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THE IMPORTANCE OF SOME NEW CLINICAL INDICES IN THE EVALUATION OF CHILDHOOD OBESITY

Mustafa Metin Donma
Department of Pediatrics, Medical Faculty, Namik Kemal University, Tekirdag, Turkey
mdonma@gmail.com
mdonma@nku.edu.tr

Orkide Donma
Department of Medical Biochemistry, Cerrahpasa Medical Faculty, Istanbul University, Istanbul, Turkey
odonma@gmail.com
donmaohm@istanbul.edu.tr

Abstract

Childhood obesity is a multisystem disease and associated with severe complications. Accurate evaluation requires difficult and detailed investigation. Therefore, assessment of anthropometric measurements and formulas as well as some ratios, is important. The aim of the study is to introduce an obesity index, which is capable of discriminating the children in different obesity grades. A total of two hundred and fifty children were included into the scope of the study. Anthropometric measurements and obesity classification were performed. Waist-to-height, head-to-neck ratios, body mass index (BMI), recently developed indices; "Diagnostic Obesity Notation Model Assessment" (DONMA) Index-I derived from weight and DONMA Index-II derived from fat mass were calculated. Upon evaluation of waist circumference, waist-to-height, head-to-neck ratios, no statistically significant difference was observed between groups. Strong correlations were found between BMI and DONMA Index-I as well as II in all groups. Overlapping patterns were observed for overweight and obese children for waist circumference,

waist-to-height, head-to-neck ratios, BMI and DONMA Index-I. However, DONMA Index-II showed a clear-cut separation between groups; normal weight-overweight and overweight-obese. This study revealed that body ratios and formulas based upon body fat are more valuable parameters than those based on weight for the evaluation of obesity in children.

Key words

Obesity, Childhood, Index, Gender

1. Introduction

Obesity currently becomes one of the leading causes of death and disability throughout the world. The consequences of obesity negatively affect health both in adults and in pediatric population. Childhood obesity may be associated with some short- or long-term problems. Obese children are at high risk for multiple comorbidities affecting all organ systems (Wright & Jones, 2017). The rising prevalence of obesity in children points out severe health problems during adulthood in future years. Overweight/obese children and adolescents are at an increased risk of developing morbid obesity in future years of life. The positive association between being overweight/obese and cardiovascular diseases (CVDs) as well as other chronic diseases is well established (Alpsoy et al., 2013a; Alpsoy et al., 2013b; Alpsoy et al., 2013c, Donma, 2015; Donma, 2016). Obesity is also known to be associated with depressive symptoms (Esmeilzadeh et al., 2016; Donma & Donma, 2010; Donma & Donma, 2017). Therefore, much should be done to protect youth from increasing obesity rates (Wright & Jones, 2017). Exclusive breastfeeding and the diligent care as well as solicitude of primary care givers are some of the preventive measures against the development of obesity among pediatric population (Wright & Jones, 2017; Anggraini, 2017).

2. Scope of the Problem

Obesity indices have recently been a point of interest during the investigation of obesity, risk factors of obesity and obesity-related diseases such as metabolic syndrome, coronary artery disease, acute myocardial infarction and type 2 diabetes (Motamed et al., 2016; Motamed et al., 2017; Mondal & Mishra, 2017; Chua, Zalilah, Haemamalar, Norhasmah, & Geeta, 2017; Patel et al., 2017; Abulmeaty et al., 2017; Tsioufis et al., 2016; Jelavic, Babic & Pintaric, 2017; Liu, Ma, Lou & Zhu, 2016; Tao et al., 2016; Oguoma et al., 2016). So far a great number of studies

have been performed on adults with different obesity grades, however research performed on pediatric population (Ma et al., 2016) is scarce.

There are some body circumferences, ratios, indices used for the evaluation of adiposity. However, there exist also quite a number of controversial studies on the matter. Some studies inform that body mass index (BMI) have no value to predict hypertension (Chua, Zalilah, Haemamalar, Norhasmah, & Geeta, 2017), the incidence of coronary artery disease in patients with essential hypertension (Tsioufis et al., 2016), the low maximal oxygen consumption- a measure of cardiorespiratory capacity (Mondal & Mishra, 2017), clinical severity and prognosis of acute ST- elevation myocardial infarction (Jelavic, Babic & Pintaric, 2017), to identify adults with cardiovascular risk factors (Patel et al., 2017), to determine the best usual discriminator index of obesity to diagnose diabetes mellitus (Motamed et al., 2016). In a similar manner, there are also reports informing waist circumference and waist-to-hip ratio have no predictive value for coronary artery disease with essential hypertension and for the identification of children with elevated blood pressure, respectively (Tsioufis et al., 2016; Ma et al., 2016).

