

# Correlation of Lipid Profiles and Inflammatory Markers with Visceral Fat in Young Adult Men with Normal and Higher Body Mass Index

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**Abstract:** Excessive visceral fat is correlated to the increased risk of cardiovascular and metabolic diseases by increased lipid profiles and circulation of inflammatory cytokines. Men have higher accumulated visceral fat due to hormone and other factors. The aim of this research is to study the correlation of lipid profiles (total cholesterol, high-density lipoprotein/HDL, low-density lipoprotein/LDL, and triglyceride/TG) and inflammatory markers (Leukocyte, Neutrophil, Lymphocyte, Erythrocyte Sediment Rate/ESR, Monocyte, Eosinophil). The cross-sectional study recruited 37 adult men with the mean age 24 years old. BIA was used to measure visceral fat rating ( $r = 0.465$ ,  $p = 0.002$ ), and samples of blood were collected following an overnight fast. The results showed that significant correlations were found between the serum cholesterol ( $r = 0.524$ ,  $p = 0.001$ ), LDL ( $r = 0.547$ ,  $p = 0.001$ ), triglyceride and visceral fat. From variables of inflammatory markers, the significant positive correlations were shown between leukocyte between visceral fat ( $r = 0.281$ ,  $p = 0.046$ ) and between ESR and visceral fat ( $r = 0.402$ ,  $p = 0.007$ ). In conclusion, statistically significant positive correlations were found between several lipid profiles (total cholesterol, LDL and TG) and visceral fat, and between specific inflammatory markers (leukocyte and ESR) and visceral fat.

## 1 INTRODUCTION

An excessive amount of visceral fat (VF) is linked to metabolic and cardiovascular disorders and could indicate defective subcutaneous fat that results in ectopic fat deposition, or the build-up of unwanted lipids in the pancreas, liver, heart, or skeletal muscle (Lim and Meigs, 2014). In fact, visceral adipose tissue is an important part of total body fat, and visceral obesity is defined as an excessively increased deposition of visceral adipose tissue. However, both metabolic and cardiovascular diseases are linked to this body composition (Piche et al, 2020). In order to estimate the possible risk of developing metabolic and cardiovascular diseases, visceral obesity must be quantitatively assessed

Numerous techniques, including computed tomography (CT) scanning, ultrasonography, dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), and magnetic resonance imaging (MRI), can be used to evaluate visceral fat in the abdominal cavity. BIA is a radiation-free,

noninvasive technique that can be used to evaluate visceral fat in the abdominal cavity (Schwartz et al, 2017). The abdominal cavity's visceral fat is evaluated by BIA, which also provides the visceral fat grading level (Sukkriang et al, 2021). Therefore, accessible and affordable measurement of VF using BIA could be used in many health facilities.

Compared to adult women, adult males have lower average body fat percentages. Even with these variations in overall body fat, adult males specifically have higher abdominal VF depots than premenopausal women (Nauli and Matin, 2019). Research has attempted to ascertain the role that testosterone plays in controlling the distribution of body fat. Testosterone production increases throughout puberty (about age 45) and begins to decrease after age 20 to 30 by up to 1% annually, reaching its lowest points in males 70 years of age (Frank et al, 2019). Reduced testosterone levels have been linked to an increase in the accumulation of abdominal VF (He et al, 2018). Thus, the accumulation of abdominal visceral fat could begin in young age.

Studies investigating correlation lipid profiles and inflammatory markers and VF mostly conducted in obese adults. In fact, a study in Chinese adults showed that an increased total cholesterol and low-density protein was correlated with VF in participants with normal Body Mass Index (BMI) (Lu et al, 2022). Meanwhile, an observational study indicated that VF in Korean adults with higher BMI was strongly associated with white blood cells (WBC) and neutrophil lymphocyte ratio (NLR) as inflammatory markers (Yu et al, 2019). Thus, further research is needed to evaluate the relationship between VF and biomarkers of inflammatory and cardiovascular diseases including subjects with normal BMI.

This study aimed to investigate the relationship between VF and various serum lipid profiles (total cholesterol, high-density lipoprotein/HDL, low-density lipoprotein/LDL, and triglyceride/TG), and inflammatory markers (leukocyte, neutrophil, lymphocyte, Erythrocyte Sediment Rate/ESR, monocyte, eosinophil) in young adult men with normal and higher BMI.

