistical package (SPSS) for Windows Version 16.0 was used for statistical evaluations. The values below 0.05 were accepted as statistically significant. All the groups were matched based upon age ($p > 0.05$). BMI values were calculated as 22.6 ± 1.7 kg/m^2, 27.1 ± 1.4 kg/m^2, 32.0 ± 1.2 kg/m^2, 37.2 ± 1.8 kg/m^2, and 47.1 ± 6.1 kg/m^2 for groups 1, 2, 3, 4, and 5, respectively. Visceral adiposity and BMR values were also within an increasing trend. Percentage values of mineral, protein, fat-free portion and skeletal muscle masses were decreasing going from normal to TLO. Upon evaluation of the percentages of protein, fat-free portion and skeletal muscle, statistically significant differences were noted between NW and OW as well as OW and FLO ($p < 0.05$). However, such differences were not observed for body and bone mineral percentages. Correlation existed between visceral adiposity and BMI was stronger than that detected between visceral adiposity and obesity degree. Correlation between visceral adiposity and BMR was significant at the 0.05 level. Visceral adiposity was not correlated with body mineral mass but correlated with bone mineral mass whereas significant negative correlations were observed with percentages of these parameters ($p < 0.001$). BMR was not correlated with body mineral percentage whereas a negative correlation was found between BMR and bone mineral percentage ($p < 0.01$). It is interesting to note that mineral percentages of both body as well as bone are highly affected by the visceral adiposity. Bone mineral percentage was also associated with BMR. From these findings, it is plausible to state that minerals are highly associated with the critical stages of obesity as prominent parameters.

Keywords**—**Bone, men, minerals, obesity.

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I. Introduction

OBESITY is a well-known public health problem throughout the world. It is associated with a low-grade inflammation and may lead to chronic diseases such as diabetes mellitus, metabolic syndrome, cardiovascular diseases, and certain types of cancer. Although it is a life-threatening clinical problem, beneficial effects of obesity on bone health were being reported. Some studies confirmed that increased BMI is associated with higher bone mineral density (BMD) [1], [2]. It is also reported that individuals have higher bone mineral content (BMC) and BMD in obese children and adults [1]-[4]. All have the common point of view related to the evidence suggesting that excess fat accumulation may have beneficial effects on particularly weight-bearing bones by way of mechanical loading such as increased weight. However, there are reports opposing this view. In experimental studies, fat accumulation has been shown to impair bone health [5], [6]. Another study reported that certain types of bone fracture rates increase in obese individuals [7].

BMD and BMC are two related bone measures. Generally, dual-energy X-ray absorptiometry scanning is used to determine BMD. BMC was calculated from BMD and bone area. Body composition monitors using bioelectrical impedance analysis technology also report body mineral content and BMC. In a very recent sophisticated study published in 2019 [8], researchers have discussed these opposing views and suggested that bone health might gain little from obesity, if there is any, through its added weight.

Since there are discrepancies on the topic discussing the effects of obesity on bone health, further studies are needed to bring the matter into the light. Therefore, in this study, mass and percentage values of body mineral, bone mineral, fat, protein, fat-free portion and skeletal muscle contents were investigated and their associations with some obesity-related parameters were introduced.

II. Patients and Methods

A. Patients

The study population comprised 103 healthy adult men. Anthropometric measurements were performed. BMI values were calculated. The study was approved by Namik Kemal University, Faculty of Medicine, non-interventional ethical committee. Written informed consent forms were filled by the individuals participated in the study.

B. Obesity Classification

Based upon their BMI values [9], five groups were created; being individuals with N-BMI (Group 1: 18.5-24.9 kg/m^2), OW (Group 2: 25.0-29.9 kg/m^2), FLO (Group 3: 30-34.9 kg/m^2), SLO (Group 4: 35-39.9 kg/m^2) and TLO (Group 5: 40 kg/m^2 <).

