

# The Correlation of Hemoglobin Levels and Metabolic Syndrome Components in Teachers in Makassar, Indonesia

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## ABSTRACT

**Background:** This study explores the correlation between anemia and metabolic syndrome (METS) components in teachers. **Method:** This cross-sectional study was conducted in Makassar City, Indonesia. The total of 121 teachers from 12 secondary schools were observed. Anemia was defined using the WHO standard (Hb <13 g/dl in men and Hb <12 g/dl in women). The METS was defined using criteria from the International Diabetes Federation (IDF). Pearson tests were performed to determine the correlation between hemoglobin levels and METS components, while chi-square tests were performed to determine the connection between anemia and METS components. **Result:** This study found that hemoglobin levels had a significant correlation ( $p < 0.05$ ) with waist circumference ( $r = 0.22$ ), triglycerides ( $r = 0.342$ ), cholesterol ( $r = -0.333$ ) and systole ( $r = 0.228$ ), although the relationship was weak. Hemoglobin levels were not correlated with the blood glucose levels, diastole, and body mass index ( $p > 0.05$ ). **Conclusion:** Hemoglobin levels have a weak correlation with several METS components. Knowledge about anemia and METS is needed to prevent serious effects in adults in the future.

**Keywords:** Teacher, blood glucose, component, weight, triglycerides

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## Introduction

Metabolic Syndrome (METS), characterized by five parameters: blood pressure, central obesity, triglyceride, high-density lipoprotein (HDL) and glucose level, a cluster of conditions that can grow the risk of metabolic diseases. The pooled prevalence of METS in patients with T1DM in 2021 was 23.7% worldwide [1]. Studies showing metabolic syndrome prevalence in Indonesia is still less, although the incidence tends to increase along with the increase in obesity [2,3].

Anemia is a condition where the hemoglobin (Hb) or hematocrit attention is lower than the specified threshold (reference). Anemia commonly known as a blood deficiency disease by communities, can be caused by low production of red blood cells (erythrocytes) and hemoglobin, leading to erythrocyte damage (hemolysis) or excessive blood loss. This disease can affect long-term health during the life cycles and thus needs to prevent [4]. It is estimated that 1.62 billion people globally were affected by anemia, especially in South East Asia regions as the second contributor of anemia prevalence [5].

Studies in the literature have shown inconsistent results in the

relationship between anemia and METS components. While some studies have found that METS components are high in anemia, another study found otherwise. A study conducted in Mali investigated the relationship between iron deficiency and body weight in women of childbearing age, and found no differences in serum ferritin levels between overweight and normal-weight women [6]. Likewise, a study examining the connection between iron lack and extra body fat in non-obese menopausal women found that the prevalence of iron deficiency anemia in obese women (body fat/BF  $\geq 30.0\%$ ) was not different from normal-weight women (body mass index/BMI 25.0-30.0 kg/m<sup>2</sup>) [7]. A study examining iron stores and the risk of developing type 2 diabetes mellitus (T2DM) found that T2DM patients with normal weight have no difference in ferritin levels with overweight and obese adults [8]. Another study found that people who are overweight and obese do not have advanced hazard of anemia than the general population [9].

Many studies confirmed the relationship between anemia and the presence of METS components. A study by Cheng et al. found that obese individuals had increased hemoglobin and ferritin concentrations and decreased transferrin saturation compared to adults of normal weight [10]. It is supported by a study conducted

by Yu Qin et al., who found that in the obese group, Hb concentration was higher than in the non-obese group [11].

Hu et al., who examined the bond among Hb and each component of METS found that Hb levels increased with an increasing proportion of METS [12]. A study conducted by Orban et al. found that there was an increased hazard of T2DM with the elevation of ferritin and transferrin saturation [13]. Among premenopausal and postmenopausal adults, METS is common in those who had a higher serum ferritin level, indicating that there might be an association between anemia and METS [14]. A study conducted by Bozzini, who examined the prevalence of increased iron reserves in people with METS, found that iron increases occurred significantly higher in those who experienced METS when compared to the control group [15].

Different consequences were found by Zhao et al., who revealed that the study participants Those who are overweight or obese have a significantly increased hazard of iron deficiency [16]. Likewise, it was found by Lisa et al. that there was an increasing iron deficiency prevalence among adolescent girls who had a rising body weight. These findings indicate that adolescent girls who have more weight are more likely to be anemic or have insufficient iron stores [17]. This is supported by a study that found a higher prevalence of iron deficiency in obese women than in women of normal weight [18].

