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# A Study of Young Individuals' Metabolic Syndrome Components and Hematological Status

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**Abstract**
Metabolic syndrome (MetS) or clustering of different cardiac and metabolic risk factors is an emerging problem affecting the young adults worldwide. Various hematological indices have been identified recently to have important predictive values on components of MetS. The objective of the study was to investigate the association between components of cardio-metabolic risk and hematological parameters in young adults of Tripura. The assessment was done on 347 randomly selected young adults (age 18-25 years) belonging to mixed Indian population residing in Kanyakumari. National Cholesterol Education Programme Adult Treatment Panel III (NCEP ATP III) criteria was followed to evaluate the cardio-metabolic risk of the subject. Hematological parameters were recorded by using an automated hematological analyzer. Most of the anthropometric, cardio-metabolic and hematological parameters differ significantly between subjects with and without profound cardio metabolic risk except blood pressure in females and fasting blood sugar in males. Hematological parameters like RBC count, PLT count, Hb content showed lower values and WBC showed significantly higher values in subjects with MetS. In both male and female, the haemoglobin content significantly negatively correlated with BMI, waist circumference and triglyceride level whereas only in females it also varied significantly positively with HDL-C level. There was over all impairment of the hematological status in subjects with profound cardio-metabolic risk. The presence of risk factors for metabolic syndrome at the young age have an impact on hematological status of young adults.

## INTRODUCTION

Metabolic syndrome (MetS) is a collective term that include various metabolic disturbances, viz. central obesity, hyperglycemia, dyslipidaemia and hypertension. Evidently, people with MetS are at increased risk of future development of cardiovascular diseases and type II diabetes mellitus[1]. Findings from different corners of the world suggest that prevalence of metabolic syndrome is increasing among young adults and has emerged as a major public health problem world over[2,3]. Recently, there has been an increased attention on role of MetS on hematogram. Various hematological parameters showed correlation with metabolic syndrome components in different population groups. Alteration in hematogram viz, white blood cell (WBC), red blood cell (RBC) and platelet (PLT) has been found to be related to hypertension, type II diabetes, low density lipoprotein, cholesterol, overall obesity, abdominal obesity and insulin resistance. Both metabolic syndrome and hematological parameters varies according to age and ethnicity of the subject[4-6,1]. Haematogram also predict the occurrence of future metabolic disorders[7]. Increasingly investigators have noted that hematological parameters may be used in early detection of metabolic syndrome, its clinical evaluation and for monitoring the progression of the syndrome[2] (Gkrania-Klotsas *et al.,* 2010). Insulin resistance, an essential core contributing factor for metabolic syndrome has been demonstrated in some studies to be associated with white blood cell (WBC) and red blood cell (RBC) count. Subjects in highest quartile of WBC or RBC count demonstrated a three or two fold increase, respectively, in the odds ratio of metabolic syndrome with 3 or more metabolic features compared to subjects in the lowest quartile of WBC or RBC counts[8] (Wang *et al.,* 2004). In both men and women, WBC counts were positively associated with BMI and waist circumference, RBC counts were associated with DBP[3] (Nebeck *et al.*, 2012).The relationship between haemoglobin content of the blood and risk of metabolic syndrome is also established through various studies. Higher haemoglobin was found to be associated with increased chances of having metabolic syndrome in elderly adults. The most important contributors were found to be waist circumference, blood pressure and LDL cholesterol in both male and female subjects[9] (Hu *et al.,* 2016). A significant difference in red blood cell distribution width was observed between diabetic patients and controls. Total WBC count, absolute lymphocyte count, absolute neutrophil count, mean platelet volume and platelet distribution width where found to be significantly higher in diabetic subjects[4] (Baidgo *et al.,* 2016). WBC count was found to be positively correlated with metabolic syndrome for young adults of 20-30 years irrespective of sex of the subject[10] (Tao *et al.,* 2014). Studies have reported elevation of WBC count in subjects with metabolic syndrome irrespective of their gender[11] (Pei *et al.,* 2015). Though the relationship between MetS with many factors are being studied broadly, but reports on the association between MetS and hematological parameters at the population level, especially among young adults are scarce. The predictive potentials of different hematological parameters in young adult subjects is very important. Till today, little information is available on relationship between hematogram and cardio-metabolic risk components in young Indian male and female subjects. With this background, in this cross-sectional study, our purpose was to demonstrate the demographic information of the hematological parameters and further analyze their relationships with MetS components among the adult male and female subjects of Tripura with and without MetS.

