Correlation between Waist Circumference with Complete Blood Count: A Cross-Sectional Study

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ABSTRACT

Obesity induces dyslipidemia, hypertension, glucose intolerance, and inflammatory state which results in atherogenic processes, diabetes, and cardiovascular disease. Waist circumference (WC) is a measure of accurate and simple abdominal obesity. Obesity is said to be associated with higher haemoglobin levels and elevated white blood cell (WBC) counts. Association between WBC count and cardiovascular disease that inflammation plays a central role in atherosclerosis. This study aimed to investigate the correlation between WC with complete blood counts (CBC). This cross-sectional study was conducted in Ngawi, Central Java and was carried among 57 subjects. Waist circumference was measured using measurement tape. Cut-off points used to define obesity were waist circumference ≥ 80 cm for women and ≥ 90 cm for men. CBC were measured using automated tool Haematology Analyzer Nihon Kohden Celltac ES Type 7300K. Data were analysed using IBM SPSS Version 20.0. The results showed WC was positively correlated with total leukocytes (p:0.000; r:0.567) and neutrophil count (p=0.000; r=0.475) and inversely correlated with lymphocytes (p=0.012; r=-0.332), monocytes (p:0.050; r: -0,261, eosinophils (p=0.009; r=-0.342) and basophil (p=0.042; r=-0.270). WC was not correlated with haemoglobin, erythrocyte sedimentation rate, platelets, haematocrit, MCV, MCH, and MCHC. There was a significant correlation between waist circumference with differential leukocyte count and total leukocytes..

Keywords: waist circumference, obesity, complete blood count, erythrocyte sedimentation rate

1. INTRODUCTION

Obesity is an excessive accumulation of adipose tissue in the body that causes health disorders. Obesity induces dyslipidaemia, hypertension, glucose intolerance, and inflammatory state which results in atherogenic processes, diabetes, and cardiovascular disease [1]. Based on Basic Health Research (Riskesdas) 2018 data, obesity in Indonesia shows 21.8 percent. That number has continued to rise since Riskesdas 2007 by 10.5 percent and 14.8 percent in Riskesdas 2013[2]. Central obesity (abdominal obesity) is characterized by the accumulation of fat tissue, especially in the abdomen. The criteria for determining central obesity is if the size of the waist circumference (WC) is≥90 cm in men and ≥80 cm in women[3].

A complete blood count is an inexpensive, frequently obtained test of haematological status recorded during routine health examinations. Elevated haemoglobin, haematocrit, white blood cell (WBC), red blood cell (RBC), and blood platelet counts are correlated with metabolic syndrome and its components[4].

In obese people, there is an excessive expansion of adipocytes that will trigger hypoxia in adipocyte cells. Hypoxia followed by high levels of oxidative stress in adipocytes will be able to cause death from adipocytes. Dead adipocytes will attract macrophages to adipose tissue to eliminate dead adipocytes resulting in different types of adipocytes that trigger a series of chronic inflammatory processes. The resulting variety of adipokines will then cause local effects on the vascular endothelial which will affect the increase in vascular permeability which will further cause fluids (which contain molecules such as complement proteins) and cells (PMN, MN, and other cells) to exit the intravascular compartment to the extravascular compartment[5]. Leukocyte count is a way of measuring the distribution/percentage of white blood cell (WBC) based on their type. In certain circumstances such as infection, inflammation, allergies, and others can cause changes in the type of leukocytes[6].

Obesity indicates chronic inflammation; this is because there is the production of various proinflammatory cytokines causes increased fibrinogen activity. Fibrinogen is one of the components of plasma proteins that cause a decrease in negative charge in erythrocyte cells so that erythrocyte cells will stay together so that blood deposits are formed. The rate of erythrocyte cell deposition is the erythrocyte sedimentation rate (ESR)[7]. This study aimed to investigate the correlation between abdominal obesity with leukocyte count and erythrocyte sedimentation rate.

2. METHOD

This observational study uses a cross-sectional approach method and has been conducted in the polyclinics of the Ngawi Police Station and the clinical laboratory of Widodo Ngawi Hospital at November-December 2018. The inclusion criteria of the subjects were a Ngawi Police Station officer aged 20-55 years with abdominal obesity or size of abdominal circumference ≥90 cm for men and ≥80 cm for women. The subject exclusion criteria are police officers who are having a fever marked with an axilla temperature of >37.5oC, pregnant women, smoking, are in drug therapy (steroids and antibiotics), suffer from asthma, chronic bronchitis, diabetes mellitus, hypo/hyperthyroidism, flu/cough of colds, and urinary tract infections. From these criteria are used sampling methods in the form of purposive sampling.

