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The Evaluation of Complete Blood Cell Count-Based Inflammatory Markers in Pediatric Obesity and Metabolic Syndrome

Mustafa M. Donma, Orkide Donma

***Abstract*—**Obesity is defined as a severe chronic disease characterized by a low-grade inflammatory state. Therefore, inflammatory markers gained utmost importance during the evaluation of obesity and metabolic syndrome (MetS), a disease characterized by central obesity, elevated blood pressure, increased fasting blood glucose and elevated triglycerides or reduced high density lipoprotein cholesterol (HDL-C) values. Some inflammatory markers based upon complete blood cell count (CBC) are available. In this study, it was questioned which inflammatory marker was the best to evaluate the differences between various obesity groups. 514 pediatric individuals were recruited. 132 children with MetS, 155 morbid obese (MO), 90 obese (OB), 38 overweight (OW) and 99 children with normal BMI (N-BMI) were included into the scope of this study. Obesity groups were constituted using age- and sex-dependent body mass index (BMI) percentiles tabulated by World Health Organization. MetS components were determined to be able to specify children with MetS. CBC were determined using automated hematology analyzer. HDL-C analysis was performed. Using CBC parameters and HDL-C values, ratio markers of inflammation, which cover neutrophil-to-lymphocyte ratio (NLR), derived neutrophil-to-lymphocyte ratio (dNLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), monocyte-to-HDL-C ratio (MHR) were calculated. Statistical analyses were performed. The statistical significance degree was considered as $p < 0.05$. There was no statistically significant difference among the groups in terms of platelet count, neutrophil count, lymphocyte count, monocyte count, and NLR. PLR differed significantly between OW and N-BMI as well as MetS. Monocyte-to HDL-C value exhibited statistical significance between MetS and N-BMI, OB, and MO groups. HDL-C value differed between MetS and N-BMI, OW, OB, MO groups. MHR was the ratio, which exhibits the best performance among the other CBC-based inflammatory markers. On the other hand, when MHR was compared to HDL-C only, it was suggested that HDL-C has given much more valuable information. Therefore, this parameter still keeps its value from the diagnostic point of view. Our results suggest that MHR can be an inflammatory marker during the evaluation of pediatric MetS, but the predictive value of this parameter was not superior to HDL-C during the evaluation of obesity.

***Keywords*—**Children, complete blood cell count, high density lipoprotein cholesterol, metabolic syndrome, obesity.

Mustafa M. Donma 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).

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

I. Introduction

CBC analysis is a routine hematological test for the evaluation of complete blood picture including the cells that make up blood; erythrocytes, leukocytes and platelets to check for certain diseases and conditions. It is the most commonly ordered blood test.

Aside from counts of major cells, counts and percentages of leukocyte subgroups such as neutrophils, leukocytes, monocytes, eosinophils and basophils were also reported. In addition to these cell counts, parameters such as hemoglobin, hematocrit and the indices related to these three main blood cell types were also obtained. Mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width, mean platelet volume, platelet distribution width, plateletcrit, and platelet larger cell ratio, are some of these indices.

In recent years, ratios obtained from leukocyte subgroups were gaining importance. Among all, NLR was the most popular and frequently studied one [1]-[16]. To some extent, PLR is also being investigated. They were investigated in certain diseases such as obesity, cancer, polycystic ovary syndrome (PCOS), glaucoma, in vitro fertilization outcomes, sleep apnea, melanoma [2], [17]-[20]

LMR was reported for its prognostic value in high-risk papillary thyroid carcinoma [21].

The excessive activation of monocytes exacerbates oxidative stress and inflammation. HDL-C neutralizes the proinflammatory and prooxidant effects of monocytes. The MHR has been investigated in PCOS and in some cardiovascular diseases. It has been reported that MHR may be a useful predictor for PCOS. Elevated MHR associated with smoking may be an indicator of a systemic inflammatory response [22]-[25].

The aim of this study was to investigate which inflammatory marker was the best to evaluate the differences between different obesity groups and MetS.

II. Patients and Methods

A. Patients

Ninety-nine children with N-BMI, 38 OW, 90 OB, 155 MO and 132 children with MetS participated into the study. Written informed consent forms were obtained from the parents of the participants. The Helsinki Declaration was approved.

