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Assessment of Obesity Parameters in Terms of Metabolic Age above and below Chronological Age in Adults

Orkide Donma, Mustafa M. Donma

***Abstract*—**Chronologic age (CA) of individuals is closely related to obesity and generally affects the magnitude of obesity parameters. On the other hand, close association between basal metabolic rate (BMR) and metabolic age (MA) is also a matter of concern. It is suggested that MA higher than CA is the indicator of the need to improve the metabolic rate. In this study, the aim was to assess some commonly used obesity parameters, such as obesity degree, visceral adiposity, BMR, BMR-to-weight ratio, in several groups with varying differences between MA and CA values. The study comprises adults, whose ages vary between 18 and 79 years. Four groups were constituted. Group 1, 2, 3 and 4 were composed of 55, 33, 76 and 47 adults, respectively. The individuals exhibiting -1, 0 and +1 for their MA-CA values were involved in Group 1, which was considered as the control group. Those, whose MA-CA values varying between -5 and -10 participated in Group 2. Those, whose MAs above their real ages were divided into two groups [Group 3 (MA-CA; from +5 to + 10) and Group 4 (MA-CA; from +11 to + 12)]. Body mass index (BMI) values were calculated. TANITA body composition monitor using bioelectrical impedance analysis technology was used to obtain values for obesity degree, visceral adiposity, BMR and BMR-to-weight ratio. The compiled data were evaluated statistically using a statistical package program; SPSS. Mean ± SD values were determined. Correlation analyses were performed. The statistical significance degree was accepted as $p < 0.05$. The increase in BMR was positively correlated with obesity degree. MAs and CAs of the groups were 39.9 ± 16.8 *vs* 39.9 ± 16.7 years for Group 1, 45.0 ± 15.3 *vs* 51.4 ± 15.7 years for Group 2, 47.2 ± 12.7 *vs* 40.0 ± 12.7 years for Group 3, and 53.6 ± 14.8 *vs* 42 ± 14.8 years for Group 4. BMI values of the groups were 24.3 ± 3.6 kg/m^2, 23.2 ± 1.7 kg/m^2, 30.3 ± 3.8 kg/m^2, and 40.1 ± 5.1 kg/m^2 for Group 1, 2, 3 and 4, respectively. Values obtained for BMR were 1599 ± 328 kcal in Group 1, 1463 ± 198 kcal in Group 2, 1652 ± 350 kcal in Group 3, and 1890 ± 360 kcal in Group 4. A correlation was observed between BMR and MA-CA values in Group 1. No correlation was detected in other groups. On the other hand, statistically significant correlations between MA-CA values and obesity degree, BMI as well as BMR/weight were found in Group 3 and in Group 4. It was concluded that upon consideration of these findings in terms of MA-CA values, BMR-to-weight ratio was found to be much more useful indicator of the severe increase in obesity development than BMR. Also, the lack of associations between MA and BMR as well as BMR-to-weight ratio emphasize the importance of consideration of MA-CA values rather than MA.

***Keywords*—**Basal metabolic rate, chronologic age, metabolic age, obesity degree.

O. D. is with the Istanbul University Cerrahpasa, Cerrahpasa Medical Faculty, Department of Medical Biochemistry, Istanbul, Turkey (e-mail: odonma@gmail.com).

M. M. D. is with the Namik Kemal University, Faculty of Medicine, Department of Pediatrics, Tekirdag, Turkey (corresponding author, phone: 00-90-532-371-72-07; fax: 00-90-282-250-99-28; (e-mail: mdonma@gmail.com).

I. Introduction

OBESITY prevalence in children, adolescents, adults and in the elderly continues to rise over time. Obesity degree, BMI, visceral adiposity, BMR, BMR-to-weight ratio, fat percentage, MA, and CA are some parameters, which are commonly considered during the evaluation of obesity [1]-[16].