The preliminary research conducted in the senior high schools in Makassar City found that 87.3% of teachers had poor iron adequacy. This survey also reported that METS components such as fasting blood sugar, HDL and triglycerides levels were disturbed. 37.9% of respondents had high fasting blood sugar, 36.4% of low HDL, and 41.8% of high triglyceride levels were observed. The study aimed to observe the association among hemoglobin status and METS components among teachers in Makassar.

## Methods

This study was a cross-sectional study conducted at 12 secondary schools in Makassar. A total of 129 teachers were selected using the objective sampling process. The inclusion criteria were civil servants and willingness to participate in study activities. Teachers who were pregnant and had a history of chronic diseases such as diabetes mellitus, heart disease, stroke, and cancer were excluded from the study.

Body weight was measured with the Camry Digital Scale, while upper mid-upper arm circumference height was measured with microtois and a tape measurement. Trained research staff collected characteristics including age, gender, ethnicity, marital status, educational level, incom level, family history of the disease, and anthropometric measurements of the participants. Blood samples were used to determine levels of hemoglobin, blood glucose, triglycerides, and cholesterol. Before receiving blood, all respondents were asked to fast for 10 hours.

A total of 10 ml of blood was taken from each participant, and the collected blood was stored in a cold box at 80°C. The blood samples were analyzed at the prodia laboratory, which provided the staff for recreising blood. The study has been approved under protocol number uh17080549 from the medical research ethics committee of the faculty of medicine of hasanuddin university.

Anemia is diagnosed using World Health Organization Standards. HB Levels Less than 13 g/dl for men and less than 12 g/dl for women are Considers anemia. Metabolic Syndrome was defined using criteria from the IDF. Based on This Definition, Blood Glucose  $\geq 100$  mg/dl, Triglyceride Levels  $\geq 150$  mg/dl, Blood Pressure  $\geq$

130/85 mmhg, HDL  $<50$  mg/dl and  $<40$  mg/dl for Women, Central Obesity and Waist Circumference  $\geq 80$  cm in women and waist circumference in men.

Statistical Analysis was performed with  $p < 0.05$  using the Pearson and Chi-Square to test the correlation Among hemoglobin Levels, anemia and mets components.

## Result

Table 1 reveals the features of participants in this study. Most of them were women (79.3%), aged  $> 40$  years (90.1%), married (91.7%), graduated from university (76.9%), monthly income  $<Rp. 4. 300,000$  (54.5%), teaching less than 24 hours per week (54.5%) and work experience in between 21-30 years (42.1%).

Hemoglobin levels and METS components are shown in Table 2. The mean of all parameters shows normal ranges, except for triglyceride levels in men.

Table 3 shows the correlation among METS components with hemoglobin levels. The result shows that blood glucose, BMI, and diastolic blood pressure has no correlation with hemoglobin level.

## Discussion

The present study shows a weak correlation between the METS components and hemoglobin level. Waist circumference, triglycerides, HDL, and systole showed a weak correlation, while the rest of the METS components showed no correlation. This study is in line with Lee et al., who found that METS was not associated with anemia [19], although in contrast to another study [20]. The average Hb levels of the study participants showed in the normal range, and it was not defined as anemia. A lower Hb levels in the body can result in adverse outcome for individuals [21].

Furthermore, a study conducted by Qin et al. examined the bond among waist circumference and BMI with anemia in women in China found a higher Hb concentration in the obese group than the other groups. The study involving 1,537 women aged over 20 years concluded that women who are obese seem to have a lower risk for anemia than those who have a normal BMI [11]. Unlike the previous studies, our finding shows no correlation between BMI and anemia. Karl et al. reported no relationship between insufficient iron level and increasing body fat [7]. BMI and anemia are related to multiple factors and many potential confounders and therefore, cause different results from other studies [9].

Regarding the correlation between obesity and anemia, Zhao et al. conducted a meta-analysis study with a quantitative approach. They found a lower iron concentration in overweight/obese than those who were not overweight/obese. The study also found that iron deficiency was more prevalent in overweight or obese participants. The study involved 26 case-control and cross-sectional studies, concluded that obesity was significantly associated with iron deficiency. Thus, it is necessary to monitor and prevent iron deficiency events, especially for overweight/obese adults [16].

A study conducted by Lisa et al. regarding excess fat found that inflammation and iron deficiency in young overweight women were more prevalent than normal body weight. The study also found that adolescents with high BMI might have a low Hb level. These findings indicate that adolescent girls with more weight have greater potential for becoming anemia. Inflammation that occurs due to fatty tissue probably contributes to this phenomenon. Therefore, it is recommended to make adolescent girls with increased in body weight / BMI a vulnerable group with a high risk for anemia [17].