3. Objectives of the study

The development of an obesity index, which is helpful during the evaluation of a child patient, is quite important. This study aims to assess the ability of obesity indices to make the clear-cut separation among children being in different obesity grades.

4. Methodology

4.1 Patients

A total of two hundred and fifty children (06-18 years) consulted to Namik Kemal University, Medical Faculty Hospital, Department of Pediatrics, Outpatient Clinic were included into the scope of the study. Written informed consent forms were obtained from the parents of the children, who were admitted to the study. Namik Kemal University Medical Faculty Ethical Committee has approved the study protocol. The study has been carried out within the scope of Helsinki Declaration.

4.2 Criterias for being normal weight, overweight and obese

World Health Organization BMI –for –age and –sex- percentile values were used for the classification of the study population. Children, whose percentiles were between 84-15th (n=110), 95-85th (n=40) and 99-96th (n=100) were defined as normal weight (NW), overweight (OW) and obese (OB), respectively.

4.3 Measurements

Anamnesis and physical examination were performed. Anthropometric measurements such as weight, height values as well as waist, hip, head, neck circumferences (Cs) and body fat ratios of children participated in the study were recorded.

4.4 Ratio calculations

BMI [body weight (kg)/height (m) * height (m)] values and waist-to-hip (waist C/hip C), head-to-neck (head C /neck C) ratios were calculated.

Within this context, recently developed indices; diagnostic obesity notation model assessment (DONMA) Index-I and DONMA Index II (Donma et al., 2016a; Donma et al., 2016b) were introduced.

DONMA Index- I: [weight (kg) * 100/height (cm)]

and

DONMA Index- II: [total body fat mass (kg) * 100/height (cm)]

were calculated.

They were compared to previously introduced traditional ratios and indices such as BMI, waist-to-hip and head-to-neck ratios.

4.5 Statistical Evaluations

Data were evaluated statistically by using the 20th version of SPSSx software package. Statistics including scatterplot analysis were conducted (NIST-SEMATECH, 2012). The degree for statistical significance was accepted as $p \leq 0.05$.

5. Results

Mean age±SD values of three study groups were calculated as 9.1±2.2 years for NW, 10.9±3.0 years for OW and 11.9±2.3 years for OB children ($p \geq 0.05$). Descriptive statistics for traditional and recently developed indices were calculated in NW, OW and OB children.

Waist C values were measured as 55.2±5.9 cm in NW, 71.7±10.4 cm in OW and 81.8±9.3 cm in OB children. Corresponding values for waist-to-hip ratios were 0.86±0.06, 0.90±0.06 and 0.89±0.07. Head-to-neck ratios were calculated as 1.94±0.13, 1.82±0.22 and 1.73±0.23 in NW, OW and OB groups, respectively. Any significant differences could not be observed between NW-OW and OW-OB groups ($p \geq 0.05$).

BMI values were 15.7±1.1 kg/m^2 for NW, 21.0±2.7 kg/m^2 for OW, 24.7±2.7 kg/m^2 for OB groups ($p \leq 0.05$ for NW *vs* OW, $p \geq 0.05$ for OW *vs* OB). The corresponding values for

DONMA Index-I were 20.4±3.5, 30.5±6.9, 37.9±6.8 ($p \leq 0.05$ for NW *vs* OW, $p \geq 0.05$ for OW *vs* OB) and for DONMA Index- II were 3.4±0.9, 7.4±2.8, 12.3±3.1 ($p \leq 0.05$ for NW *vs* OW, $p \leq 0.05$ for OW *vs* OB).

Strong correlations were observed between BMI and DONMA Index-II in NW children ($r=0.632$, $p \leq 0.01$), in OW children ($r=0.975$, $p \leq 0.01$), and in OB children ($r=0.898$, $p \leq 0.01$) groups. Data were evaluated by scatterplot matrices, which determine if correlations exist between multiple variables. Scatterplot matrix analysis revealed correlations of indices. The data visualization by the scatterplot matrices serve as a tool to find pairwise correlations of indices (Figures 1-3).

