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White blood cell count and clustered components of metabolic syndrome: A study in western Iran

Abstract

Background: White blood cell count (WBC) is one of the objective parameters of systemic inflammation. The aim of present study was to evaluate the relationship between WBC count and metabolic syndrome.

Methods: In this study on Lor population in Borujerd province (West of Iran), from 2011 to 2013, 800 persons were enrolled. MetS was defined based on ATP III criteria. Differences among the quartiles of WBC were examined by one-way analysis of variance.

Results: Only 14.7% did not have any of the five components and 43% of all subjects had metabolic syndrome. The means of WBC count in MetS group were significantly higher than the control group ($p < 0.0001$). In subjects without any MetS components, the means of WBC was 5.321 / μ L, and it was 5.664, 5.714, 5.961, 6.302, and 6.572 / μ L in subjects with 1, 2, 3, 4, and 5 components, respectively. These differences show a significant increasing trend ($p < 0.0001$).

Conclusion: WBC count was associated with clustered components of metabolic syndrome. It seems that WBC counts could be considered as a predictive factor for metabolic syndrome in preventive medicine.

Keywords: Metabolic syndrome; White blood cell; Inflammation

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White blood cell count (WBC) is one of the objective parameters of systemic inflammation. High levels of WBC are associated with smoking, obesity and low physical activity (1-3). In contrast, compliance with health conditions, such as maintaining a normal weight and smoking cessation is inversely associated with WBC count. Also, promoting healthy behaviors in society leads to decreased WBC count and inhibits the incidence of inflammation (4). One important advantage with WBC count is that it can be usually measured in all laboratories and medical centers, and is considered as the only cellular marker for systemic inflammation. The metabolic syndrome (MetS) refers to a set of conditions, including obesity, insulin resistance, elevated fasting glucose, elevated triglycerides (TGs), decreased high-density lipoprotein cholesterol (HDL-C), and elevated blood pressure (BP) (5, 6), and is present in approximately 43 percent of adults in Iran (7). Metabolic syndrome is a series of metabolic disorders, which can increase the risk of cardiovascular diseases (5). Previous studies have shown a significant relationship between WBC and insulin resistance (8). Also in other studies, a relationship between elevated WBC count as a systemic marker and components of metabolic syndrome has been reported (9-11). However, few studies, particularly on Iranian population, have assessed the association between WBC count and the metabolic syndrome. Accordingly, the aim of the present study was to evaluate the relationship between WBC count and metabolic syndrome in Iranian population.

Methods

This study was a part of the Borujerd Health and Nutrition Survey (BHNS) that performed on Lor population in Borujerd province (West of Iran), from 2011 to 2013, and 800 persons were enrolled. As hematologic parameters may be affected by medical conditions such as infections, disorders and malignancies, the patients with WBC counts higher than 15,000/mm³ were excluded from the study.

Blood samples were drawn after 10-12 hours of fasting through the antecubital vein. Fasting blood sugar (FBS), triglycerides (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C) were measured by standard kits (ParsAzmoon, Iran) (12).

According to the definition of the third report of the National Cholesterol Education Program Adult Treatment (NCEP-ATPIII) (13), metabolic syndrome was defined as a presentation of three or more of the following five components: Abdominal obesity (waist circumference (WC) >102 cm for men and >88 cm for women), hypertriglyceridemia (triglycerides \geq 150 mg/dl or drug treatment for elevated TG), Low HDL-cholesterol (HDL cholesterol < 40 mg/dl for men and < 50 mg/dl for women or drug treatment for low HDL-C), elevated blood pressure (blood pressure \geq 130/ \geq 85 mmHg or drug treatment for high BP), and elevated fasting glucose (fasting glucose \geq 110 mg/dl or on treatment for diabetes). Categories of WBC count were defined by the following quintiles (14): < 5.2 \times 10⁹ cells/L,

5.2 - 5.8 \times 10⁹ cells/L, 5.9 - 6.6 \times 10⁹ cells/L, 6.7 - 7.7 \times 10⁹ cells/L, > 7.8 \times 10⁹ cells/L.

Statistical analysis: All data were entered to the SPSS software (Version 21) and were analyzed. Differences among the quartiles of WBC were examined by one-way analysis of variance (ANOVA). Chi-square test was used to compare categorical variables among the quartiles of WBC. The means were compared with student t-test and Kruskal-Wallis, and the prevalence of metabolic syndrome among males and females was compared with chi-square test. A p-value<0.05 was considered significant.

Results

Participants in the lower WBC count quintile had a lower BMI and waist circumference, lower concentration of FBS, triglycerides, and LDL, and higher concentration HDL than the participants in the higher quintiles (table 1). Only 14.7% of all subjects were free of all 5 components and 43% were diagnosed as having MetS.

The age- and sex-adjusted means of WBC count were significantly higher in MetS group than in non-MetS group (p<0.0001) (Table 2).

