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Original Article

Blood count to determine chronic inflammation severity in obese adolescents

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Abstract

Background Obesity is a growing public health problem of rapidly increasing prevalence in developing countries. Chronic low-grade inflammation plays a key role in the pathophysiology of obesity. Blood count values and ratios have been used as markers of inflammatory diseases. These parameters may be useful to determine the severity of chronic inflammation in obese children.

Objective To determine if red blood cell distribution width (RDW), neutrophil-to-lymphocyte ratio (NLR), mean platelet volume (MPV), platelet distribution width (PDW), and platelet-to-lymphocyte ratio (PLR) can be useful for determining the severity of chronic inflammation in obese children.

Methods This study was conducted in obese adolescents aged 14-18 years at senior high schools in Manado, North Sulawesi, from July to September 2018. Students with congenital anomalies, autoimmune diseases, history of asthma, or malignancy were excluded. Pearson's correlation was used to analyze for potential relationships between obesity and red blood cell distribution width (RDW), neutrophil-to-lymphocyte ratio (NLR), mean platelet volume (MPV), platelet distribution width (PDW), and platelet-to-lymphocyte ratio (PLR).

Results There was a negative relationship between obesity and MPV, but it was not statistically significant (r=-0.006 ; P=0.485). There were positive, but not significant relationships between obesity and RDW (r=0.139; P=0.192), NLR (r=0.155; P=0.166), PDW (r=0.02; P=0.45), and PLR (r=0.146; P=0.181).

Conclusion The RDW, NLR, MPV, PDW, and PLR values are not significantly associated with severity of obesity in adolescents. **[Paediatr Indones. 2020;60:6-12; doi: http://dx.doi.org/10.14238/pi60.1.2020.6-12]**.

Keywords: *obese; blood count; adolescents*

Obesity in children has reached epidemic levels in both developing and developed countries, and is known to have an impact on physical and psychological health. One-third of obese children become obese adults and are more likely to experience chronic inflammatory diseases, such as diabetes mellitus and cardiovascular disease at a young age. In Indonesia, the prevalence of childhood obesity is 11.5%, with overweight and obesity in urban areas twice those in rural areas (10.7 and 5.1%, respectively).[1]

A biomarker is a variable used as an indicator of biological or nutritional conditions. Increased levels of high-sensitivity C-reactive protein (hsCRP) were detected in obese people and were a useful marker of cardiovascular risk for obese children. Because of racial and ethnic variations, a limit of 3 mg/L, based on *Center for Disease Control* (CDC)/*American Heart Association* (AHA), cannot be applied to all people, thus other tests are needed to show inflammatory

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status.[2] Laboratory examinations from routine blood specimens are fast, easy, and inexpensive. The red blood cell distribution width (RDW), neutrophil-to-lymphocyte ratio (NLR), mean platelet volume (MPV), platelet distribution width (PDW), and platelet-to-lymphocyte ratio (PLR) are known as inflammatory markers of complete blood counts.[3]At present, there is no laboratory examination to reliably assess chronic inflammation severity. Red blood cell distribution width is a novel biomarker that describes multiple physiological disorders associated with atherosclerosis and coronary heart disease. The ratio between the number of neutrophils and lymphocytes (neutrophils lymphocytes ratio/NLR) is a simple, cost-effective, and profitable inflammation marker which has been studied in many inflammatory diseases, cardiovascular diseases, and cancer. Mean platelet volume, a component of the routine complete blood count, is a marker of platelet function and activity. Decreased MPV levels have been reported as good indicators of disease activity and inflammatory burden in various inflammatory diseases. Platelet distribution width shows differences in platelet size in circulation, while PLR is the ratio between the number of platelets and lymphocytes. These are novel inflammatory markers, which has been demonstrated to be the predictors of various cardiovascular diseases and tumors.

We aimed to determine if RDW, NLR, MPV, PDW, and PLR can be useful for determining the severity of chronic inflammation in obese adolescents.