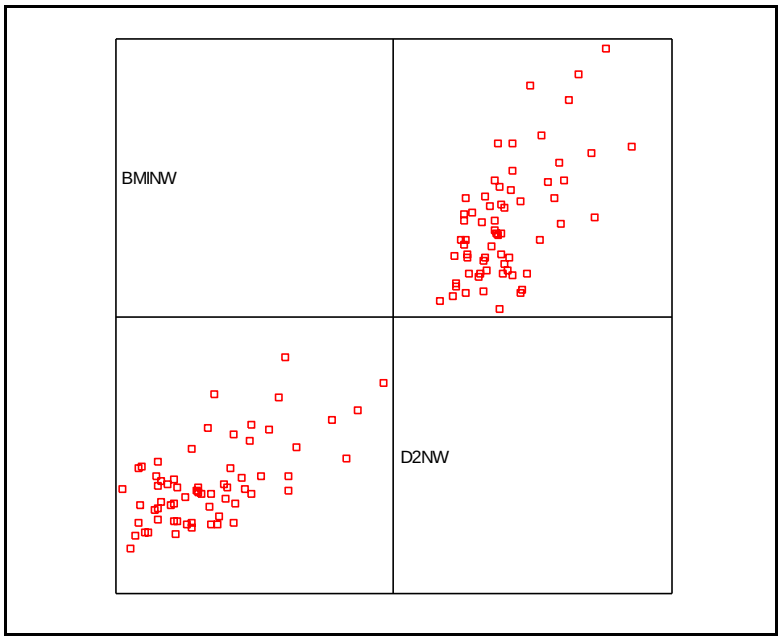

Figure 1: *Scatterplot matrix depicting BMI vs DONMA Index-II (D2) index in NW children*

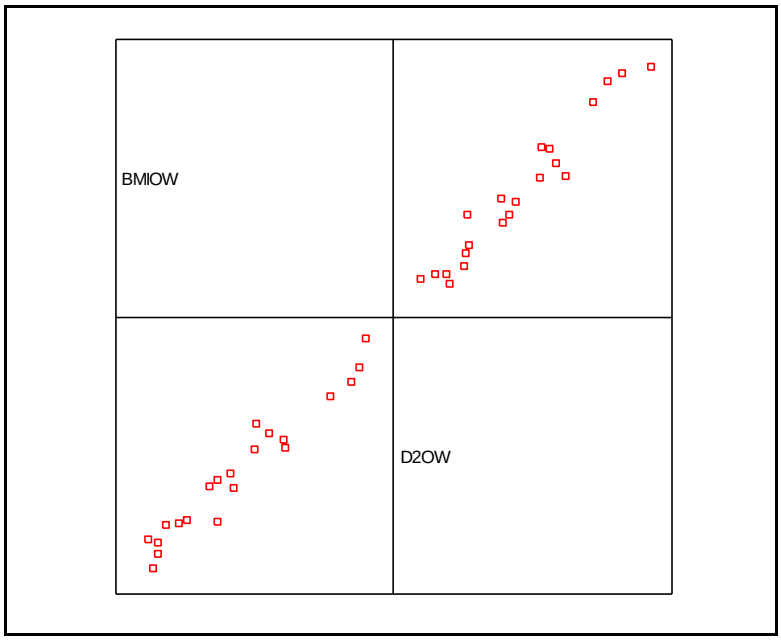

Figure 2: *Scatterplot matrix depicting BMI vs DONMAIndex-II (D2) index in OW children*

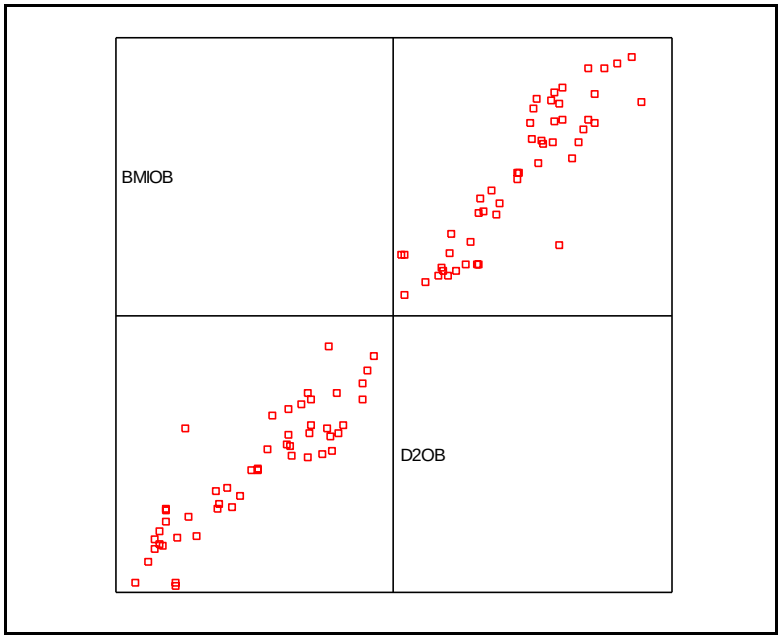

Figure 3: *Scatterplot matrix depicting BMI vs DONMA Index-II (D2) index in OB children*

Figure 4-6 show the distribution of the data displayed by box plots for three indices calculated for NW, OW and OB children.