## MATERIALS AND METHODS

Data was collected from patients attending the Department of General Medicine of Sree Mookambika Institute of Medical sciences, kanyakumari, Tamil nadu, from march 2023-september 2024 Total no of subjects evaluated was three hundred forty seven (347), male (183) and female (164). Out of 183 male subjects, 78 were tribal and 105 were non-tribal whereas, out of 164 females, 75 were tribal and 89 were from non-tribal population. History of any disease and past or present medication was recorded to exclude the subjects having any cardio-metabolic disorder from the study. Subjects having diabetes mellitus, hypertension, polycystic ovary and any other cardiovascular disorders were excluded from the study. A questionnaire was formulated for the purpose. Cardio metabolic risk of the subject was assessed according to National Cholesterol Education Programme Adult Treatment Panel III [NCEP ATPIII] criteria[13]. Individuals were considered to have profound cardio metabolic risk if they had any three or more of the following conditions according to NCEP ATP III criteria. Statistical analysis was done using the statistical package for social sciences (SPSS). Different statistical methods were used as appropriate. Mean±SD was determined for quantitative data and frequency for categorical variables. The independent t-test was performed on all continuous variables. The normal distribution data was checked before any t-test. The Chi-Square test was used to analyze group difference for categorical variables. In logistic regression models, age was adjusted for estimation of each or all the independent effects of hypertension, ischemic heart disease and diabetes mellitus. A p-value <0.05 was considered significant.

## RESULTS AND DISCUSSIONS

Analysis of anthropometric characters revealed that in subjects with MetS BMI, WC, HC, WHR and WHtR were significantly higher than the subjects without MetS in

both male and female groups. Comparison of cardio-metabolic components showed that in male subjects with MetS, parameters like SBP, DBP, TG, HDL-C showed significantly higher values whereas FBS, TC and LDL-C showed non-significant difference between subjects with and without MetS. In case of female subjects, all components of metabolic syndrome except SBP, DBP and TC showed significantly higher values in subjects with MetS . In both tribal and non-tribal male subjects with MetS, all components except TC, LDL-C, FBS showed significantly higher values than their non-MetS counterparts. Female subjects with MetS showed significantly higher values in all components of MetS except SBP, DBP, TC in comparison to their non-MetS counterparts among both tribal and non-tribal groups. Comparison of hematological parameters among young male and female subjects with and without metabolic syndrome showed that in both male as well as female subjects with metabolic syndrome, total RBC count was significantly lower and total WBC count was significantly higher than their non-metabolic syndrome counter parts. Hb content, PLT count were lower in subjects with MetS than their counterparts without MetS irrespective of their sexes (Table I).

- **RBC-red blood corpuscles.**
- **WBC-white blood corpuscles**
- **PLT-platelet, Hb- hemoglobin.**
- ***-p<005, **-p<0.01, ***-p<0.001, #-not significant.**