Methods

This was an observational study in the form of a correlation with a cross-sectional approach. The study was conducted in senior high schools in Manado from July to September 2018. Laboratory tests were conducted in a Prodia laboratory, a private laboratory. The study subjects were comprised of obese adolescents aged 14-18 years who met the following inclusion criteria: diagnosed with obesity, healthy, and whose parents were willing to sign an informed consent. Exclusion criteria were subjects with congenital abnormalities, autoimmune diseases, history of asthma, or malignancy. The sample size was 41 children, selected by two-stage random sampling. The first stage was a simple randomization from all senior high schools to find the number of high schools representing the population. The sampling stage was carried out by simple random sampling from selected high schools.

The independent variable was obesity, and the dependent variables were RDW, NLR, MPV, PDW, and PLR. Obesity was defined as an abnormality or disease characterized by excessive accumulation of body fat. In our study, body mass index (BMI) was calculated based on commonly used guidelines, according to the *Centers for Disease Control* (CDC) 2000 according to age, sex, weight, and height.[4] Obesity was classified as BMI above the 95% percentile. Obesity severity was determined by a comparison of measured BMI and BMI in the 95th percentile, expressed as a percentage.

Subjects underwent complete blood count examinations, which included the five pertinent parameters. The RDW was an indicator of variation in size and volume of red blood cells,[5] NLR was the ratio of absolute neutrophil count (ANC) to absolute lymphocyte count (ALC),[6] PDW showed differences in platelet size in the circulation,[7] MPV determined platelet function and was a new risk factor in determining atherothrombosis,[8] and PLR was the ratio of platelet count over ALC.[9]

This study was approved by the Health Research Ethics Committee from RSUP Prof. Dr. R.D. Kandou and the Manado City Education Office. Descriptive analyses were shown in the form of tables and graphs. Analysis of possible correlations between obesity and RDW, NLR, MPV, PDW, and PLR was by Pearson's correlation. Results with P values <0.05 were considered to be significant. Data processing was done with *SPSS 25* software.

Results

During the study period, 41 obese children fulfilled the inclusion criteria, consisting of 25 (61%) males and 16 (39%) females. Subjects' mean age was 16.2 years, with a range of 14.33 to 18.33 years. Subjects' mean weight was 80.28 kg, ranging from 64.5 to 109 kg, and mean height was 159.92 cm, ranging from 148 to 180 cm. Mean BMI percentile was 111.68% of the 95th percentile ranging from 100 to 141.2% (**Table 1**).

Table 2 shows the mean, median, minimum, and maximum of the complete blood counts and ratios from the laboratory examinations.

Potential relationships between obesity and RDW, NLR, MPV, PDW, and PLR were analyzed by Pearson's correlation coefficient. A negative relationship trend was observed between obesity and MPV, but it was not significant (r=-0.006, P=0.485) (**Figure 1**).

Pearson's correlation analysis revealed positive but not significant correlations between obesity and RDW, NLR, PDW and PLR (r=0.139, P=0.192; r=0.155, P=0.166; r=0.02, P=0.45; and r=0.146, P=0.181, respectively). The scatter diagrams for each laboratory parameter are shown in **Figures 2, 3, 4,** and **5**.

Table 1. Basic anthropometric characteristics of subjects

Characteristics	Mean	Median (range)
Age, years	16.2	16.25 (14.33-18.33)
Weight, kg	80.28	77 (64.5-109)
Height, cm	159.92	160 (148-180)
BMI/age* %	111.68	107.8 (100-141.2)

*comparison of measured BMI and BMI in the 95th percentile according to age

Table 2. Laboratory results

Parameters	Mean	Median (range)
Hemoglobin, gr/dL	12.1	15.1 (12.7-17.9)
Hematocryte, %	44.4	45.3 (36.7-51.5)
Erythrocytes, 10^6/mm^3	5.4	5.4 (4.3-6.4)
Leukocytes, cells/mm^3	10,398	10,400 (5,500-18,200)
Thrombocytes, /mm^3	361,926	356,000 (230,000-506,000)
RDW, %	12.7	12.6 (11.5-14.9)
NLR	1.7	1.7 (0.8-2.8)
MPV, fL	9.8	8.8 (8.4-11.4)
PDW, fL	10.9	10.6 (8.7-14)
PLR	113.8	107 (55-215)