## 2 MATERIALS AND METHODS

### 2.1 Study Design, Setting and Sample Size

This cross-sectional study was conducted in Bandar Lampung, Lampung Province, Indonesia, from December 2019 to January 2020. The study was granted by the ethics committee of Politeknik Kesehatan Kementerian Kesehatan Tanjung Karang, Bandar Lampung, Indonesia. A total of 37 men was included in this study using purposive sampling. The inclusion criteria were (i) aged 18-35 years old, (ii) undiagnosed by type 2 diabetes, cardiovascular diseases, metabolic syndrome and cancer, (iii) no smoking, (iii) no fluctuated weight changes for 6 months.

### 2.2 Anthropometric and Biochemical Variables

The measurement of height (cm) and weight (kg) was collected using a stadiometer to the nearest 0.5 cm and digital weight scale to the nearest 0.1 kg. BMI was a result of body weight divided by the square of body height in kg/m<sup>2</sup>. Visceral fat (VF) was measured using BIA, a body composition analyser (OMRON HBF 375) in standing position. VF was

rated by the BIA between 1 and 59 (low to high level which greater visceral fat indicated a greater level).

Samples of blood were collected following an overnight fast (>12 hours). A Hitachi 7600 Automatic analyser (High-Technologies Corporation, Hitachi; Tokyo, Japan) was used to test the serum levels of total cholesterol, HDL, LDL, and TG. With the aid of an automated blood counter system (ADVIA 120, Bayer; Whippany, NJ, USA), total differential blood counts were recorded as Leukocyte, Neutrophil, Lymphocyte, ESR, Monocyte, Eosinophil

### 2.3 Stastical Analysis

Characteristics and variables were shown as the mean with standard deviation (SD) for normally distributed data. Kolmogorov-Sminrov test assessed normality of variables. Person's correlation analysis was used to compute the correlation of lipid profiles and inflammatory markers with VF rating. Data were analyzed by SPSS version 25 (SPSS Inc., IBM, Armonk, NY, USA) for IOS. Significance was defined as p value below 0.05.

## 3 RESULTS

A total 37 males aged 24.6 years old in average were recruited in this study. Table 1 presents the age, anthropometric and biochemical data. The mean all anthropometric data of male subjects were higher than the recommendation value. The mean of BMI ( $24.6 \pm 5.6$  kg/m<sup>2</sup>) was above the cut off of normal BMI (25-29.9 kg/m<sup>2</sup>) according to WHO. The mean of total body fat, subcutaneous fat and muscle mass were  $26.7 \pm 8.5$  %,  $19.3 \pm 6.3$  %, and  $31.1 \pm 3.6$  % respectively. In addition, the mean of visceral fat was  $14.4 \pm 8.5$  %.

The mean inflammatory markers and lipid variables are also shown in Table 1. The mean ESR and was 33.7 mm/h, and the mean leukocyte 9105.4 /uL. The mean total cholesterol, LDL and triglyceride were 158.7 mg/dL, 82.4 mg/dL and 139.1 mg/dL respectively.

Table 2 displays the correlation of inflammatory markers and lipid profiles with visceral fat. In variables of inflammatory markers, significant positive correlations between ESR and visceral fat ( $r = 0.402$ ,  $p = 0.007$ ). It is shown similar results between leukocyte and visceral fat ( $r = 0.281$ ,  $p = 0.046$ ), although no significant were found for lymphocyte, neutrophil, monocyte, and eosinophil level in relation to visceral fat.

Table 1: Descriptive characteristic of subjects

| Variables                   | Mean Values     |
|-----------------------------|-----------------|
| Age (year)                  | 24.6 ± 5.6      |
| <b>Anthropometry</b>        |                 |
| BMI (kg/m <sup>2</sup> )    | 30.2 ± 7.3      |
| Body Fat Percentage (%)     | 26.7 ± 8.5      |
| Visceral Fat (%)            | 14.4 ± 7.9      |
| Subcutaneous Fat (%)        | 19.3 ± 6.3      |
| Skeletal Muscle (%)         | 31.1 ± 3.6      |
| <b>Inflammation Markers</b> |                 |
| ESR (mm/h)                  | 33.7 ± 20       |
| Leukocyte (/uL)             | 9105.4 ± 3457.7 |
| Lymphocyte (%)              | 19.9 ± 7.3      |
| Neutrophil segment (%)      | 58.2 ± 8.6      |
| Neutrophil (%)              | 3.9 ± 2.4       |
| Monocyte (%)                | 12.6 ± 4.2      |
| Eosinophil (%)              | 5.4 ± 4.5       |
| <b>Lipid Profiles</b>       |                 |
| Total Cholesterol (mg/dL)   | 158.7 ± 37.9    |
| HDL Cholesterol (mg/dL)     | 48.5 ± 9.9      |
| LDL Cholesterol (mg/dL)     | 82.4 ± 32.6     |
| Triglyceride (mg/dL)        | 139.1 ± 46.5    |

Significant positive correlations were found between the serum total cholesterol and visceral fat ( $r = 0.524$ ,  $p = 0.001$ ) and between serum LDL and visceral fat ( $r = 0.547$ ,  $p = 0.001$ ). In addition, there was a significant correlation between serum triglyceride and visceral fat ( $r = 0.465$ ,  $p = 0.002$ ). However, there was no correlation between serum HDL and visceral fat ( $r = -0.232$ ,  $p = 0.084$ ).