A multi variable logistic regression model applied to determine the effect of haematological parameters on the risk of MetS after adjusting for confounding factors showed for males, the haematological parameters positively and significantly associated with the risk of MetS included Hb level (OR: 19.408, 95% confidence interval [CI]: 6.542-57.575, P-value <0.05) and RBC (OR: 2.351, 95% CI: 1.160-4.765, P-value <0.05) while significantly negative association with WBC (OR: 0.089, 95%CI: 0.012-0.677, P-value <0.05). No significant association was observed with platelet count and MetS (OR: 0.968, 95%CI: 0.459-2.043, P-value=0.934) in male subjects. In female subjects, it was observed that, the MetS components positively and significantly associated with the Hb level (OR: 18.888, 95% CI: 6.996-51.000, P-value <0.05) and RBC (OR: 6.500, 95% CI: 2.946-14.342, P-value <0.05). But WBC showed a non-significant negative association (OR: 0.200, 95%CI: 0.026-1.566, P-value=0.125) and also there was a non-significant but positive association with platelet count (OR: 1.148, 95%CI: 0.513-2.570, P-value=0.737) (Table 2). Among hematological parameters, RBC and Hb showed significantly higher values in male subjects. Subjects with MetS, showed significantly higher WBC count and lower RBC count and Hb content irrespective of sex and ethnicity of the subject. Analysis revealed various hematological parameters showed variable correlation with components of MetS. After adjustment for various co-founding factors, it was observed that the hematological parameters could predict occurrence of MetS in subjects. The study evaluated relationship between components of cardio metabolic risk and hematological parameters in a sample of young adults (age 18-25 years), both male and female population residing in kanyakumari. Subjects were screened for cardio metabolic risk according to NCEP-ATP III criteria. Hematological analysis in our study showed that WBC count increased in subjects with MetS., while there was a decrease in RBC count and haemoglobin (Hb) concentration in subjects with MetS., irrespective of gender and ethnicity. Lohsoonthorn *et al.* from their study among population from Thailand have reported that men in highest quartiles of WBC counts had an increased risk of MetS in comparison to people belonging to lower quartiles of WBC count with odds of MetS particularly elevated for women with high WBC count[1]. Cheng *et al.* from their study on association of hematological parameters and MetS in an older population observed that both WBC count and hemoglobin levels are independent risk factors for MetS in both genders[2] Hung *et al.* from their study on association of erythrocyte parameters with metabolic syndrome have found that the association differed between sexes. RBC and Hb were identified as risk factors for MetS in women and Hb and red blood cell distribution width (RDW) as risk factors in men[3]. Ahmadzadeh *et al.* found an increase in haemoglobin, platelet and white blood cell count with increasing numbers of MetS components among Iranian men[4]. In a recent study Yan *et al.* have observed an association of RDW with MetS and hypothesized that this association may be mediated via inflammation[5]. In a retrospective cohort study to find out whether the baseline plasma level of WBC count can be associated with future risk of MetS, it was observed that the baseline inflammation mirrored by WBC level can impact future MetS development. The study showed a positive association persisted with lowest quartile of WBC count after adjustment for baseline BMI, BP, FBS, HDL-C, TG and homoeostatic model assessment- insulin resistance[6]. Oda and Kawai, 2009 reported the prevalence of MetS and diabetes increases through the quartiles of WBC in Japanese men and women[12]. The relationship between WBC count and hypertension was studied in a population based retrospective study in the general Japanese population. A total of 2935 participants without hypertension at baseline were included for analysis during an average follow up of 4.5 years, the incidence of hypertension was increased with an elevation of WBC count after adjustment for other risk factors including age, sex, current smoking habits, current alcohol intake, exercise habits, obesity, elevated BP, diabetes mellitus and dyslipidemia[13]. Our

**Table I: Univariate Analysis of Hematological Parameters and MetS Components for Male Subjects**

| | Hb | RBC | WBC | PLT |
|---|---|---|---|---|
| **Height** | 0.185 (0.2468) | 0.114 (0.4764) | 0.068 (0.6717) | 0.1593333 (0.3197) |
| **Weight** | 0.065 (0.6873) | 0.219 (0.1683) | -0.083 (0.606) | 0.0668731 (0.6778) |
| **BMI** | -0.120 (0.4521) | 0.0799 (0.6194) | -0.123 (0.4444) | -0.095 (0.5562) |
| **WC** | 0.266 (0.09195) | 0.0319 (0.8431) | -0.512*** (0.0006224) | 0.286 (0.06975) |
| **SBP** | 0.379* (0.01436) | 0.049 (0.7588) | -0.112 (0.4838) | -0.035 (0.8274) |
| **DBP** | 0.338* (0.03033) | -0.070 (0.6617) | -0.124 (0.439) | -0.057 (0.7241) |
| **TG** | -0.104 (0.5195) | 0.162 (0.3109) | -0.148 (0.3551) | -0.011 (0.9479) |
| **HDLC** | 0.331* (0.03431) | -0.088 (0.5837) | -0.061 (0.7039) | 0.188 (0.239) |
| **FBS** | 0.239 (0.133) | -0.034 (0.8339) | 0.110 (0.4901) | 0.004 (0.9789) |