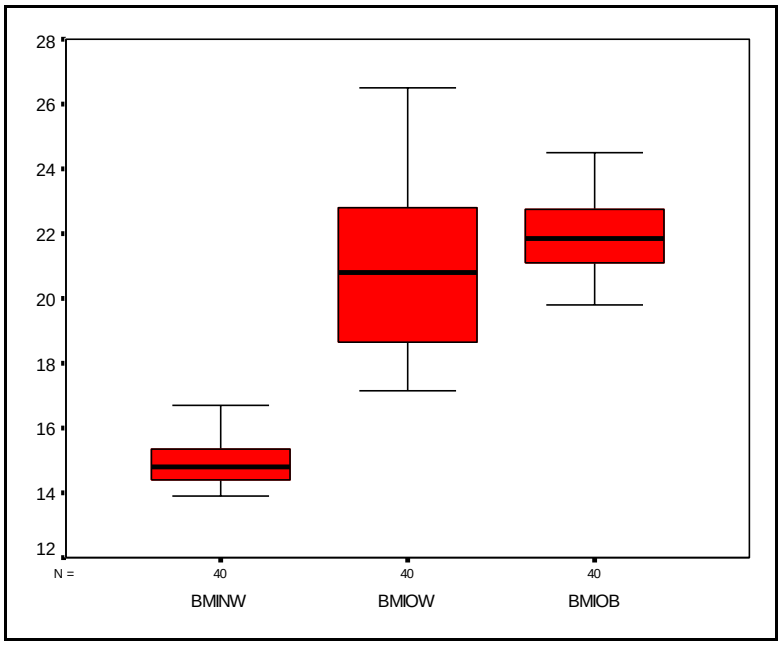

Figure 4: *Comparison of BMI values in NW, OW and OB children*

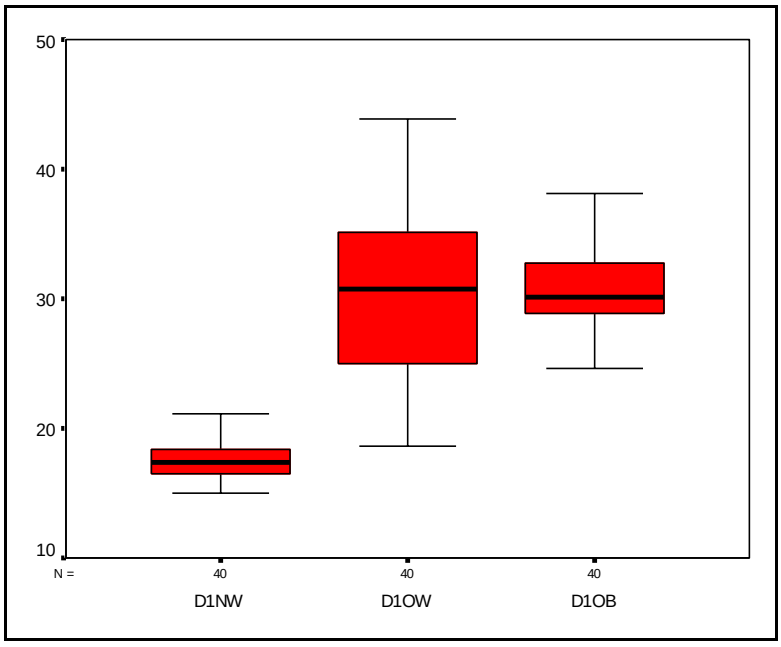

Figure 5: *Comparison of DONMA Index-I (D1) values in NW, OW and OB children*

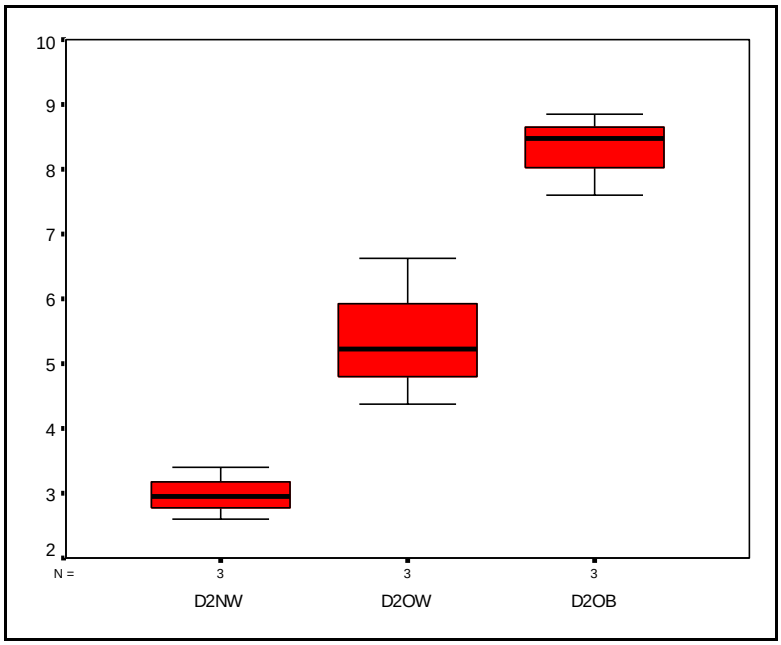

Figure 6: *Comparison of DONMA Index-II (D2) values in NW, OW and OB children*

6. Discussion

In this study, the performance of four commonly used and two recently developed obesity indices were evaluated to identify OW and OB children. Waist circumference, waist-to-hip and head-to-neck ratios are commonly used obesity indices. BMI, which uses overall body weight, is being used for years. It is reported that this index gives particularly a notion about being overweight or obese among adults. However, there are many studies performed on adults that do not recommend BMI, instead propose other obesity indices for various purposes such as prediction of hypertension, cardiovascular disease risk classification or as discriminators of in the diagnosis of metabolic syndrome (Chua, Zalilah, Haemamalar, Norhasmah, & Geeta, 2017; Patel et al., 2017; Motamed et al., 2016; Motamed et al., 2017; Fan et al., 2016). Besides, a very recent study has reported that LDL-cholesterol, which is found to be elevated in obese individuals and also known as a risk factor for CVDs is not associated with BMI or waist circumference (Oda, 2017).

As far as gender differences were considered, while BMI values of NW children did not differ between genders, DONMA Index-II exhibited statistically significant differences between the genders both in NW as well as morbid obese groups (Donma et al., 2016a).

So far, any study evaluating BMI by way of scatterplot matrix analysis has not been detected. This study is the first comparing BMI values with DONMA Index- I as well as

DONMA Index-II. Both of the recently developed indices DONMA Index-I and DONMA Index-II were found to be strongly correlated with BMI values in each group. This pattern is a finding, which emphasizes particularly the value of DONMA Index- II. The scatterplot matrices inform that there are strong pairwise relationships between the variables. Outliers as well as clustering by groups in the data were much less in OW and OB groups in comparison with those observed in NW group.

