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Correlation of Triglyceride/HDL-Cholesterol Ratio and Visceral Adiposity Index with 25(OH)D in Obese Female

Monica, Meita Hendrianingtyas

Department of Clinical Pathology, Faculty of Medicine, Diponegoro University/Diponegoro General Hospital, Semarang, Indonesia. E-mail: monica_yong@outlook.com

ABSTRACT

Obesity is a condition of excess body fat mass with cardiometabolic complications. The levels of serum 25-hydroxyvitamin D (25(OH)D) decrease in obesity because it is stored in adipose tissue compartments and is related to dyslipidemia conditions. A high triglyceride/HDL-cholesterol (TG/HDL-C) ratio in obesity is related to dyslipidemia. Visceral Adiposity Index (VAI) is one of the parameters indicating central obesity related to visceral fat distribution in dyslipidemia conditions. This study aimed to prove a correlation between TG/HDL-C ratio and VAI with 25(OH)D levels in obese females. Observational study with cross-sectional design in 66 female patients. HDL-C examinations and triglyceride using the enzymatic colorimetry method. The TG/HDL-C ratio was calculated by dividing TG by HDL. The equation obtained visceral adiposity index (WC/(36.58+(1.89xBMI)) x (TG/0.81) x (1.52/HDL). 25(OH)D examinations used the Enzyme Linked Fluorescent Immunoassay (ELFA) method. Relationship status used the spearman rank test ($p<0.05$). Median 25(OH) levels were 9.75 (8-18.6)ng/mL. There was a weak negative correlation between TG/HDL-C ratio with 25(OH)D levels in obese females ($p=0.020$; $r=-0.287$) and VAI with 25(OH)D in obese females ($p=0.019$; $r= 0.287$). There was a weak negative correlation between TG/HDL ratio and VAI with 25(OH)D in obese female patients.

Keyword: TG/HDL-C, VAI, obese females, 25(OH)D

INTRODUCTION

Obesity is a condition hallmarked with excess adipose mass, calculated by Body Mass Index (BMI) is calculated by weight in kilograms divided by height in meters squared and defined by the World Health Organization (WHO) for the Asia Pacific region with IMT > 25 kg/m^2.[1] Waist circumference for the Asian ethnic with male > 90 cm and female > 80 cm are related to a BMI that usually has comorbidities.[2]

Obesity is the third highest event to cause chronic health disorders and has a global economic effect.[3] The number of obesity in the world has significantly increased since 1975. According to WHO, in 2016, there were 6050 million adults with obesity, and 39% were over 18 years old.[4] The adult female prevalence of obesity in the United States of America in 2017-2018 does not differ from male prevalence, but the prevalence of type II obesity was higher in females.[5] Female obesity in Canada was more elevated than males.[6] According to Baseline Health Research (Riset Kesehatan Dasar/Riskesdas) 2018, there was an increase in adult obesity proportion in Indonesia between 2007, 2013, and 2018 from 10.5% to 14.8% and 21.8%. Obesity was higher in the female population compared to the male.[3,7]

Obesity increases the risk of health disorders with high mortality and morbidity. The distribution of body fat plays a role in these disorders. Females with increased body weight usually accumulate fat in the abdomen.[8] Obesity, particularly central obesity, is related to metabolic syndrome, which is marked by a decrease in glucose tolerance, hypertension, and abnormalities in the lipid profile.[2,9]

The TG/HDL-C ratio is an atherogenic index that is cheap, convenient, and can be implemented in many laboratories. TG/HDL-C ratio is used as an independent predictor for cardiovascular disease, atherosclerosis progression, and insulin resistance linked with dyslipidemic conditions.[10-12] High TG and low HDL levels can be found notably in females with central obesity.[8] Insulin resistance, Type 2 Diabetes Mellitus (T2DM), and cardiovascular disease (CVD) are related to hypertriglyceridemia and low HDL cholesterol levels.[12] Low HDL cholesterol levels strongly predict ischemic cardiovascular disease mortality in females more than males.[6]

Adiponectin increase, proinflammatory activation, a decrease in insulin sensitivity, an increase in diabetes risk, dyslipidemia in the form of high TG and low HDL, hypertension, atherosclerosis, and high mortality are found in central obesity linked

with metabolic syndrome. Evaluation of the abnormal body fat distribution in obesity uses general body fat distribution (DEXA), central fat distribution (CT/MRI).[2]