C. Technical Information

Obesity degree, body fat mass, body fat percentage, fat-free mass, fat-free percentage, skeletal muscle mass, skeletal muscle percentage, protein content, protein percentage, body mineral content, body mineral percentage, BMC, bone mineral percentage, and visceral adiposity values were registered with body composition monitor (Body Composition Analyzer, Tanita Corp., Tokyo, Japan).

D. Evaluation of the Study Data

Data were evaluated using the statistical package SPSS for Windows, Version 16.0. Mean ± standard deviation (SD) values were calculated. Analysis of variance and post hoc Tukey tests were used. Pearson's and Spearman's rho correlation analyses were performed based upon the type of the data distribution. Scatterplot analyses were performed. Graphics were plotted with a linear regression line. A p level of ≤ 0.05 was accepted as the degree of statistically significant difference.

III. Results

The ages varied between 19 to 79 years. Mean ± SD values for the age of study population were calculated as 47.1±16.9 years. This value was obtained as 49.7 ± 17.7, 47.3 ± 17.2, 42.0 ± 14.9, 43.4 ± 18.5, and 48.0 ± 10.9 for groups 1, 2, 3, 4, and 5, respectively.

Obesity-related parameters tabulated according to different obesity classes were shown in Table I.

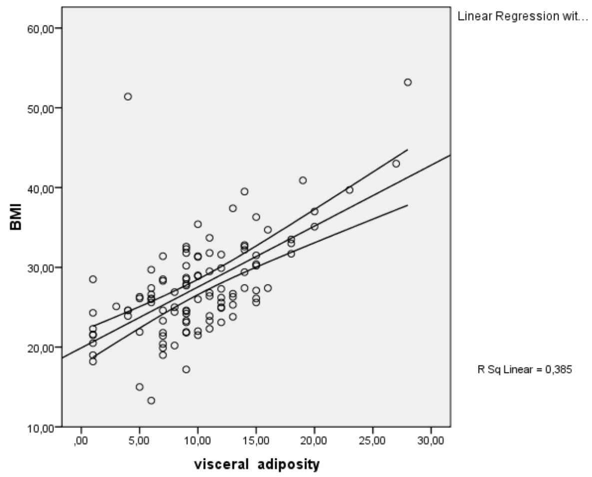
TABLE I
Obesity-Related Parameters Based on Obesity Classification

Parameter	MEAN ± SD				
	Group 1	Group 2	Group 3	Group 4	Group 5
BMI	22.6±1.7	27.1±1.4	32.0±1.2	37.2±1.8	47.1±6.1
Obesity degree	- 3.7±16.6	13.7±13.6	38.5±18.6	56.4±16.0	95.2±31.7
Visceral adiposity	7.1±3.6	9.7±3.7	12.7±3.4	16.4±4.7	19.5±11.1
Fat %	17.5±10.0	21.9±4.1	27.9±2.9	31.0±3.6	38.1±4.5
Fat-free %	84.1±5.6	78.1±4.1	72.1±2.9	69.0±3.6	61.9±4.5
Protein %	17.2±1.3	15.7± 1.0	14.4±0.6	13.8±0.5	12.3±0.9
Skeletal muscle %	47.6±3.2	44.2±2.4	40.8±1.7	39.2±2.0	35.1±2.5
Body mineral %	5.3±0.6	5.2±0.6	4.9±0.6	4.7±0.6	4.4±0.5
Bone mineral %	3.8±0.4	3.5±0.3	3.3±0.2	3.2±0.2	3.0±0.2

