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Evaluation of the Weight-Based and Fat-Based Indices in Relation to Basal Metabolic Rate-to-Weight Ratio

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***Abstract*—**Basal metabolic rate is questioned as a risk factor for weight gain. The relations between basal metabolic rate and body composition have not been cleared yet. The impact of fat mass on basal metabolic rate is also uncertain. Within this context, indices based upon total body mass as well as total body fat mass are available. In this study, the aim is to investigate the potential clinical utility of these indices in the adult population. 287 individuals, aged from 18 to 79 years, were included into the scope of the study. Based upon body mass index values, 10 underweight, 88 normal, 88 overweight, 81 obese, and 20 morbid obese individuals participated. Anthropometric measurements including height (m), and weight (kg) were performed. Body mass index, diagnostic obesity notation model assessment index I, diagnostic obesity notation model assessment index II, basal metabolic rate-to-weight ratio were calculated. Total body fat mass (kg), fat percent (%), basal metabolic rate, metabolic age, visceral adiposity, fat mass of upper as well as lower extremities and trunk, obesity degree were measured by TANITA body composition monitor using bioelectrical impedance analysis technology. Statistical evaluations were performed by statistical package (SPSS) for Windows Version 16.0. Scatterplots of individual measurements for the parameters concerning correlations were drawn. Linear regression lines were displayed. The statistical significance degree was accepted as $p < 0.05$. The strong correlations between body mass index and diagnostic obesity notation model assessment index I as well as diagnostic obesity notation model assessment index II were obtained ($p < 0.001$). A much stronger correlation was detected between basal metabolic rate and diagnostic obesity notation model assessment index I in comparison with that calculated for basal metabolic rate and body mass index ($p < 0.001$). Upon consideration of the associations between basal metabolic rate-to-weight ratio and these three indices, the best association was observed between basal metabolic rate-to-weight and diagnostic obesity notation model assessment index II. In a similar manner, this index was highly correlated with fat percent ($p < 0.001$). Being independent of the indices, a strong correlation was found between fat percent and basal metabolic rate-to-weight ratio ($p < 0.001$). Visceral adiposity was much strongly correlated with metabolic age when compared to that with chronological age ($p < 0.001$). In conclusion, all three indices were associated with metabolic age, but not with chronological age. Diagnostic obesity notation model assessment index II values were highly correlated with body mass index values throughout all ranges starting with underweight going towards morbid obesity. This index is the best in terms of its association with basal metabolic rate-to-weight ratio, which can be interpreted as basal metabolic rate unit.

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I. Introduction

OBESITY is a public health and clinical problem. Anatomic, physiologic, biochemical, histologic, metabolic, immunologic, endocrinologic alterations are only a few pathologic signs associated with an obese individual. Due to such a complex nature of obesity, obesity indices and their associations with the parameters obtained within the scope of body composition analyses gained importance to be able to find those with the best agreement among them.

Performances of weight- and fat-based indices were examined for the purpose. Although there are some opposing ideas against the use of body mass index (BMI) [1]-[3], it is the most widely used index. This index is based upon body weight as well as height. In recent years, two new indexes; diagnostic obesity notation model assessment index I and diagnostic obesity notation model assessment index II, have been introduced [4], [5] and their accordance with BMI as well as basal metabolic rate-to-weight were investigated.

Body fat mass is the actual weight of fat in your body. Body fat percentage is the proportion of fat to the total body weight. Reducing excess levels of body fat has been shown to directly reduce the risk of certain conditions such as high blood pressure, heart disease, type 2 diabetes and certain cancers.

Visceral adipose tissue (VAT) is located deep in the core abdominal area, surrounding and protecting the vital organs and is associated with increased risk of developing life-threatening diseases. Even if body weight and fat remains constant, as the age increases, fat may shift to the abdominal area. Even if an individual has low body fat rate, however, still may have a high visceral fat level.

Visceral fat is the fat that is in the internal abdominal cavity, surrounding the vital organs in the trunk area. Healthy levels of visceral fat may reduce the risk of certain diseases such as diabetes mellitus, high blood pressure and heart diseases. Visceral fat rates from 1 to 59. Rating from 1 to 12 indicates a healthy level of visceral fat. Rating from 13 to 59 indicates an excess level of visceral fat [6], [7].