Adipose tissue markers include leptin, adiponectin, and liver fat content (MRS).[2] A more feasible parameter is needed for day-to-day practice to evaluate visceral fat distribution, using the evaluation of dysfunctional visceral fat index: Visceral Adiposity Index (VAI).[12,13] Visceral adiposity index is a gender-specific mathematical calculation index using simple anthropometric parameters (Body Mass Index/BMI and Waist Circumference/ WC) and biomarker parameters (TG and HDL). Visceral adiposity index female calculation is WC (cm)/36.58 + (1.89 x BMI) x (TG(mmol/L)/L/0.81) x 1.52/HDL(mmol/L)). The visceral adiposity index mirrors visceral fat storage and insulin resistance, is related to all metabolic syndrome factors, and is used to grade cardiometabolic risks.[10,14]

25-hydroxyvitamin D (25(OH)D) has an essential biological function in Calcium and bone metabolism.[15] Vitamin D status is based on blood 25(OH)D.[16,17] A study by Fan *et al*. shows that 84% of females with 25(OH)D deficiency, aged 22-32 years old were lower than those aged 31-44 years. 25(OH)D levels decrease with age, starting with perimenopause in females.[17] A study by Korean National Health and Nutrition Examination Survey (KHANES) found 25(O)D deficiency was more remarkable in females (64.5%) compared to males (47.3%): Yu *et al*. found 20.8% of the study subjects had severe deficiency where 11% of the subjects were male, and 31.5% of the subjects were female.[18] Jung CH *et al.* found a 25(OH)D decrease in female patients with metabolic syndrome.[9] Obesity is associated with deficiency of 25(OH)D by several mechanisms, including dyslipidemia and dissolution of 25(OH)D in fat tissue compartments.[15,19,20] A study by Elmi *et al*. in patients with 25(OH)D deficiency (levels <30 ng/mL) had higher LDL-C and TG compared to normal controls. Normal 25(OH)D control had significantly higher HDL-C.[21]

According to the description above, researchers wanted to know the correlation between TG/HDL-C ratio and VAI with 25(OH)D in obese female patients.

This study aimed to prove the correlation between TG/HDl-C ratio and VAI with 25(OH)D in obese females.

METHODS

This study was a cross-sectional observational analytic study conducted throughout July–November 2020 in Diponegoro General Hospital, Semarang, after getting permission from the Study Ethics Committee with an article number: No 32/EC/KEPK/FKUNIDIP/III/2020. Sample collection was done consecutively according to study criteria until the minimum number of samples was fulfilled. HDL-C and TG examinations were done using the enzymatic colorimetric method with an automatic clinical chemistry analyzer. The TG/HDL ratio was calculated by dividing TG by HDL. The calculation of BMI was obtained by weight in kilograms divided by height in meters squared (kg/m^2). Female VAI was obtained by WC (cm)/35.58 + (1.89 x BMI)) x (TG (mmol/L)/0.81) x (1.52/HDL (mmol/L)). 25(OH)D examination used Enzyme-Linked Fluorescent Immunoassay (ELFA). Inclusion criteria were female patients, aged 25-45 years old, BMI > 25 kg/m^2, WC > 80 cm, normal Serum Glutamic Pyruvic Transaminase (SGPT), and normal ureum. Exclusion criteria were pregnant or breastfeeding females, vitamin D consumption, hormonal/steroid therapy, and hormonal dysfunction.

RESULTS AND DISCUSSIONS

Sixty-six study subjects met the inclusion and exclusion criteria. The distribution of basic characteristics of the subjects is presented in Table 1.

The results of the examination data analyzed included Tg/HDL-C ratio, VAI, and 25(OH)D levels. Although the ratio of Tg/HDL-C, VAI, and 25(OH)D (p=0.000) data were not normally distributed, after undergoing data transformation, the proportion of Tg/HDL-C, VAI was normally distributed. At the same time, 25(OH)D levels remained not normally distributed. Therefore, relationship analysis was done using the Spearman Rank test. The correlation between TG/HDL-C ratio and VAI with 25(OH)D data in obese female patients can be seen in Table 2.

There was a weak negative correlation between TG/HDL-C ratio with 25(OH)D in obese female patients (p=0.020; and r = -0.287). Data distribution of the Tg/HDL-C ratio with vitamin D levels can be seen in Figure 1. There was a weak negative correlation between VAI and 25(OH)D levels in obese females (p= 0.019; and r= 0.287). VAI and 25(OH)D levels data distribution can be seen in Figure 2.