In subjects without any MetS components, the means of WBC was 5.321 / μ L, and it was 5.664, 5.714, 5.961, 6.302, and 6.572 / μ L in subjects with 1, 2, 3, 4, and 5 components, respectively. These differences show a significant increasing trend (p<0.0001 for trend) (Table 2).

Table 1: Baseline characteristics by quintiles of white blood cell count

	Q1	Q2	Q3	Q4	Q5	P -value
Participant, n (%)	225 (28.1)	137 (17.1)	165 (20.6)	134 (16.8)	139 (17.4)	
Age (Years)	55.26 \pm 12.41	54.64 \pm 10.77	54.83 \pm 12.23	55.42 \pm 11.73	54.11 \pm 13.11	0.893
BMI (kg/m ²)	25.47 \pm 4.40	26.56 \pm 5.29	27.22 \pm 4.61	27.55 \pm 5.07	27.73 \pm 125.17	<0.0001
Gender (%)						0.239
Males	98 (25.7)	70 (18.3)	82 (21.6)	69 (18.2)	62 (16.2)	
Females	127 (30.3)	67 (15.9)	83 (19.8)	65 (15.6)	77 (18.4)	
SBP (mmHg)	124.91 \pm 20.18	126.07 \pm 19.74	128.16 \pm 21.84	129.35 \pm 20.87	129.07 \pm 23.35	0.217
DBP (mmHg)	78.99 \pm 12.12	79.31 \pm 10.99	80.43 \pm 12.23	78.93 \pm 11.44	79.85 \pm 11.92	0.761
WC (cm)	88.95 \pm 11.31	92.59 \pm 10.39	93.35 \pm 11.65	94.63 \pm 11.73	95.02 \pm 12.39	<0.0001
Cholesterol (mg/dl)	189.76 \pm 38.86	191.85 \pm 40.19	194.47 \pm 43.99	190.01 \pm 37.89	197.36 \pm 41.66	0.412
TG (mg/dl)	140.82 \pm 99.41	158.62 \pm 94.26	165.71 \pm 84.43	169.94 \pm 99.73	186.57 \pm 66.74	<0.0001
LDL (mg/dl)	116.17 \pm 35.31	116.11 \pm 39.04	118.76 \pm 41.14	110.67 \pm 38.55	122.25 \pm 40.88	0.012
HDL (mg/dl)	45.34 \pm 6.83	44.64 \pm 7.19	43.32 \pm 6.79	43.22 \pm 7.81	42.31 \pm 6.59	0.026
FBS (mg/dl)	101.95 \pm 40.88	108.96 \pm 43.16	108.81 \pm 33.59	112.16 \pm 35.24	118.29 \pm 54.27	0.002

Table 2: the means of the WBC count for clustered components of metabolic syndrome

No. of components	N	Means in men	Means in women	age- and sex-adjusted means (95% CI)
0	113	5.56±1.39	4.95±1.17	5.321 (5.065-5.576)
1	151	5.79±1.47	5.44±1.52	5.664 (5.423-5.906)
2	192	5.86±1.29	5.56±1.41	5.714 (5.521-5.909)
3	162	5.94±1.23	5.97±1.54	5.961 (5.737-6.184)
4	123	6.36±1.54	6.25±1.54	6.302 (6.027-6.576)
5	59	6.51±2.45	6.59±2.05	6.572 (6.011-7.133)

WBC counts showed a significant stepwise increase from the MetS-0 to the MetS-5 group (Figure 1). We have found a total of 344 (43%) met MetS criteria according to ATP III criteria, and 91, 55, 72, 61 and 65 diagnoses were received in Q1, Q2, Q3, Q4 and Q5, respectively.

The prevalence of MetS had a significant increasing trend from lowest WBC count quintile (Q1) to highest quartile of WBC (Q5) (P=0.029). Table 3 shows the frequency for clustered features of MetS according to WBC count quartiles (P=0.651).

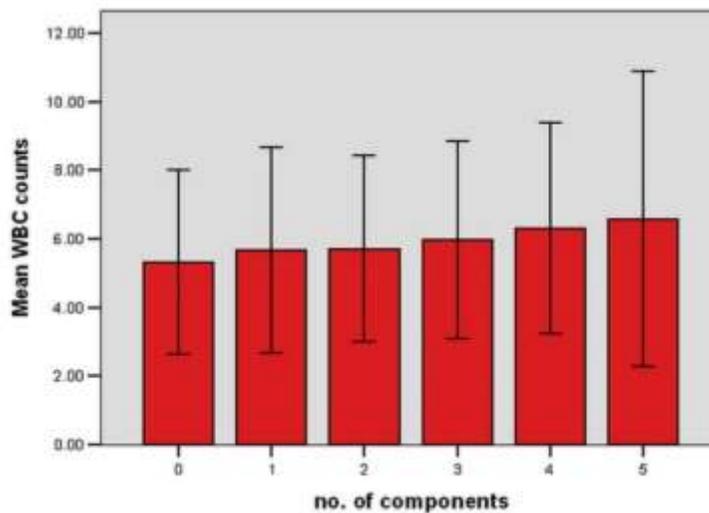


Figure 1: Comparing the mean of WBC counts between the six groups of patients for clustered features of metabolic syndrome