BMI-Body mass index, WC- Waist circumference, SBP-Systolic blood pressure, DBP-Diastolic blood pressure, FBS-Fasting blood sugar, TG-Triglyceride, HDL-C- High density lipoprotein- Cholesterol. RBC-red blood corpuscles, WBC-white blood corpuscles, PLT-platelet, Hb-hemoglobin.*- p<005., **-p<0.01. ***-p<0.001., #-not significant.

**Table II: Univariate Analysis (Correlation Test) of Hematological Parameters and MetS Components for Female Subjects**

| | Hb | RBC | WBC | PLT |
|---|---|---|---|---|
| **Height** | 0.168 (0.3123) | 0.057 (0.7329) | 0.010 (0.9503) | -0.226 (0.1714) |
| **Weight** | -0.138 (0.4101) | 0.089 (0.5916) | 0.274 (0.09637) | -0.060 (0.7198) |
| **BMI** | -0.261 (0.114) | 0.034 (0.8394) | 0.229 (0.1666) | 0.136 (0.4152) |
| **WC** | 0.089 (0.5955) | 0.015 (0.9279) | 0.095 (0.5713) | 0.115 (0.493) |
| **SBP** | -0.085 (0.6103) | -0.069 (0.6794) | 0.309 (0.05907) | 0.033 (0.8436) |
| **DBP** | -0.104 (0.531) | 0.0004 (0.9978) | -0.012 (0.945) | 0.0806 (0.6303) |
| **TG** | 0.099 (0.5558) | -0.021 (0.9008) | 0.082 (0.6234) | 0.100 (0.5472) |
| **HDLC** | -0.194 (0.2427) | -0.032 (0.8466) | 0.131 (0.4299) | 0.251 (0.1288) |
| **FBS** | 0.374* (0.02071) | -0.353* (0.02989) | 0.266 (0.1065) | -0.113 (0.4988) |

BMI-Body mass index, WC-Waist circumference, SBP-Systolic blood pressure, DBP-Diastolic blood pressure, FBS-Fasting blood sugar, TG-Triglyceride, HDL-C- High density lipoprotein-Cholesterol, RBC-red blood corpuscles, WBC-white blood corpuscles, PLT-platelet, Hb-hemoglobin*-p<005., **-p<0.01., ***-p<0.001., #-not significant.

**Table III: Multi Variable Logistic Regression Model of Hematogram for the Risk of Metabolic Syndrome in Male and Female Subjects**

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | **OR** | **95% CI** | **P-value** | **OR** | **95% CI** | **P-value** |
| **Hb** | 19.408 | 6.542-57.575 | <0.05 | 18.888 | 6.996-51.000 | <0.05 |
| **RBC** | 2.351 | 1.160-4.765 | <0.05 | 6.500 | 2.946-14.342 | <0.05 |
| **WBC** | 0.089 | 0.012-0.677 | <0.05 | 0.200 | 0.026-1.566 | 0.125 |
| **PLT** | 0.968 | 0.459-2.043 | 0.934 | 1.148 | 0.513-2.570 | 0.737 |

RBC-red blood corpuscles, WBC- white blood corpuscles, PLT-platelet, Hb-haemoglobin.