The tools used in this study are abdominal circumference measuring tape, blood sampling equipment (spuit 3cc, alcohol swab, tourniquet, EDTA tube, and label), analyser haematology leukocyte type measurement tool (5 diffs) Nihon Kohden Celtac ES Type 7300K. The material used is venous blood approximately 3cc which has been mixed with anticoagulant Na2EDTA 1 mg/cc.

Waist circumference (WC) was measured using a band of abdominal circumference measurement and adjusted to WHO cut-off points for Southeast Asia, namely central obesity, or abdominal obesity if the size of abdominal circumference ≥90 cm for men and ≥80 cm for women [5].

The Complete Blood Count was measured using the Haematology Analyzer (5 diffs) Nihon Kohden Celtac ES Type 7300K. Interpretation of the results used normal neutrophil values (40-65%) increased (>65%), normal lymphocyte values (20-35%) increased (>35%), normal monocyte values (1-7%) increased (>7%), normal eosinophil values (0-3%) increased (>3%), normal basophil values (0-1%) increased (>1%). ESR is the deposition speed of erythrocyte cells in plasma in blood-filled tubes and anticoagulants over a period. This study used a manual method called Westergren. The deposition distance is observed after 1 hour, the height of the plasma layer can be seen with millimetre units (mm/hour).

Data analysis using IBM SPSS Statistics software. The normality test of the data was conducted using The Kolmogorov-Smirnov test. Obtained data is not normally distributed, then statistical analysis of data using Spearman test.

The research has obtained a feasibility permit from the Ethics Committee of the Faculty of Medicine, Islamic University of Indonesia with the ethical number 39/Ka.Kom.Et/70/KE/XI/2018.

3. RESULT

Description of Subject Characteristics. Based on the criteria of inclusion and exclusion of subject obtained 57 people. Male subjects amounted to 55 (96.4%) female subjects amounted to 2 people (3.6%).

Table 1. Characteristics of the Subject

Characteristic	Mean ± SD
Age (Years)	40.260 ± 7.4200
Waist Circumference (cm)	105.02 ± 7.8480
Height (cm)	170.51 ± 3.7470
Weight (kg)	93.880 ± 7.3020
Body Mass Index (BMI)	32.302 ± 2.4722
Systole (mmHg)	129.82 ± 12.746
Diastole (mmHg)	85.790 ± 6.8000
Pulse (x/min)	85.790 ± 4.4670
Temperature(oC)	36.609 ± 0.3481
Frequency of Breath (x/min)	18.460 ± 1.4400

Correlation of abdominal obesity with leukocyte count. Based on the correlation test between waist circumference with total leukocytes and neutrophils, it was found that there is a significant positive correlation between the waist circumference and total leukocytes and neutrophils. It can be showed that larger the waist circumference, the greater the value of leukocytes and neutrophils.

The results of the correlation between waist circumference with lymphocytes, monocytes, eosinophils, and basophils found a significant correlation between waist circumference with lymphocytes, monocytes, eosinophils, and basophils that show a negative correlation. The larger waist circumference, the smaller the value of lymphocytes, monocytes, eosinophils, and basophils (Table 2).

Correlation abdominal obesity with ESR. Normality test result obtained data distribution that was not normal, therefore the correlation analysis method used is the Spearman test. The results of the statistics of this study showed that correlation abdominal obesity correlation to either ESRs in the first 1 hour or 2 hours

Table 2. Correlation of abdominal obesity with leukocyte count

Parameters	Correlation Coefficient
Leukocyte	r = 0.567; p=0.000
Neutrophils	r = 0.475; p=0.000
Lymphocytes	r = -0.332; p=0.012
Monocytes	r = -0.261; p=0.050
Eosinophil	r = -0.342; p=0.009
Basophils	r = -0.270; p=0.042

was not significant. This is because the value p = 0.504 for a 1-hour ESR and p = 0.751 for a 2-hour ESR which means the value p>0.05. As for the correlation coefficient value, r = 0.081 on a 1-hour ESR and r = 0.039 on a 2-hour ESR. The correlation coefficient is positive and has a weak correlation strength because r = 0.0 - <0.2.