B. Group Classification

Age- and sex-adjusted BMI percentile tables prepared by World Health Organization [26] were used for the constitution of N-BMI group as well as obesity groups. For the selection of the individuals, who participated in MetS group, MetS components were determined [27]. Fasting blood glucose, triacylglycerol, HDL-C concentrations, systolic blood pressure, diastolic blood pressure values in addition to central obesity were recorded for the purpose.

C. Laboratory Analyses

Values for NLR, dNLR, PLR, LMR, MHR were calculated from neutrophil, lymphocyte, platelet, monocyte counts and HDL-C concentrations. Cell counts were obtained by way of automated CBC analyzer.

D. Statistical Evaluation

Statistical package program SPSS for Windows was used to evaluate the study data. Descriptive statistics and correlation analyses of the parameters studied were performed. Scatter plot linear regression lines were drawn. p value smaller than 0.05 was accepted as the statistical significance degree.

TABLE I
CBC-BASED INFLAMMATORY MARKERS (MEAN ± SD)

	N-BMI	OW	OB	MO	MetS
NLR	1.52 ± 0.90	1.76 ± 1.26	1.46 ± 0.50	1.51 ± 0.65	1.69 ± 1.10
dNLR	1.05 ± 0.69	1.19 ± 0.54	1.10 ± 0.34	1.12 ± 0.42	1.22 ± 0.60
PLR	0.12 ± 0.04	0.15 ± 0.07	0.13 ± 0.04	0.13 ± 0.05	0.12 ± 0.05
LMR	5.14 ± 2.07	4.57 ± 1.58	4.79 ± 1.35	4.75 ± 1.69	4.62 ± 1.74
MHR	12.5 ± 7.9	14.8 ± 11.6	13.3 ± 5.7	13.0 ± 5.0	18.7 ± 9.1
HDL-C	54.7 ± 14.1	49.3 ± 14.1	48.9 ± 14.1	51.8 ± 18.1	40.6 ± 9.1

III. RESULTS

Five hundred and fourteen children were classified into five study groups, being N-BMI, OW, OB, MO and MetS groups. BMI values of the groups were 15.7 ± 1.1 kg/m^2, 21.0 ± 2.7 kg/m^2, 24.7 ± 2.7 kg/m^2, 27.1 ± 3.8 kg/m^2 and 29.0 ± 5.3 kg/m^2, respectively.

Mean ± SD values for the ratios calculated from CBC-based inflammatory markers and HDL-C concentrations in mg/dl for the study groups were shown in Table I.

Fig. 1 demonstrates MHR values calculated for N, OW, OB, MO and MetS groups. All groups except OW differed significantly from MetS ($p < 0.05$).

Fig. 2 shows HDL-C concentrations obtained for N, OW, OB, MO and MetS groups. All groups differed significantly from the MetS group ($p < 0.05$).

Scatterplot regression line drawn between LMR *vs* MHR for the study population was shown in Fig. 3. A significant correlation was found between LMR and MHR ($r = 0.526$; $p < 0.05$), when all of the participants were considered.

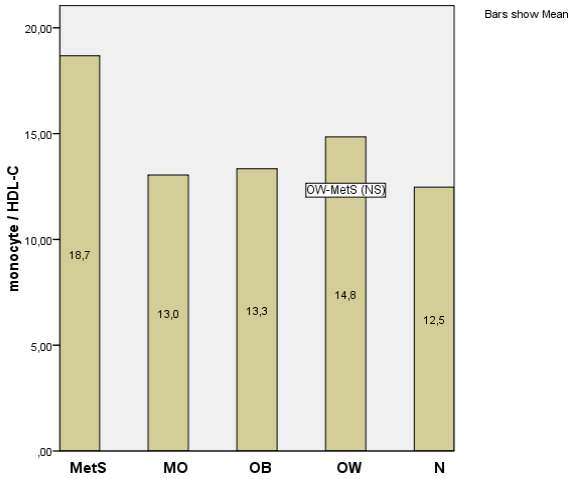

Fig. 1 MHR values of the groups (N = N-BMI, NS = nonsignificant)