Analysis test results on the subjects of this study show a weak negative correlation between TG/HDL-C ratio with 25(OH)D levels and between VAI with 25(OH)D levels in female patients with obesity. The 25(OH) median was 9.75 (8–18.6) ng/mL. This data shows that the higher the TG/HDL ratio, the lower the 25(OH)D levels and vice versa. The same results were

Table 1. Basic characteristics of study subjects

Variable (n=66)	Mean±SD	Median (min-max)
Age (years old)	33.94±5.43	33 (25–48)
Systolic blood pressure (mmHg)*	114,24±13,819	110 (90–170)
Diastolic blood pressure (mmHg)*	71.52±9,322	70 (60–110)
Weight (kg)*	74.31±11,849	71.65 (58–127)
Height (cm)	155,62±4,816	156 (145–167)
BMI (kg/m^2)8	30,7788±4,4803	29.4 (25.3–52)
Waist circumference (cm)*	91.45±7.933	89.25 (80–120)
Hip circumference (cm)*	108,5±9,252	108 (91–150)
SGOT (U/L)*	22.11±7.87	21 (14–75)
SGPT (U/L)*	19.5±7,863	18 (6–38)
Ureum (mg/dL)	22,233±7,838	21 (8–46)
Creatinine (mg/dL)	0,7791±0,14906	0.8 (0.5–1.2)
Total cholesterol (mg/dL)	182,02±31,021	179 (98–252)
LDL-C (mg/dL)*	110,17±27.876	110,5 (64–186)
HDL-C (mg/dL)*	55.11±10.57	54.5 (32–81)
Triglyseride (mg/dL)*	94.92±36,358	88.5 (31–191)
HDL-C (mmol/L)	1,4252±0,27275	1.41 (0.83–2.09)
Triglyceride (mmol/L)*	1,0718±0,41074	0,995 (0.35–2.16)
TG/HDL-C Ratio*	1,8452±0,9636	1,535 (0.51– 4.59)
VAI *	1,4612±0,77751	1,175 (0.4–3.71) /
25(OH)D (ng/mL)*	10,789±3,1472 /	9.75 (8–18.6)

BMI, Body Mass Index; SGOT, Serum Glutamic Oxaloacetic Transaminase; SGPT, Serum Glutamic Pyruvic Transaminase; HDL, High Density Lipoprotein-Cholesterol; LDL, Low Density Lipoprotein-Cholesterol; TG, Triglyceride, VAI, Visceral Adiposity Index; SD (Standard Deviation); min (minimal); max (maximal); *not normal data distribution

Table 2. TG/HDL-C ratio and VAI with 25OH)D correlation in obese female patients

Variable	Vitamin D (ng/mL)	
	p	r
Tg/HDL-C ratio	0.020*	-0.287
VAI	0.019*	-0.287

HDL, High Density Lipoprotein-Cholesterol; Tg, Tryglyceride, VAI, Visceral Adiposity Index; Spearman Rank test, *p< 0.05; r, correlation coefficient

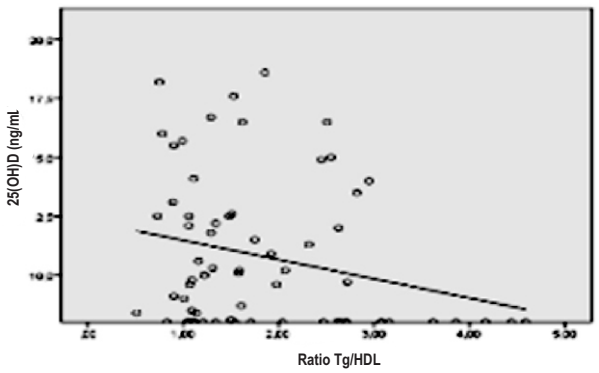

Figure 1. Scatter plot of the correlation of Tg/HDL-c ratio with 25(OH)D levels in female patients with obesity

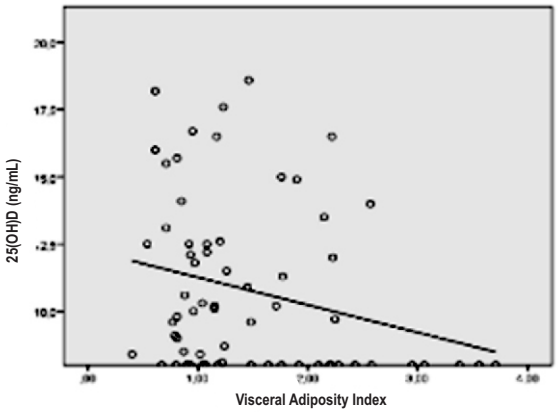

Figure 2. Scatter plot of the correlation between VAI with 25(OH)D levels in female obese patients

obtained for VAI, where the higher the VAI, the lower 25(OH)D levels and contrarily.