Aging is associated with a progressive remodeling. CA is generally accepted as one of the important risk factors for adverse clinical outcomes. Individuals with the same CA may be in different biological aging states. This may lead to different risk profiles confined to different individuals [13], [17]. Physiological age rather than CA is suggested for the identification of suitable candidates for bariatric surgery. MA score is used as a prognostic factor for weight loss in individuals following bariatric surgery [1], [13].

MA gives the opportunity of comparing a person's CA with that of other individuals. It is generally expected to be higher in obese individuals. In such cases, it is suggested to speed up the metabolism. A lower MA in comparison with the CA of an individual is generally accepted as a sign for a healthy living. Low energy diet has a beneficial effect on reducing body mass, BMI as well as MA [2]-[16], [18].

MA score was proposed as an informative measurement of biological age with possible applications in personalized medicine. Biological age, rather than CA, was reported to be associated with late-life depression [1], [13], [19].

In a recently published report, the weight-based and fat-based indices, BMI, diagnostic obesity notation model assessment indices I and II- in relation to BMR-to-weight ratio, were evaluated. It was reported that all three indices were associated with MA, but not with CA [9].

In a recent study, obesity degree has been evaluated from the points of view of CA as well as MAs. Within this context, it has been concluded that the difference between CA and MA may give more valuable information than CA or MA only, during the evaluation of obesity [2].

The aim of this study was to examine some obesity-related parameters in groups that differ from one another in terms of their MA-CA values and interpret the potential use of this difference in obesity development.

II. Patients and Methods

A. Patients

211 adults were recruited for participation in the study. Ages varied between 18 and 79 years. Informed consent forms were obtained from the participants. The study was carried out according to Helsinki Declarations.

B. Groups

Four groups were constituted. Individuals, whose MA-CA values were -1, 0 and +1 years formed Group 1. Group 2 was composed of adults, whose MA-CA values varied from -5 to -10 years. In Group 3, MA-CA values were between +5 and +10 years. Finally, participants, whose MA-CA values were +11 and +12 years were included into Group 4.

C. Obesity Related Parameters

Ages of the individuals were recorded as CA. M MA, BMI, obesity degree, visceral adiposity, BMR, BMR-to-weight ratio, fat percentage values were determined by bioelectrical impedance analysis technology using TANITA body composition analyzer (Tanita SC-330 Body Composition Analyzer, Tanita Corp., Tokyo, Japan) [15]. Chronological ages, MAs as well as weights and heights of the participants were used to determine indices. BMI and [MA-CA] values were calculated.

D. Statistical Evaluation

A statistical package program, SPSS, was used for the evaluation of the study data. Mean ± SD values of the parameters studied were computed for each individual group. Means of the groups were compared. One-way analysis of variance and post hoc Tukey tests were used. Correlation analyses were performed. Scatterplots with regression lines were drawn. Confidence intervals were added to graphs. A p value less than 0.05 was accepted as statistically significant.

III. Results

In Fig. 1, a strong positive correlation (r = 0.599; p = 0.000) between obesity degree and BMR was shown for the study population.

The mean values ± SD for the difference between MA and CA, MA, CA, BMI, obesity degree, BMR, BMR-to-weight ratio, and fat percentage for the study groups were given in Table I.

Lower MA-CA values in Group 2 and higher values for Group 3 and Group 4 were obtained in comparison with those calculated for Group 1. BMI and fat percentage values were almost the same in Group 1 and Group 2. However, statistically significant increases were observed in Group 3 and Group 4. The lowest obesity degree and BMR were observed in Group 2. An increasing pattern was obtained from Group 1 to Group 3 as well as Group 4. BMR-to-weight values were almost the same in Group 1 and Group 2. However, statistically significant decreases were observed in Group 3 and Group 4. In Group 3, strong correlations were calculated between MA-CA and obesity degree (r = 0.561; p = 0.000), BMI (r = 0.544; p = 0.000), as well as BMR-to-weight ratio (r = - 0.394; p = 0.000) (Figs. 2 (a)-(c)). BMI and BMR-to-weight ratio was also correlated in this group (r = - 0.447; p = 0.000). Similar findings were noted also for Group 4.