Since bone mass as well as muscle mass may cause some alterations and deviations from the standards in body weight values, which are used to calculate BMIs of the individuals, use of fat mass values in DONMA Index-II makes this index much more valuable. Besides, upon evaluation of six indices by comparing mean±SD values of each in all of three groups of children emphasized another important aspect of DONMA Index- II. While waist circumference, waist-to-hip, head-to-neck ratios, BMI as well as DONMA Index- I values calculated for NW, OW and OB children were compared, similar overlapping patterns were noted for OW and OB children for all of these indices. However, a preponderance of DONMA Index- II in comparison with other indices was clearly demonstrated upon evaluation of the distribution of the data displayed by box plots for three indices calculated for NW, OW and OB children, because there is a clear-cut separation between groups; NW *vs* OW and OW *vs* OB.

7. Conclusion

In this study, the most commonly used obesity indices were examined to discriminate OW and OB children. This is quite important because there is a great tendency to progress from obese state to morbid obesity, which may easily lead to children with metabolic syndrome. Waist circumference, waist-to-hip ratios, head-to-neck ratios as well as BMI values were evaluated for the purpose. However, discriminating NW from OW and OW from OB children could not be possible using the first three frequently used obesity indices. BMI values showed statistically significant differences between the above mentioned groups. However, BMI and DONMA Index-I based upon body weight were of overlapped values in OW and OB children. Only DONMA Index-II based upon fat mass had the capability for discriminating OW children from the children in obese grade, and therefore, may serve as simple and inexpensive screening tool for the purpose. This finding will lead to the studies, which will be performed on adults with obesity, risk factors of obesity as well as obesity-related diseases such as metabolic syndrome, cardiovascular diseases, diabetes on a much larger population.

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