TG/HDL-C ratio has been related to insulin resistance, coronary heart risks, and metabolic disease predictor.[11,12,22] Triglyceride and HDL-C are affected by age and gender. Females usually have lower triglycerides and higher HDL-C levels compared to males. A study by Tang found that gender, BMI, TG, and urea nitrogen are risk factors

for HDL-C hypolipidemia.[23] Menopaused females experience an increase in TG and a decrease in HDL. A study by Nie G *et al*. found the TG/HDL ratio to be higher in elderly females compared to younger females, and the high correlation between TG/HDL ratio and obesity lowers with age.[11] Borrayo studies found a positive correlation between TG/HDL-C ratio and BMI.[24]

There was a weak negative correlation between VAI and 25(OH)D levels in obese females in this study. Obesity, particularly visceral obesity, is a risk factor for metabolic syndrome and is heavily related to dislipidemia. Obese individuals have increased levels of free fatty acid that affect lipid metabolism by increasing the production of very low-density lipoprotein by the liver, decreasing HDL-C levels. Female patients with central obesity have higher triglyceride and lower HDL-C levels than non-obese.[10,11] Visceral adiposity index has been identified as a visceral fat and adipose tissue dysfunction marker.[12,13] A study by Uruka *et al*. found VAI, along with the TG/HDL ratio, had a positive predictive value for muscle and liver insulin resistance.[22] High levels of both markers are associated with age-related physiological conditions related to leptin resistance, lipotoxic cardiomyopathy, and severe endothelial dysfunction.[12] Triglyceride abnormalities increase with increasing glucose intolerance and higher HDL abnormalities in females with all stages of glucose intolerance.[25] Visceral adiposity index is significantly related to all metabolic syndrome-related factors.[12]

25 (OH)D levels were lower in this study compared to Fan *et al*. 84% of females between 22–44 years old had 25(OH)D deficiency.[17] Obesity is associated with 25(OH)D deficiency through several mechanisms. Low levels of 25-hydroxyvitamin D can interfere with insulin action, glucose metabolism, and various metabolic processes in the body tissue. Lipid-soluble 25-hydroxyvitamin D is stored in fat tissue compartments and is low in serum. Calcitriol is reported to trigger lipogenesis and prevent lipolysis. Obesity is associated with chronic inflammation in adipose tissues that are proven by an increase in cytokine levels, including tumor necrosis factor-alpha (TNF-α), which is known to trigger lipogenesis and disrupt insulin signals that cause dysfunction in glucose metabolism in adipose and muscle tissue.[13,16] Fan *et al.* study shows no relationship between BMI and serum 25(OH)D.[17] 25(OH)D deficiency has been shown to impair the synthesis and secretion of insulin in human and animal diabetes models, suggesting a role in the development of type 2 diabetes, which is one of the common causes of general and abdominal obesity.[19] Dyslipidemia conditions are related to 25(OH)D. AlQuaiz *et al*. found that low levels of HDL are related to low levels of 25(OH)D in female patients.[20] Jiang found an association between 25(OH)D deficiency and dyslipidemia in the Chinese population, serum 25(OH)D had an invert relationship with LDL and TG, and a positive relationship with HDL.[25]

The limitations of this study include not analyzing factors that could affect 25(OH)D levels and obesity, such as duration of exposure to sunlight, type and amount of diet, and physical activity. Determination of exclusion and inclusion factors using questionnaires, laboratory results, and anthropometric measurements.

CONCLUSIONS AND SUGGESTIONS

The results of this experiment show a weak negative relationship between TG/HDL ratio and VAI towards 25(OH)D in obese female patients. However, further study is necessary with sample selection that considers the variables of physical activity, diet, and duration of sunlight exposure, because they affect the levels of 25(OH)D in the blood.

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