Metabolic age compares your basal metabolic rate (BMR) to an average for your age group. This is calculated by comparing your BMR to the BMR average of your chronological age group. If your metabolic age is higher than your actual age, it is an indication that you need to improve your metabolic rate. Increased exercise will build healthy muscle tissue, which in turn will improve your metabolic age.

BMR is the daily minimum level of energy required by the body at rest in order to function effectively. Increasing muscle mass will increase the basal metabolism. High BMR increases the number of calories burned and helps to decrease body fat levels. As people age, their metabolic rate changes. Basal metabolism rises during childhood, it peaks at the age of 16 or 17 years, then it starts to decrease gradually [8].

The aim of this study is to evaluate the associations among weight-/fat-based indices and the parameters such as fat percent, visceral fat, metabolic age and BMR.

II. Patients and Methods

A. Patients

Two hundred and eighty seven adults (107 men and 180 women) participated in this study. Obesity classification was performed according to criteria set by World Health Organization [9]. Written informed consent forms were taken from the participants. The non-interventional ethical committee of the University approved the design of the study.

B. Measurements, Ratios and Indices

Anthropometric data were recorded. Both chronological and metabolic ages were obtained. BMR/weight ratios as well as three indices, BMI, diagnostic obesity notation model assessment indices; donma1 and donma2 were calculated from the given data.

C. Methods

Body composition monitor (TANITA Corp. Japan) was used to report metabolic age, visceral adiposity, BMR, BMR/weight, body fat percentage.

D. Statistical Evaluation

The statistical package; SPSS for Windows was used for the evaluation of the study data. Ratios as well as indices have been computed using weight, height, BMR and fat mass of the individuals. Mean ± SD, minimum and maximum values were obtained for each parameter. Correlation and regression tests were performed. Scatterplot graphics were introduced with their linear regression lines. The statistical significance degree was accepted as $p<0.05$.

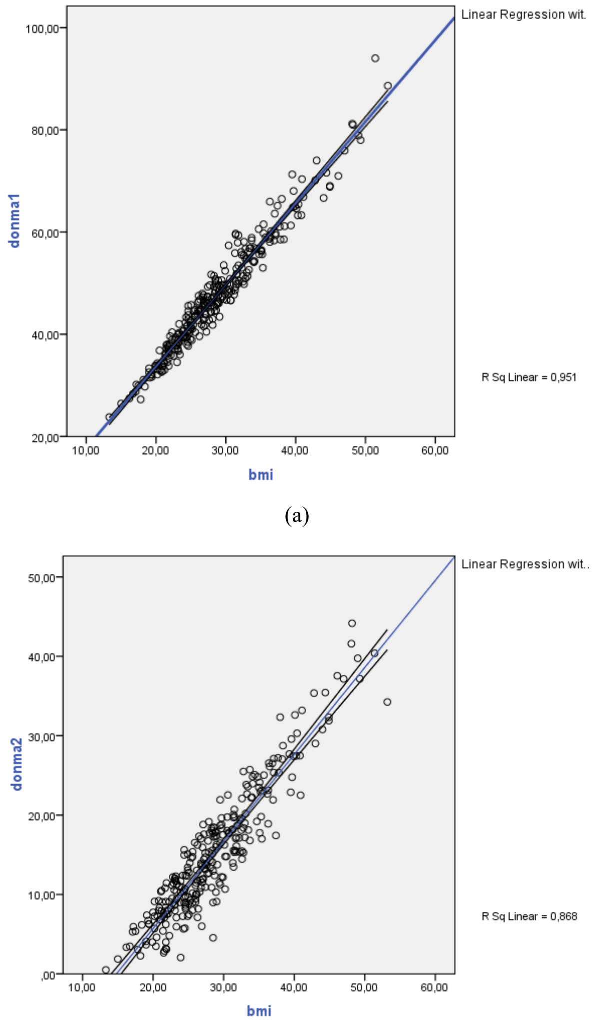
III. Results

Mean age ± SD value of the study population was 43.2±16.0 years. This value for BMI was 28.7±6.9 kg/m^2. Ages vary between 18 and 79 years. The range for BMI was 13.3-53.2 kg/m^2.