Table 3: Frequency of WBC count quintiles for clustered components of MetS

No. of components	Q1	Q2	Q3	Q4	Q5
0	33 (14.7)	16 (11.7)	23 (13.9)	19 (14.2)	22 (15.8)
1	40 (17.8)	30 (21.9)	29 (17.6)	23 (17.2)	29 (20.9)
2	61 (27.1)	36 (26.3)	41 (24.8)	31 (23.1)	23 (16.5)
3	43 (19.1)	21 (15.3)	32 (19.4)	35 (26.1)	31 (22.3)
4	35 (15.5)	25 (18.2)	25 (15.2)	19 (14.2)	19 (13.7)
5	13 (5.8)	9 (6.6)	15 (9.1)	7 (5.2)	15 (10.8)

Discussion

This study examined the relationship between WBC counts and the occurrence of metabolic syndrome in Iranian individuals. We found that WBC counts in subjects with metabolic syndrome are higher than healthy individuals, and the mean of WBC count is directly related to the number of

metabolic syndrome components; the correlation demonstrates a positive relationship between the number of metabolic syndrome components and inflammation. The WBC count is a commonly used marker for low-grade systemic inflammation (15). However, it has been reported that high sensitive C-reactive protein, another inflammatory

marker, is a better marker of inflammatory components of MetS than WBC (15). Some studies have also investigated the association of hs-CRP with diabetes, cardiovascular disease, and metabolic syndrome (7, 16-18). However, because WBC counts are routinely available and low in cost, such counts appear more useful in clinical settings than assessments of hs-CRP levels.

The relationship between WBC counts and MetS has been investigated in a number of studies (3, 10, 19-21). Wang et al. (22) reported that the risk of metabolic syndrome in individuals in the highest quartile of WBC counts was 3 times greater than the risk of individuals in the lowest quartile. Lohsoonthorn et al. (11) reported a significant correlation between WBC counts and the number of metabolic syndrome components. Nagasawa et al. (10) demonstrated that WBC counts in patients with MetS were significantly higher compared with controls. The CARDIA study (23) reported a positive correlation between WBC counts and systolic blood pressure and BMI, and also a negative correlation between WBC counts and HDL. The ARIC study (24) also reported a significant correlation between WBC counts and blood pressure, insulin concentrations, triglycerides, and uric acid levels. Despite strong clinical evidence on the relationship between hematological parameters and the risk of metabolic syndrome, the biological mechanisms of the association exist unknown. Some researchers have shown that when atherosclerotic risk factors like HTN were presented, vascular endothelial cells will be activated. Activation of these vascular endothelial cells result in an increased synthesis cytokines and chemokines and release of them (25). Pre-inflammatory factors activate processes that increase WBC counts, resulting in platelet aggregation and thrombus formation (26). The presence of pre-inflammatory cytokines, like TNF- α and IL-6, in atherosclerotic plaques suggests that vascular wall inflammation leads to a development and progression of atherosclerosis. It has also been shown that pre-inflammatory cytokines can increase WBC counts (27).

However, the number of cells in atherosclerotic lesions may indicate the severity of the inflammation, and the increased WBC counts can exacerbate the inflammation. It has also been reported that pre-inflammatory cytokines, which increase the WBC count, are released from adipose cells; therefore, the concentrations of these cytokines are relatively high in obese individuals, as compared with those of normal weight (28).

In contrast, some researchers inferred that chronic inflammation with increase in generating of pre-inflammatory cytokines and acute phase proteins may be associated with the pathogenesis of diabetes (29). Different markers such as IL-6, TNF- α and CRP not only predict the risk of diabetes, but also play a role in the pathogenesis of insulin resistance as the most important underlying disorder of metabolic syndrome (30). Other studies proposed that over-nutrition and obesity may have relationship with developing systemic metabolic disorders of the metabolic syndrome through the synthesis of IL-6 and TNF- α (29). Moreover, insulin resistance that causes the incidence of metabolic syndrome can alone increase the number of inflammatory cytokines (30). Thus, it seems that subclinical inflammation and metabolic syndrome are associated with inflammatory cytokines. These cytokines, in turn, will increase the WBCs counts (31). Although the study design was done well, there were still some limitations. The important limitation of this study was lack of investigating the WBC subtypes and determining their relationship with metabolic syndrome.

In conclusion, based on the results of this study, WBC counts could be considered as a predictive factor for metabolic syndrome in preventive medicine.

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Conflict of Interests: None declared

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