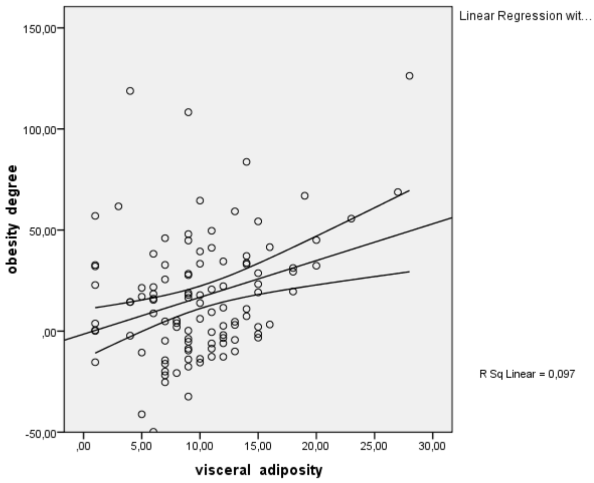
Similar increasing profiles were observed for BMI, obesity degree, body fat percentages whereas decreasing patterns were detected for the percentages of fat-free, protein, skeletal muscle, body mineral, and BMC.

BMR values were 1637 ± 183 kcal, 1864 ± 213 kcal, 2097 ± 295 kcal, 2359 ± 305 kcal, 2725 ± 351 kcal in Groups 1, 2, 3, 4 and 5, respectively.

Fig. 1 shows the correlations between visceral adiposity and (a) BMI (r = 0.621) as well as (b) obesity degree (r = 0.311).



(a)



(b)

Fig. 1 Correlations between visceral adiposity and (a) BMI as well as (b) obesity degree

A stronger correlation was detected for the association between visceral adiposity and BMI.

Fig. 2 shows another aspect of visceral adiposity. In Fig. 2 (a), its correlation with BMC, in Fig. 2 (b) its correlation with bone mineral percent were displayed.

As far as the associations between visceral adiposity and BMC as well as bone mineral percentage were considered,

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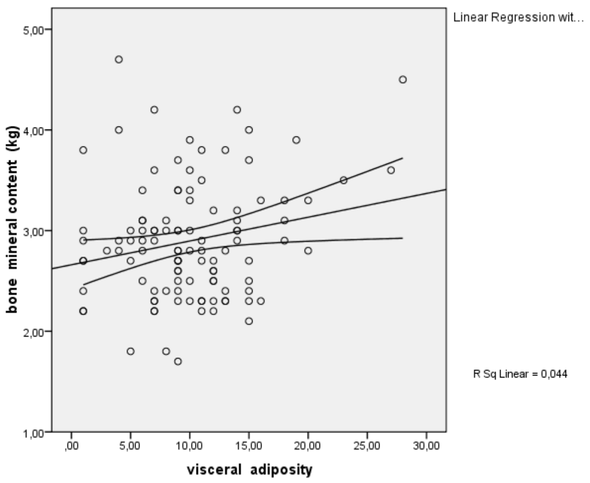
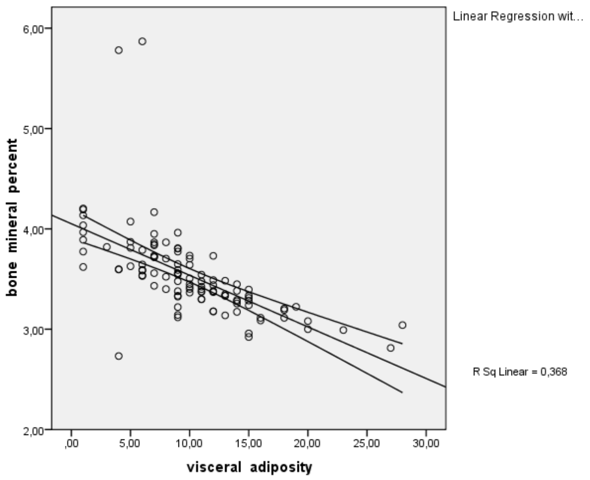
correlations were calculated as (r=0.210) and (-0.607), respectively.