Correlations between BMI and DONMA indices were displayed in Figs. 1 (a) and (b).

Very strong correlations (p=0.001) were defined between weight-based BMI and weigth-based donma1 index (r= 0.975) as well as fat-based donma index 2 (r= 0.931).

In Fig. 2, correlations between BMR and the performances of two weight-based indices were compared. In part (a) the correlation of BMR with BMI (r= 0.576) and in part (b) the correlation of BMR with donma 1 (r= 0.975) were shown.



(a)

(b)

Fig. 1 Correlations between BMI and donma indices ((a) donma1 index and (b) donma2 index)

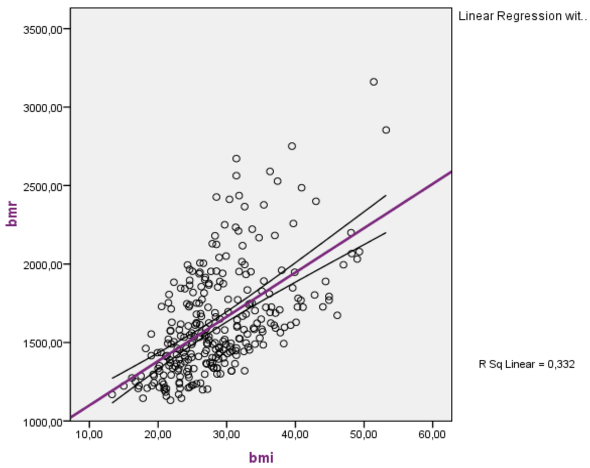
The correlation between BMR and donma1 index was much stronger than the other.

Fig. 3 showed the performances of three indices; two weight-based and one fat-based in relation to BMR/weight. Strong negative correlations existed. The correlations of BMR/weight with BMI, donma1 index and donma2 index were calculated as (r= -0.761), (r= -0.672) and (r= -0.902), respectively.

It was interesting to note that fat-based index donma2 was the superior index over the other weight-based indices; BMI and donma1 index upon consideration of the associations with BMR/weight.

In Fig. 4, associations between fat percentage and (a) BMR/weight as well as (b) donma2 index were shown.

Correlations of fat percentage with BMR/weight and donma2 index were calculated as (r= – 0.938) and (r= 0.878), being negative and positive, respectively.



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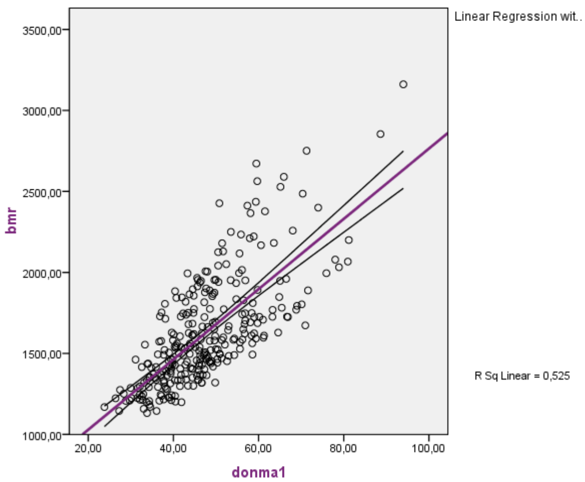
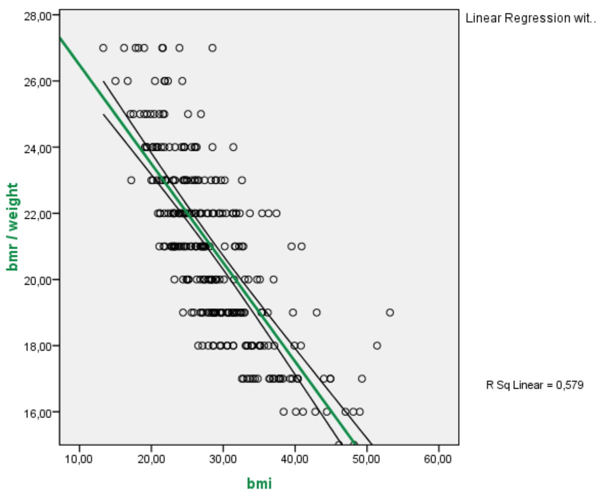