TABLE I
Age, BMI, Obesity Degree, BMR, BMR -to-Weight, and Fat Percentage Values of the Groups (mean ± SD)

		Group 1	Group 2	Group 3	Group 4
MA-CA	years	(-1)-(+1)	(-5)-(-10)	(+5)-(+10)	(+11)-(+12)
MA	years	0.11±0.76 39.9±16.8	-6.4±1.4 45.0±15.3	7.2±1.7 47.2±12.7	11.6±0.5 53.6±14.8
CA	years	39.9±16.7	51.4±15.7	40.0±12.7	42.0±14.8
BMI	kg/m^2	24.3±3.6	23.2±1.7	30.3±3.8	40.1±5.1
Obesity Degree	%	10.8±23.7	-5.9±5.1	28.9±16.0	70.1±23.8
BMR	kcal	1599±328	1463±198	1652±350	1890±360
BMR/Weight	kcal/kg	23.0±2.3	22.4±1.3	19.8±1.9	17.5±1.5
Fat	%	23.5±10.1	23.3±4.4	34.5±7.5	43.8±5.4

MA-CA = difference between MA and CA.

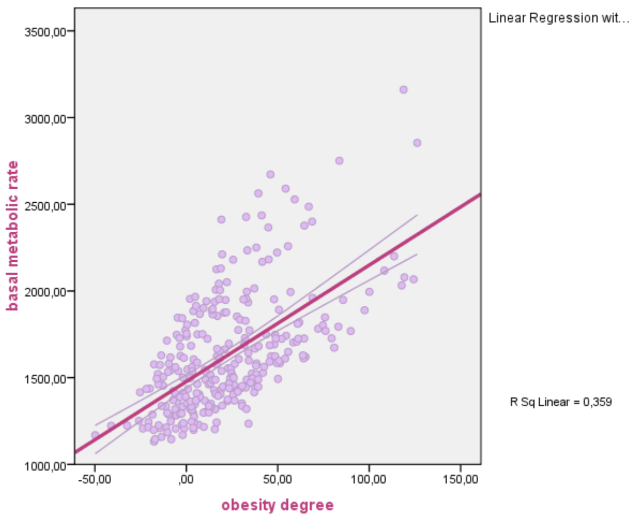

Fig. 1 Correlation between BMR and obesity degree (Linear Regression wit… = Linear Regression with 95.0% Mean Prediction Interval)

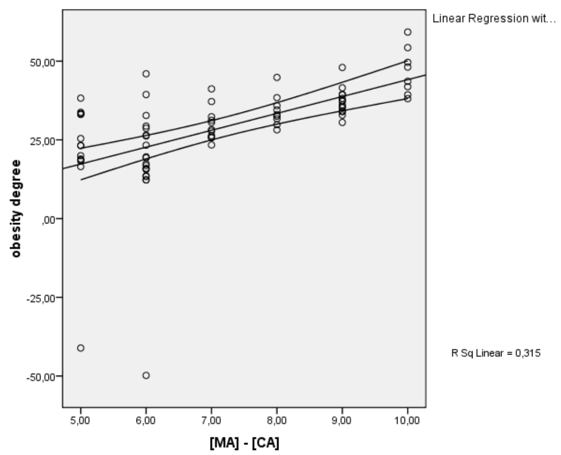

Fig. 2 (a) Correlation between obesity degree and [MA]-[CA] in Group 3 (Linear Regression wit… = Linear Regression with 95.0% Mean Prediction Interval)