Discussion

Obesity is defined as a disorder characterized by excessive accumulation of body fat. Obesity has various sequelae related to health, including chronic inflammation.[10] Several blood count values and ratios have been used as indicators of chronic inflammation.[11] A previous study compared RDW in 139 morbidly obese children, 28 overweight children and 82 healthy children of normal weight. This study showed that RDW was significantly higher in

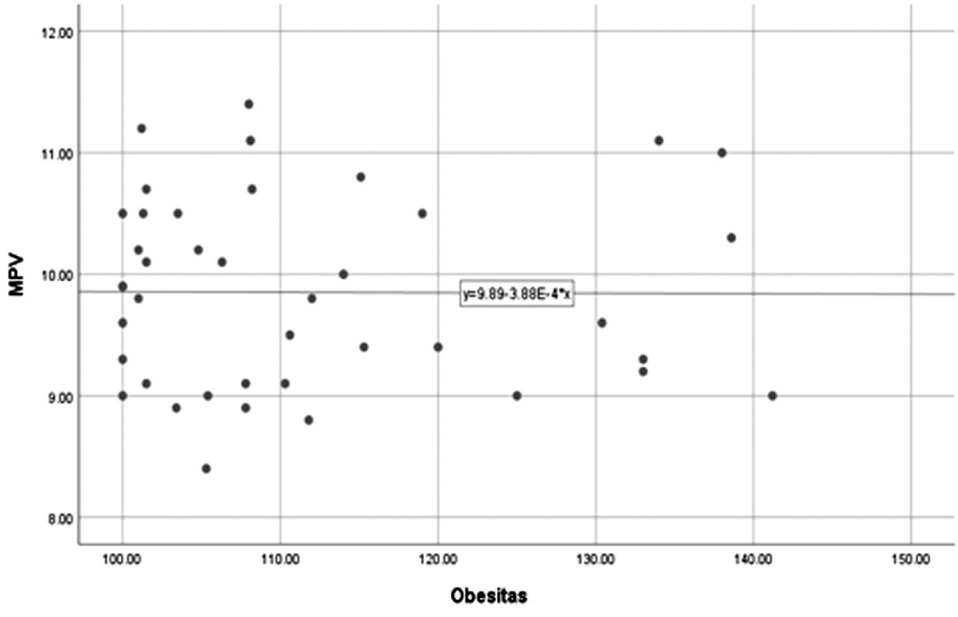

Figure 1. Scatter diagram of the analysis of severity of obesity and MPV

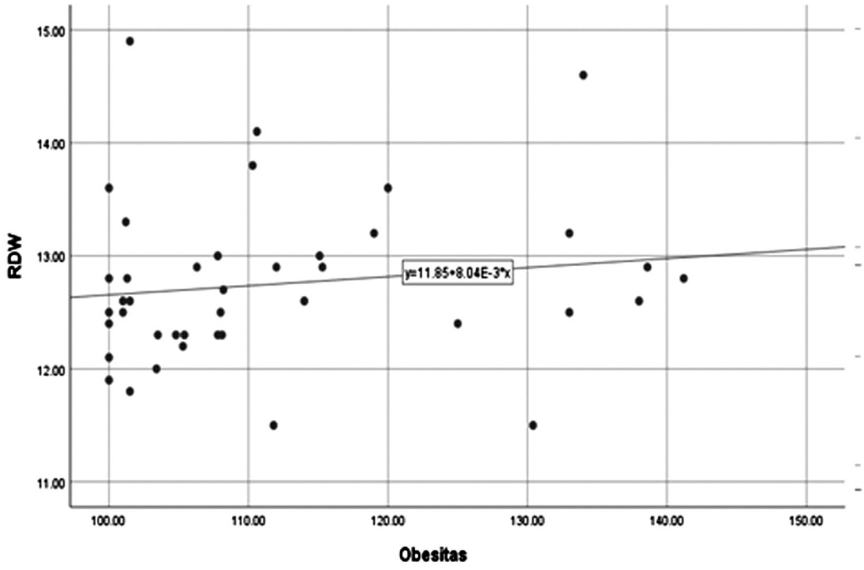

Figure 2. Scatter diagram of the analysis of severity of obesity and RDW

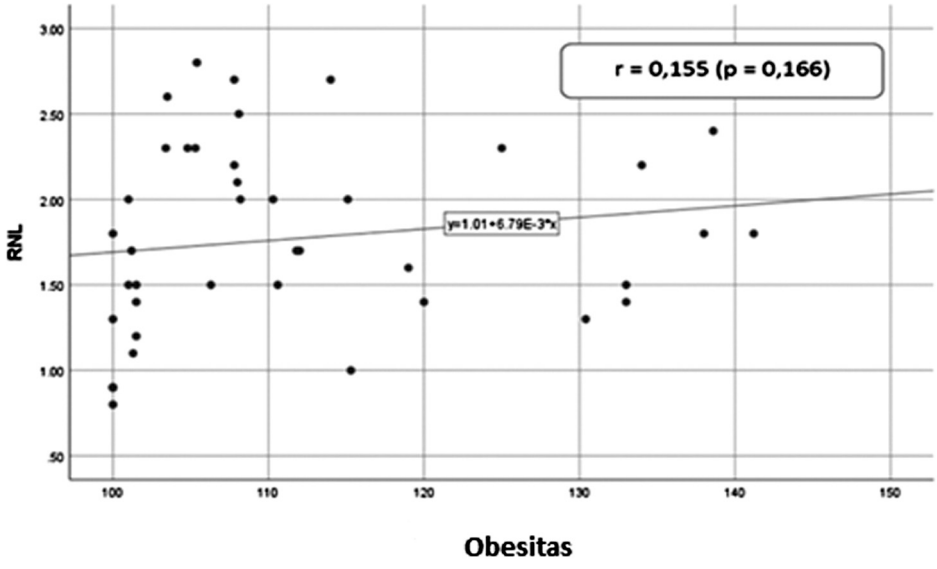

Figure 3. Scatter diagram of the analysis of severity of obesity and NLR

overweight and obese children compared to those with normal weight.[12] The RDW is a novel biomarker that describes multiple physiological disorders associated with atherosclerosis and coronary heart disease.[13] Our study also found the same trend between RDW value and the severity of obesity.

The NLR was also found to be a potent marker of inflammation in children.[14,15] PA previous study assessed the inflammatory status of obese children using NLR. Of 130 obese children (aged 6-15 years) and 57 control children with normal weight (aged 7-15 years), a significant increase in neutrophils, lymphocytes, CRP, and NLR was found in the obese group compared to the control group.[16] Findings in our study show the same possible positive relationship in our study where more increased in NLR found in more severe obesity.