(b)

Fig. 2 Correlations between BMR and (a) BMI as well as (b) donma1 index



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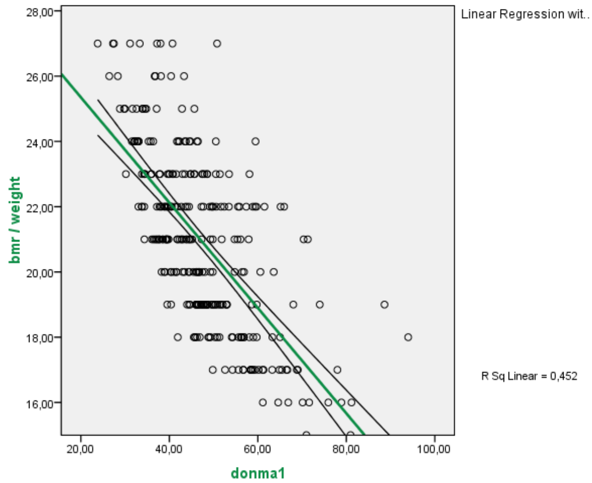

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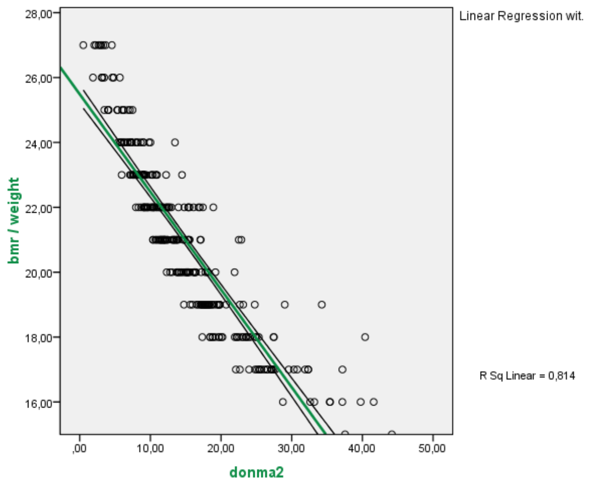

(c)

Fig. 3 Correlations between BMR/weight and (a) BMI, (b) donma1 index, (c) donma2 index

BMR/weight as well as donma2 index; each exhibited a very good performance. They were both consistent with body fat percentage.

In Fig. 5, the correlations between visceral adiposity and chronological age as well as metabolic age were displayed.

The values obtained for these couples were r= 0.603 for chronological age *vs* visceral adiposity, and r= 0.741 for metabolic age vs. visceral adiposity.

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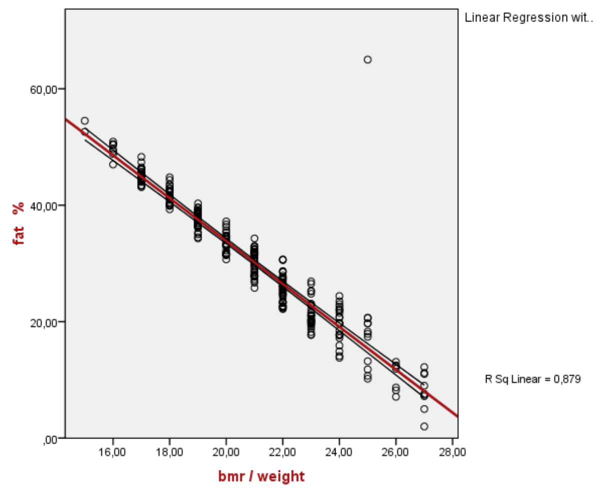