Table 3. Abdominal obesity correlation test results with 1-hour and 2-hour ESRs

	1-hour ESR	2-hour ESR
Abdominal obesity	p = 0.504	p = 0.751
	r = 0.081	r = 0.039

DISCUSSION

Several studies have examined the relationship between the abdominal circumference and neutrophil counts and leukocyte count. A study by Kim and Park (2008) conducted study on the relationship of calculating leukocyte and abdominal fat types in obese adolescents in Seoul, South Korea, there was a correlation between abdominal circumference and neutrophils and a positive correlation of weakness and there was a correlation between the abdominal circumference and leukocyte count. If the level of obesity increases, there is a process of hypertrophy and excessive expansion of adipocytes that will trigger hypoxia in adipocyte cells. Hypoxia followed by high levels of oxidative stress will lead to apoptosis of adipocytes. Apoptosis of adipocytes will attract macrophages to adipose tissue to eliminate it. Macrophages and adipocytes will produce different types of adipocytes that trigger a series of chronic inflammatory processes. Adipocytes secreted some proinflammatory adipokines and cytokines such as leptin, C-reactive protein (CRP), transforming growth factor β (TGF-β), plasminogen activator inhibitor-1 (PAI-1), interleukin-1β (IL-1β), IL-6, and tumour necrosis factor-α (TNF-α). The role of this molecule is the key link between obesity and inflammatory processes. Leptin will be released more in people with high subcutaneous adipose tissue, while TNF-α will be more widely released in people with high visceral adipocyte tissue [8].

The various adipocytes produced will then cause local effects on the vascular endothelial. Adipocytes will trigger the production of vascular cell adhesion molecules (VCAM) and intercellular cell adhesion molecules (ICAM) causing an increase in vascular permeability. This increase in permeability will further cause fluids (which contain molecules such as complement proteins) and cells (PMN, MN, and other cells) to exit from the intravascular compartment to the extravascular compartment. This process of inflammation is what causes the increase of leukocytes and neutrophils [5].

Several studies have examined the relationship between the abdominal circumference and the calculation of lymphocyte and monocyte types. A study by Rodriguez et al. (2018) conducted research on the relationship between lymphocytes and monocytes to obesity seen from body fat mass and abdominal circumference (visceral adipocyte tissue) obtained a meaningful relationship between monocytes and body fat mass. The results of this study also explained that there is a meaningful relationship between lymphocytes and body fat mass. This is explained if there is an increase of 1 kg of subcutaneous body fat mass has an association with a decrease of 2% (range 0.3% - 3%) of the percentage of monocytes, and if there is an increase of 1 kg of subcutaneous fat mass the body has an association with a decrease of 0.5% (range 0.1% - 1%) of the percentage of lymphocytes [9].

Rodriguez et al. (2018) it was obtained that there is a correlation between the abdominal circumference and monocytes. The results of this study also explained that there is a correlation between abdominal circumference with lymphocytes. This explains if there is an increase of 1 cm of the abdominal circumference and 1 cm2 visceral adipocyte tissue has an association with a decrease of

7% (range 3% - 11%) of the percentage of monocytes, and if there is an increase of 1 cm of abdominal circumference of the body and 1 cm2 visceral adipocyte tissue has an association with a decrease of 2% (range 0.5% - 3%) of the body relining percentage of lymphocytes.[9]

Brown et al. (2014) explained that CD3+ cells (CD45RO+) and CD44+ cells should increase in obese individuals, due to the activation of immune adaptation processes resulting in the proliferation of inflammatory cells that make chronic inflammatory processes increase in obese people. But it was also found that there were CD3+ (CD45RO+) cells that still showed a tendency to decrease when body fat mass and adipose tissue increased in obese people. The activity of natural killer cells (NK-cells), T cytotoxic/suppressor cells (CD8), proliferation of B cells, and T cells will tend to decrease in people with obesity [10].

Eosinophils have a major role in the body's immunity to allergic reactions and parasitic infections. However, eosinophils are also detected in adipocyte tissue to contribute to the homeostasis of adipocyte cells and the energy metabolism of adipocyte cells. In obese people, the mass of adipocyte tissue increases to make the eosinophil value will below. This is due to the presence of interleukin 33 (IL-33) as the main mediator for activating innate lymphoid cells (ILC2s) that will release IL-5 which further increases the accumulation of eosinophils in adipocyte tissue. The accumulation of eosinophils in adipocytes encourages thermogenic activity in adipocyte tissue, where energy stored in lipid form can be used or converted as the energy needed by adipocyte cells. More adipocyte cells will require a greater number of eosinophils for energy metabolism. This condition makes the value of eosinophils in the blood will decrease in levels [11].