study on correlation of Hb with components of MetS revealed correlation of Hb with BMI, WC and TG across gender and ethnicity. This finding is consistent with the results of other major studies conducted in different age groups[14]. It is well known that increased WC can cause insulin resistance (IR) related to low grade inflammation[15]. Low grade inflammation during MetS also acts as a mediator of TG and Hb correlation[16]. Thai study of Lohsoonthorn *et al.* found significant correlation of haemoglobin and haematocrit values with MetS component in women and not in men[1]. Nebcek *et al.* in their study on an occupational cohort in Ethiopia, has found, in both men and women, WBC count and RBC count were positively correlated with BMI and WC. Both men and women in lower quartile of Hb concentration had a higher odds for MetS[2]. The possible hypothesis for reduction in RBCs is that chronic hyperglycaemia may cause non-enzymatic glycosylation of RBC membrane proteins that lead to accelerated aging of RBCs[17]. Chronic hyperglycaemia may also affect kidney function and thereby reduce production of erythropoietin, which will ultimately lead to decrease in number of RBCs and anaemia[18]. The mechanism explaining the association between WBC and metabolic syndrome are not fully elucidated, but several possibilities have been expanded. Insulin resistance, abdominal obesity and inflammation have been mentioned as the major underlying factors of metabolic syndrome. Inflammation may be a core mechanism of metabolic syndrome and is linked with obesity and insulin resistance[19]. Adipose tissue macrophages are increased in obesity and associated with low grade inflammation. IL-6 and TNF-Alpha secreted by the macrophages are possible link between WBC and pathogenesis of metabolic syndrome[20]. The mechanism of relationship between RBC count and metabolic syndrome may also be linked toinsulin resistance in MetS subjects. Insulin is known to stimulate RBC proliferation, intern, elevated RBC induce insulin resistance[21]. RDW that represents a measure of heterogeneity in size of circulating erythrocyte count acts as a potential metabolic marker for detection of metabolic diseases[22]. Pro inflammatory cytokines can inhibit erythropoietin induced erythrocyte maturation which may lead to elevation of RDW[23]. Therefore, chronic inflammation may play a role in association between RDW and metabolic syndrome. Haemoglobin on the other hand is a well-known carrier and buffer of NO, thus can regulate the endothelial function of blood vessels by modulating NO levels in blood. Furthermore, haemoglobin and various compounds of NO modulate affinity between haemoglobin and oxygen in blood, which can lead to vascular endothelial dysfunction. It has been observed that vascular endothelial dysfunction was associated with metabolic

syndrome[24]. In addition, haemoglobin plays a key role in regulating CD4 level and CD4 has been shown to participate in thrombus formation and inflammation, which is independent risk factor for atherosclerosis and metabolic syndrome[25]. Another possibility linking haemoglobin and metabolic syndrome may be adiponectin. Studies have shown that haemoglobin levels are closely related to adiponectin levels and adiponectin, intern, is associated with risk of metabolic syndrome[26]. In a retrospective cohort study to find out whether the baseline plasma level of WBC count can be associated with future risk of MetS, it was observed that the baseline inflammation mirrored by WBC level can impact future MetS development. The study showed a positive association persisted with lowest quartile of WBC count after adjustment for baseline BMI, BP, FBS, HDL-C, TG and homeostatic model assessment of insulin resistance (Jung *et al.*, 2013). Oda and Kawai, 2009 reported the prevalence of MetS and diabetes increases through the quartiles of WBC in Japanese men and women[12]. The relationship between WBC count and hypertension was studied in a population based retrospective study in the general Japanese population. A total of 2935 participants without hypertension at baseline were included for analysis during an average follow up of 4.5 years, the incidence of hypertension was increased with an elevation of WBC count after adjustment for other risk factors including age, sex, current smoking habits, current alcohol intake, exercise habits, obesity, elevated BP, diabetes mellitus and dyslipidaemia[13]. More researches are essential to expose the mechanism of relationship between haematological parameters and metabolic syndrome.

## CONCLUSION

This study indicate decrease or increase in values of some hematological parameters in subjects with metabolic syndrome. In addition, components of metabolic syndrome, particularly the markers of both general and abdominal adiposity are negatively correlated with various hematological parameters. As not much data is available on relationship between cardio metabolic risk components and hematological parameters in young adults particularly in Indian context, the finding of the present study can provide a lead to further investigate this relationship and on how to manage the influence of cardio metabolic factors on hematological parameters. However, cross sectional nature of the study and limited sample size is a limitation. Future study should include a larger sample size keeping both gender and racial factors in view.

**Conflict of Interest Statement:** There is no conflict of interest among the authors.

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