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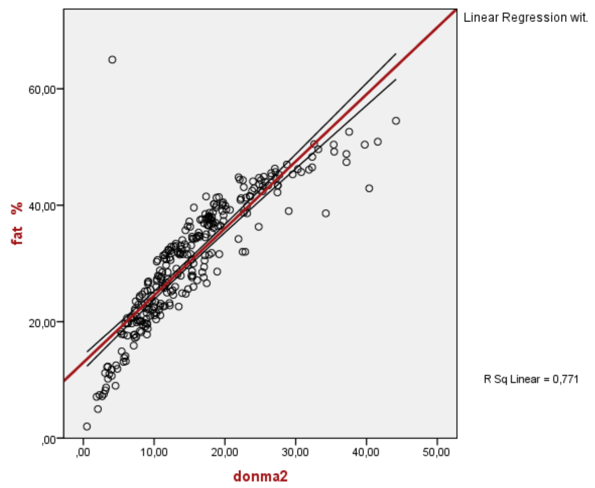
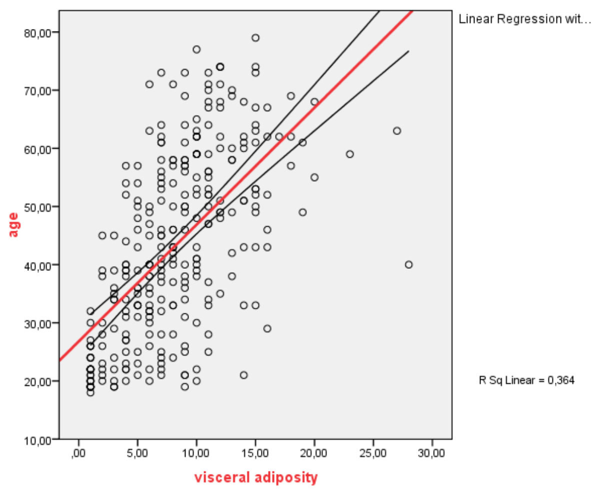


(b)

Fig. 4 Correlations between fat percentage and BMR/weight as well as donma2 index



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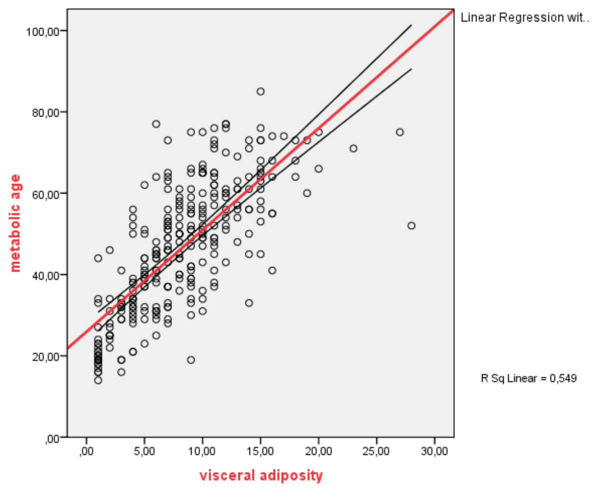

(b)

Fig. 5 Correlations between visceral adiposity and (a) chronological age as well as (b) metabolic age

IV. Discussion

BMI is a good general indicator for population studies but has serious limitations when assessing at an individual level. Body fat scales can help you keep track of your body fat. Increasing muscle mass will speed up BMR. A person with a high BMR burns more calories at rest than a person with a low BMR. It was reported that variations in BMR were not responsible for tendencies toward weight gain [10]. BMR can also be predicted using several formulas [11], [12]. However, in our study, these values were obtained by measurements using bioelectrical impedance analysis technology.

This study enrolled a series of adult individuals. Body composition parameters were evaluated based upon some obesity indices. In this study, it was observed that both donma1 index and donma2 index were in agreement with BMI, being donma1 index with a higher correlation.

Both BMI and donma1 index were positively correlated with BMR, however, the correlation between donma1 index and BMR was much stronger than that between BMI and BMR. Negative associations were observed between BMR/weight and BMI, donma1 index, donma2 index. The best and the strongest correlation existed between BMR/weight and donma2 index. Fat percentage was positively correlated with donma2 index and negatively correlated with BMR/weight.

As the degree of obesity increases, BMR also increased. These findings were confirmed by the results of another study [13].

It was reported that age may be a key feature associated with visceral fat deposition [14]. Body fat and metabolic age are reported as indicators of inflammation and cardiovascular risk. It was suggested that impedance analysis may be incorporated in cardiovascular risk evaluation [1]. Visceral fat can also be measured by impedance technology. As far as chronological and metabolic ages were compared in terms of visceral adiposity, a stronger correlation was observed between metabolic age and visceral adiposity.

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