(a)



(b)

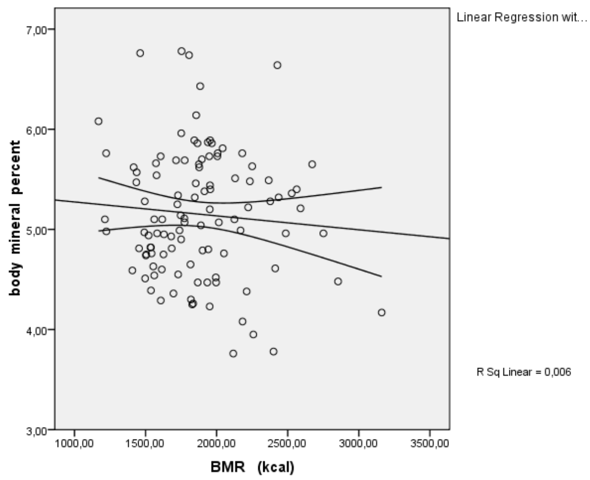
Fig. 2 Correlations between visceral adiposity and (a) BMC as well as (b) bone mineral percentage

In Fig. 3, correlations of BMR with body mineral percentage as well as bone mineral percentage were exhibited.

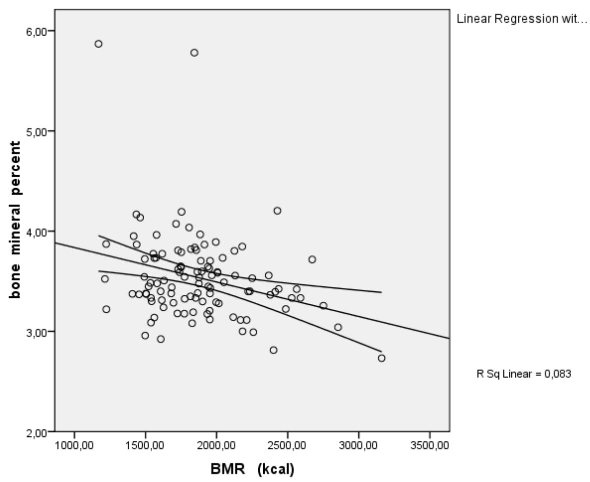
No statistically significant correlation could be obtained between BMR and body mineral percent in Fig. 3 (a) whereas a strong negative correlation was observed between BMR and bone mineral percent in Fig. 3 (b).

IV. Discussion

Studies on bone health are being carried out based upon gender difference [10]-[16]. Differences between pre- and post-menopausal women must also be considered [8]. Higher BMD and BMC were reported in OW and obese children [1], [2]. There are also some conflicting data on BMD as well as BMC [8], [17]-[20]. In a recent study performed on obesity and bone health, BMD showed positive associations with BMI whereas area-adjusted BMC, which was suggested to assess the volumetric density better than BMD, did not show such an association even for weight-bearing bones [8]. In our study, body and BMC as well as percentage values of these parameters were introduced. However, although significant differences between NW-OW and OW-FLO were observed for the percentages of protein, fat-free portion and skeletal muscle, such a profile could not be observed for body as well as bone mineral percentages.



(a)



(b)

Fig. 3 Correlations between BMR and (a) body mineral percentage as well as (b) bone mineral percentage

Visceral adiposity and the relationships between this parameter and BMI/obesity degree as well as body/bone mineral content have also been examined. Both BMI and obesity degree were correlated with visceral adiposity. However, BMI had the superiority over obesity degree.

A rather weak positive correlation existed between visceral adiposity and BMC. However, a very strong negative correlation was observed between visceral adiposity and bone mineral percentages. Bone mineral percentage had the superior correlation against the BMC. From the data, bone mineral percentage is a better indicator of obesity, decreasing with the increasing obesity.

As far as BMR values were concerned, there was no statistically significant correlation between body mineral percent and BMR. On the other hand, a strong negative correlation was found between bone mineral percentage and BMR. In a similar manner, bone mineral percentage exhibited a decreasing profile with the increasing BMR profile, which is the case in the increasing obesity state.

Both elevated visceral adiposity and BMR are the indicators of late obesity. In this study, it was concluded that bone mineral percentage value, a parameter, which is easy to obtain, may be suggested as a predictor of determining obesity development.

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