Platelets' role in systemic inflammation have

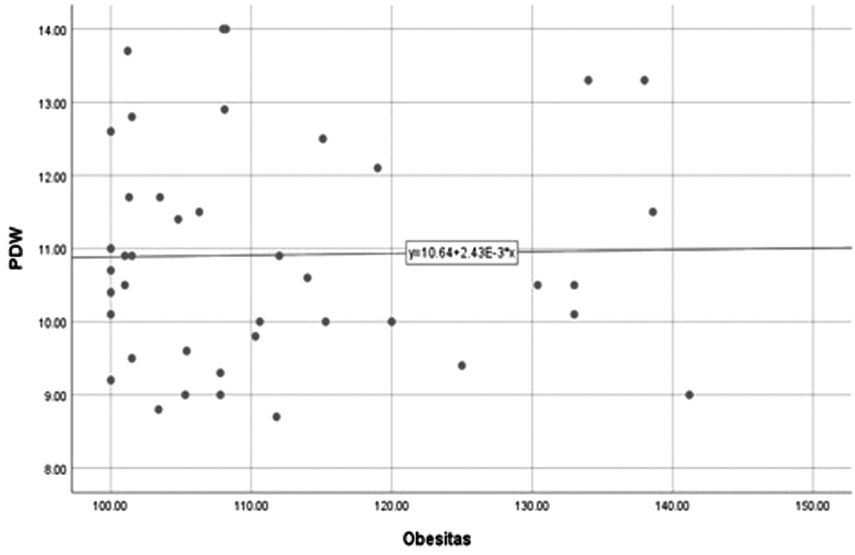

Figure 4. Scatter diagram of the analysis of severity of obesity and PDW

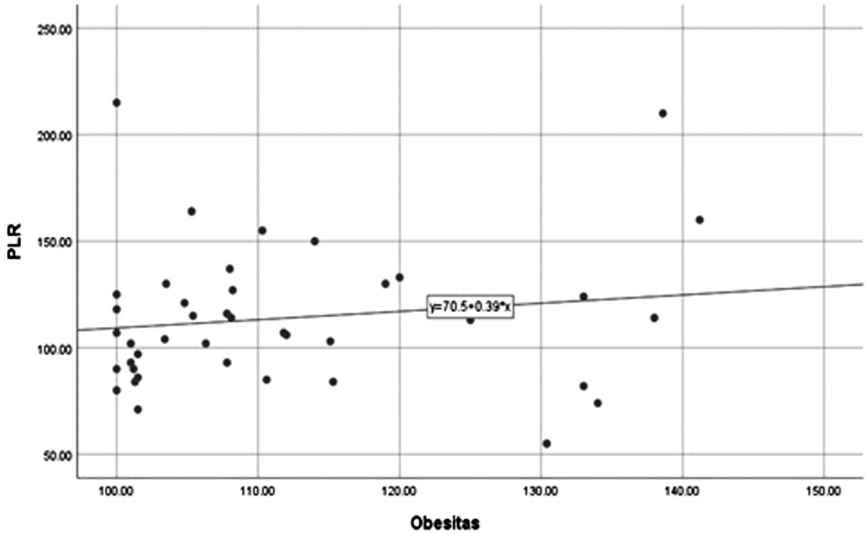

Figure 5. Scatter diagram of the analysis of severity of obesity and PLR

been reported in several studies. Level of MPV has been found associated with low grade inflammation.[17] A high PDW levels found to be caused by swelling, destruction, immaturity, and high reactivity of platelets.[18] Another study reported that MPV and PDW concentrations were significantly higher in the obese group than in the normal weight control group.[19] In obese individuals, although the mechanism underlying the increase was unclear, procoagulant status may have been induced by adipocytokines such as leptin, adiponectin, resistin, and PAI.[19] Discrepancies in MPV value still being found in recent studies.[18] Our study did not show increased MPV value parallel with severity of obesity, although PDW show a positive trend.

Another study found a positive correlation between PLR and the homeostasis model assessment of insulin resistance (HOMA-IR), potentially derived from a proinflammatory status associated with obesity from the complex interactions between platelets, insulin signaling and inflammation.[20] Chronic inflammation is a strong risk factor for many obesity-

related diseases. Increased inflammation, shown in a decrease in adiponectin and an increase in proinflammatory cytokines, found in a longer period of obesity.[21]

The limitation of this study was not including confounding factors such as age of onset and duration of obesity, family history of obesity, diabetes mellitus, and cardiovascular disease that may influence severity of obesity and the various components of complete blood counts.

In conclusion, RDW, NLR, MPV, PDW, and PLR values are not significantly associated with severity of obesity in adolescents.

Conflict of Interest

None declared.

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