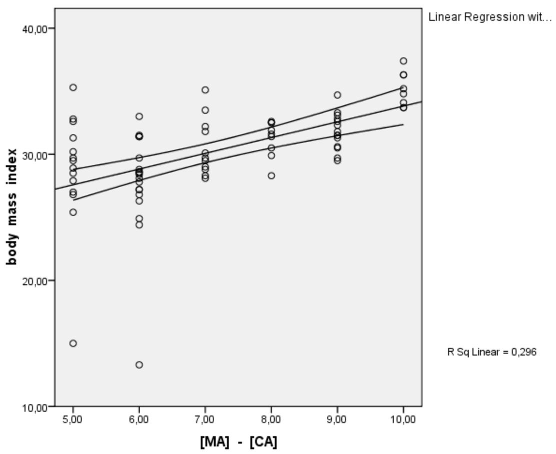

Fig. 2 (b) Correlation between BMI and [MA]-[CA] in Group 3 (Linear Regression wit… = Linear Regression with 95.0% Mean Prediction Interval)

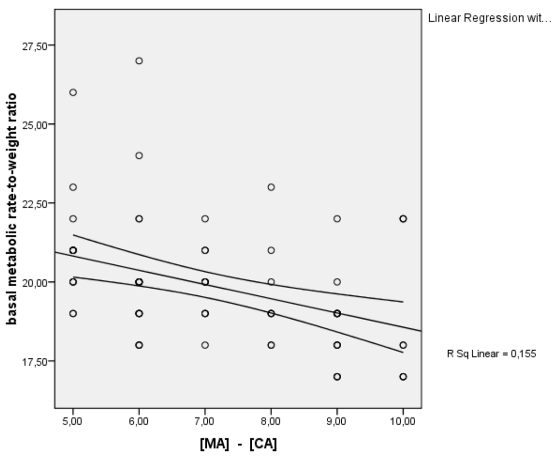

Fig. 2 (c) Correlation between BMR -to-weight ratio and [MA]-[CA] in Group 3 (Linear Regression wit… = Linear Regression with 95.0% Mean Prediction Interval)

Considering fat percentage values, correlations were found between MA-CA and fat percentage values in all groups except in Group 2. The magnitudes of the correlation coefficients were increased as going from Group 1 to Group 4. The correlations were r = 0.287 (p = 0.034), r = 0.404 (p = 0.002), and r = 0.443 (p = 0.000) in Group 1, Group 3, and Group 4, respectively.

IV. Discussion

In this study, groups were created according to their MA-CA values, determined by MAs being above or below CAs of the participants.

MA was always a matter of interest. In 1955, a related report entitled “A Measure of Metabolic Age” was published. So far, this parameter was investigated in many disease states, including obesity, obesity-related diseases, some neurodegenerative diseases [13], [17], [20]-[22].

Obesity is considered within the scope of MA-related diseases. Aside from obesity, MA-related stress triggers also diseases such as diabetes mellitus, metabolic syndrome, non-alcoholic liver diseases and atherosclerosis [21].

MA, along with body fat, were considered as indicators of inflammation and cardiovascular risk [12]. MA was also evaluated in patients with Parkinson’s disease. It was found to be lower in comparison with calendar age in such patients [22].

For the moment, it is not clear yet that the mechanism of MA-remodelling is environmental, genetic or both. However, when healthy centenarians were taken into consideration, it is plausible to think that longer life is associated with a successful MA-remodelling [17].

In a study performed on Portuguese centenarians, the overall mean MA was observed well below CA. In this report, thinness was defined as a factor contributing to longevity, and being overweight may decrease life expectancy [16].

In another study, MA-CA was called as “relative metabolic age (RMA)”. Subjects were divided into two; being young RMA (-12 years) and advanced RMA (+5 years). Younger RMA was found to be associated with a more favorable body composition [23]. A recent study has reported that the difference between CA and MA gave more useful information than CA or MA [2].

In this study, in severely obese groups, MA-CA was correlated with obesity degree, BMI and BMR-to-weight ratio. Also, fat percentage values exhibited an interesting steady-state increasing pattern in obesity groups, which were considered as advanced RMA.

The evaluation of the associations related to MA-CA values showed that BMR-to-weight ratio was more valuable indicator of the obesity development when compared to the performance of BMR. The absence of correlations between MA and BMR as well as BMR-to-weight ratio suggest that MA-CA values instead of MA should be considered during the evaluation of obesity.

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