The percentage of CD4 cells and the ratio of CD4/CD8 will also significantly increase along with the increase in abdominal circumference. However, the number and percentage of B-cells do not increase and tend to decrease along with an increase in body mass or abdominal circumference. This causes basophils, eosinophils, monocytes, and lymphocytes to have a negative association and correlation with increased body mass and circumference. Neutrophils show significant improvements as body mass and abdominal circumference increase, as neutrophils have an important role to play in the inflammatory response to obesity[12].

The results of the correlation test using the Spearman test showed uncorrelated results between abdominal obesity with 1-hour or 2-hour ESRs. The dismay of the abdominal obesity value followed by an increase in blood pressure rate can be due to the spread of various pro-inflammatory cytokines produced at the time of obesity. In obesity, there are low-level inflammatory conditions, especially in white adipose tissue (WAT). WAT tissues have founded on the accumulation of macrophages and oxidative stress due to an imbalance of pro-oxide and antioxidants in the body[5].

Pro-inflammatory cytokines are released by the body when obesity is TNF-α, IL-1, IL-6, IL-8, interferon-gamma, and others It will then stimulate the liver cells to produce acute-phase proteins such as, C-reactive protein (CRP), procalcitonin (PCT), serum amyloid A (SAA) protein, fibrinogen, ferritin, alpha-1 antitrypsin, haptoglobin, alpha-1 acid glycoprotein, ceruloplasmin and complement proteins C3 and C4 [6]. In obesity, there is an increase in fat cells that will later induce the expression of IL-6 production in fat cells. Fat tissue, especially visceral fat tissue, will release 2-3 times more IL-6 than subcutaneous fat tissue which will affect the tissue for protein synthesis. The port vein is a single blood vessel in adipose tissue and this vein is directly related to the liver. The mobilization of free fatty acids will be faster from the visceral area than the subcutaneous fat area so that the activity of lipolysis in visceral fat is greater. The concentration of IL-6 In the plasma will increase in proportion to the fat period. Increased secretion of cytokine IL-6 in obese people gives rise to chronic subclinical inflammation (asymptomatic) one of which can be characterized by an increase in blood end rate [5].

In addition, increased levels of fibrinogen also have the most important role in the assessment of erythrocyte sedimentation rate. If there is a condition that causes an increase in levels of fibrinogen, or another macroglobulin will cause erythrocytes to settle more easily so the erythrocyte sedimentation rate will be faster. An increase in fibrinogen in small amounts can affect erythrocyte aggregation. In fibrinogen contains a positive charge, while in erythrocyte contains a negative charge. It is this difference in charge that plays a role in the occurrence of deposits. The positive charge of fibrinogen can cause a decrease in the negative charge of erythrocytes. A result, the nature of mutual recent resisting between erythrocytes is reduced so that between erythrocyte cells are more easily attached and aggregation occurs. Increased aggregation of fibrinogen causes the deposits that form faster so that the value of erythrocyte sedimentation rate will be higher [13].

Hs-CRP examination is more sensitive and specific compared to ESR s where the percentage of hs-CRP sensitivity is 89.5% and specificity is 50%, while the percentage of ESR sensitivity is 60% and specificity is 8.3%. This suggests that hs-CRP examination is more reliable in determining the presence of inflammation in a person's body[14]. The best inflammatory marker today is Hs-CRP because it is synthesized in the liver and under the control of IL-6 (adipose cytokine) in response to various inflammatory stimuli both acute inflammatory (infectious) and chronic inflammation[5].

C-Reactive Protein is a better marker than other inflammatory led markers. This is because CRP is more sensitive, specific, and faster at detecting changes in acute phase reactions. Less specific ESR examinations indicate that false negative and false positive results (increased in the absence of inflammation) are more commonly found. A slow erythrocyte deposition response to an acute phase reaction leads to false negatives at the beginning of an inflammatory process. In addition, the advantage of CRP is that it can detect inflammation faster than erythrocyte sedimentation rate. Harrison also explained that there are only two conditions where ESR examination is better, namely in detecting low-level bone and joint infections, and monitoring the activity of autoimmune diseases such as systemic lupus erythematosus (SLE)[15].

CONCLUSION

There was a significant correlation between abdominal obesity with leukocyte count and total leukocytes but there was no correlation with erythrocyte sedimentation rate.

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CONFLICT OF INTEREST

Researchers stated that there was no conflict of interest between fellow researchers or others during the study.

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