**Table 1: Characteristics of respondents.**

Characteristics	n	%
<b>Gender</b>		
Male	25	20.7
Female	96	79.3
<b>Age</b>		
<40 years old	12	9.9
≥ 40 years old	109	90.1
<b>Marital status</b>		
Not married	5	4.15
Divorced	5	4.15
Married	111	91.7
<b>Education</b>		
Bachelor	95	77.7
Master	27	22.3
<b>Monthly income</b>		
<Rp.4,300,000	66	54.5
≥ Rp.4,300,000	55	45.5
<b>Teaching hours / week</b>		
<24 hours	66	54.5
≥ 24 hours	55	45.5
<b>Length of working</b>		
<10 years	7	5.8
11-20 years	32	26.4
21-30 years	51	42.1
> 30 years old	31	25.6

**Table 2: The average values of METS parameters**

Parameters (N=121)	Man				Woman			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Hemoglobin (g/dl)	15.32	±1.2	13.3	17.4	13.066	±1.7	8	15.7
BMI (Kg/m <sup>2</sup> )	24.75	±3.39	18.63	30.62	25.47	±4.46	14.5	38.27
Waist circumference (cm)	87.07	±8.95	60.6	99.5	83.18	±13.56	50.9	111.3
Blood glucose (mg/dl)	99.12	±25.54	76	184	92.05	±26.91	66	284
Triglycerides (mg/dl)	171.2	±83.24	55	360	127.35	±63.95	35	354
HDL (mg/dl)	44.88	±7.62	33	59	57.87	±10.92	35	90
Systole (mmHg)	123.2	±14.06	100	160	120.26	±15.04	90	170
Diastole (mmHg)	82	±6.46	70	100	81.13	±8.77	60	110

Hu et al., who examined the relationship between the METS components and Hb level in 3,252 older people over 65 years, found that the METS proportion increased with the increase of Hb levels. This study concluded that the increased risk of METS in the elderly was related to increasing Hb levels. The METS parameters contributing to Hb levels were waist circumference, blood pressure, and LDL in women and men [12]. Meanwhile, multivariate analysis of the present study found that the HDL and

fasting blood glucose levels were not significantly related to anemia. The weak correlation between waist circumference and METS might be due to the small sample size in this study.

### Conclusion

This study concluded that hemoglobin level had a weak correlation with most METS components in secondary school teachers in

**Table 3: Correlations between METS components and hemoglobin level.**

METS Components (N=121)	Hemoglobin Levels		
	p*	R	Interpretation
Waist circumference	0.015	0.22	Weak correlation
Blood glucose	0.603	0.048	No correlation
Triglycerides	0.00	0.342	Weak correlation
HDL	0.00	-0.333	Weak correlation
Systole	0.012	0.228	Weak correlation
Diastole	0.111	0.146	No correlation
BMI	0.075	0.163	No correlation

**Table 4: Relationship between METS components and anemia.**

METS Components (N=121)	Anemia		Normal		p*
	n	%	N	%	
<b>Waist circumference</b>					
Low risk	3	4.9	58	95.1	0.491
High risk	5	8.3	55	91.7	
<b>Blood glucose</b>					
Low risk	8	7.7	96	92.3	0.599
High risk	0	0	17	100	
<b>Triglycerides</b>					
Low risk	8	9.8	74	90.2	0.053
High risk	0	0	39	100	
<b>HDL</b>					
Low risk	8	8.9	82	91.9	0.112
High risk	0	0	31	100	
<b>Blood pressure</b>					
Low risk	8	7.8	94	92.2	0.354
High risk	0	0	19	100	

\*Chi Square

Makassar. These components are waist circumference, triglycerides, cholesterol, and systole. Although it showed a weak relationship, education regarding METS and anemia is needed to prevent further impacts.

### What is known about the subject?

Metabolic syndrome incidence tends to increase in Indonesia. Literatures showed inconsistent between anemia and metabolic syndrome. The preliminary research found that teachers in Makassar population had poor iron adequacy but also reported high levels of metabolic syndrome components.

### What does the study performed add to the literature?

This study showed that hemoglobin levels had a weak correlation with most metabolic syndrome components.

### What are the implications of the results obtained?

The results of this study showed need education regarding metabolic syndrome and anemia to prevent further impacts.

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