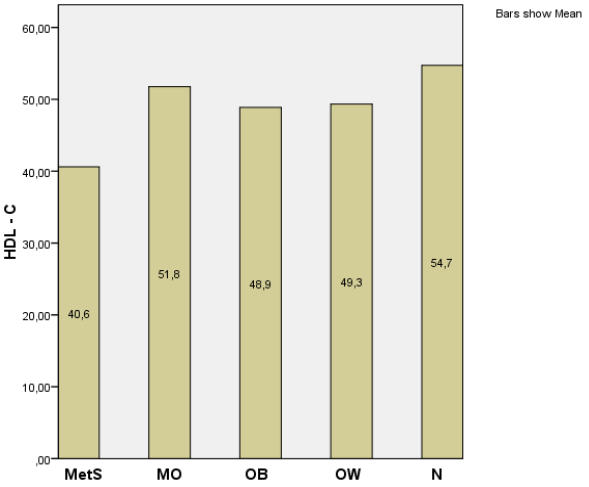

Fig. 2 HDL-C values of the groups (N = N-BMI)

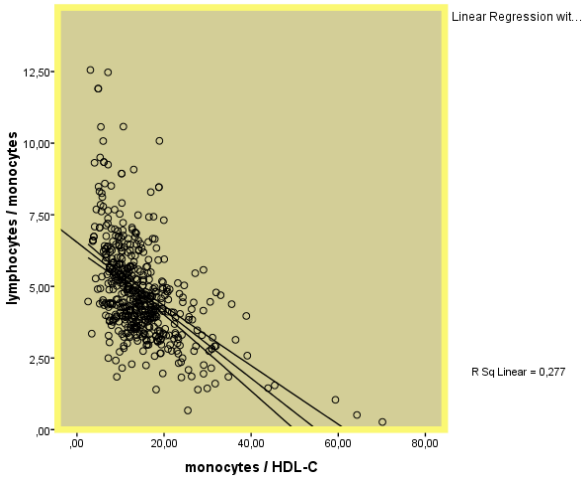

Fig. 3 Scatterplot regression line between lymphocytes-to-monocyte and MHR drawn for the study population (Linear Regression wit… = Linear Regression with 95.0% Mean Prediction Interval)

IV. Discussion

Leukocyte count is the number of white blood cells in a volume of blood. Leukocyte count is comprised of different types of cells differentiated based upon their sizes and shapes. Neutrophils, lymphocytes, monocytes, eosinophils and basophils are the cells in a differential count. Increased or decreased values of these cells give some information related to some certain diseases. Some ratios are being obtained from these parameters. There are some reports suggesting that the ratios are more informative in comparison with the cell counts during the diagnosis and evaluation of these diseases including obesity [1], [25].

NLR was reported as a potential inflammatory biomarker in cardiac disorders, gastrointestinal diseases, and malignancies [2]-[4]. Recent studies have focused on obesity and obesity-related conditions, particularly in pediatric populations. NLR was suggested as a possible marker for chronic inflammation in OB children with MetS [5], [6].

PLR has predicted mortality in patients with malignancies and coronary artery disease [2], [18], [19].

It is found that both NLR and PLR appear to be correlated with some hormonal and metabolic indices. However, they were not affected by obesity [8].

Higher PLR values were reported in young patients with morbid obesity and it was suggested that PLR may be a useful marker in determining an increased thrombotic state and inflammatory response in morbid obesity [17].

In a recently published study, CBC-based inflammatory markers (NLR, dNLR, PLR, LMR and MHR) were investigated in adults with obesity. HDL-C percent was found to be strongly associated with BMI. Inflammatory markers were not associated with BMI, except MHR [1].

In our study, all of these ratios were examined in the pediatric population and none, except MHR, was found to be informative during the evaluation of childhood obesity.

Out of CBC-based inflammatory markers, MHR displayed the best performance to discriminate the groups except OW group from MetS. Upon comparison of this ratio with HDL-C, HDL-C was capable of discriminating all groups from MetS group. Our findings suggest that MHR can be evaluated as an inflammatory marker during the evaluation of pediatric MetS, but the predictive value of this parameter was not superior to HDL-C during the evaluation of obesity.

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