Table 2: Correlation of Inflammatory markers and Lipid Profiles with Visceral Fat rating

| Variables                                                                            | Visceral fat rating     |         |
|--------------------------------------------------------------------------------------|-------------------------|---------|
|                                                                                      | Correlation Coefficient | p-value |
| <b>Inflammatory markers</b>                                                          |                         |         |
| ESR (mm/h)                                                                           | 0.402*                  | 0.007   |
| Leukocyte (/uL)                                                                      | 0.281*                  | 0.046   |
| Lymphocyte (%)                                                                       | -0.052                  | 0.381   |
| Neutrophil segment (%)                                                               | 0.243                   | 0.074   |
| Neutrophil (%)                                                                       | -0.152                  | 0.184   |
| Monocyte (%)                                                                         | -0.232                  | 0.083   |
| Eosinophil (%)                                                                       | 0.005                   | 0.488   |
| <b>Lipid Profiles</b>                                                                |                         |         |
| Total Cholesterol (mg/dL)                                                            | 0.524**                 | 0.001   |
| HDL Cholesterol (mg/dL)                                                              | -0.232                  | 0.084   |
| LDL Cholesterol (mg/dL)                                                              | 0.547**                 | 0.001   |
| Triglyceride (mg/dL)                                                                 | 0.465*                  | 0.002   |
| *statistically significant at $P < 0.05$ ** statistically significant at $P < 0.001$ |                         |         |

## 4 DISCUSSION

This study found that certain lipid profiles (Cholesterol, LDL and Triglyceride) were significantly correlated with VF in healthy and young adult men, but not with serum HDL. This is similar to previous studies in nondiabetic population Taiwan (Huang et al, 2015), Chinese (Lu et al, 2022) and Korea (Yu et al, 2019), which VF was measured using Magnetic Resonance Imaging (MRI). Asian population have higher risk factors for metabolic and cardiovascular disease, since they have more total body fat and visceral adipose tissue, despite normal BMI (Katsuki et al, 2003).

In addition, significant correlations with VF were only shown in ESR and leukocyte levels. Leukocyte or White Blood Cells (WBC) and ESR has been used to assess the risk of cardiovascular and inflammatory diseases (Danesh et al, 1998), and has also correlated with the increased visceral obese measured by waist-hip ratio (Faam et al, 2014). Similar findings were shown in the previous study that increased VF was associated with increased inflammation (Srinivasa, et al, 2019). The mechanism of this finding is unclear, visceral fat could secrete adipokines and pro-inflammatory cytokines that could alter metabolism (Deng et al, 2010). Increased leukocyte and ESR in this study might occur due to inflammation process of this altered metabolism.

Healthy individuals from Asia with increased visceral fat should concern on this condition, especially men (He et al, 2018). This is caused that a large number of studies, including this study, indicates higher visceral fat could be an independent predictor of pro-inflammatory cytokines and component of metabolic syndrome, leading to cardiovascular diseases. According to these findings, biochemical assessments of lipid profiles and inflammatory markers could be a part of cardiometabolic screening (Arakaki et al, 2018). Indeed, preventive efforts of CVD risk should include lifestyle modification such as limited alcohol and saturated fat intake, along with weight management and limited smoking habit (Traversy and Chaput, 2015).

We acknowledge that there were several limitations in this study. First, it was unable to determine causality or causation due to its observational cross-sectional design, and any potential confounding variables were unable to be controlled. Secondly, the number of subjects were limited, which might not be represent the population. Third, different adipokines or other inflammatory mediators were not collected in this study. Despite

these limitations, studies investigating correlation of visceral fat in young and healthy adult men with lipid profiles and inflammatory markers are still limited, thus this study could be the baseline to conduct the similar studies with the retrospective design.

## 5 CONCLUSIONS

This study indicated that statistically significant positive correlations were found between several lipid profiles (total cholesterol, LDL and TG) and visceral fat, and between specific inflammatory markers (leukocyte and ESR) and visceral fat.

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