Vol 10 No 1, 2025

E-ISSN: 2528-410X

RESEARCH ARTICLES

The Relationship Between Anthropometric Measurements and Low-Density Lipoprotein (LDL) Levels in Women Aged 30-50 Years

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Abstract: Nutritional status is known to influence low-density lipoprotein (LDL) levels. It can be assessed by measuring body mass index (BMI), waist circumference (WC), and mid-upper arm circumference (MUAC). Individuals with obesity are at greater risk of having elevated LDL levels compared to those with normal nutritional status. In women, hormonal changes, particularly during menopause, can affect lipid metabolism and contribute to higher LDL levels. This study aimed to examine the correlation between BMI, WC, and MUAC with LDL levels in women aged 30-50 years. This descriptive-analytical study used a cross-sectional design involving 38 females' subjects aged 30-50 years old. Anthropometric measurements and LDL levels were recorded. Pearson's correlation test was used for data analysis. The results showed a weak but statistically significant positive correlation between BMI and LDL (p = 0,034, r = 0,344), WC and LDL (p= 0,035, r=0,344), and MUAC and LDL (p = 0,046, r = 0,326). This study found a correlation between BMI, WC, and MUAC on LDL levels.

Keywords: body mass index, waist circumference, mid-upper arm circumference, LDL levels

INTRODUCTION

Anthropometry is a non-invasive, affordable, and simple method to assess nutritional status, which is influenced by the nutrients consumed, including fats.[1] Fats are processed into triglycerides, total cholesterol, high density lipoprotein (HDL), and low-density lipoprotein (LDL). LDL, formed from very low-density lipoprotein (VLDL), is responsible for transporting fats in the blood.[2–4] High levels of LDL will increase the risk of cardiovascular diseases such as heart attack, coronary artery disease, and stroke.[5,6]

BULETIN FARMATERA
E-ISSN: 2528-410X

According to Adult Treatment Panel III (ATP-III) guidelines by National Cholesterol Education Program (NCEP), optimal LDL levels for individuals aged ≥15 years should be <100 mg/dL. However, according to data obtained from Basic Health Research (*Riskesdas*) 2013, 60% of Indonesians have LDL levels in the near-optimal or borderline high range, with 76.2% exceeding the optimal level.[7,8]

Several studies show that individuals with a normal body mass index (BMI) have LDL levels within the near-optimal range. BMI, which is calculated by dividing weight (kg) by height (m²), is an important indicator of obesity and is linked to higher LDL levels. Furthermore, waist circumference (WC) is also a key measure for central obesity, and correlates with elevated LDL levels. The mid-upper arm circumference (MUAC) is another anthropometric measurement that can help assess obesity, which has been shown to align with BMI in some studies.[9–13]

In women, hormonal changes, particularly during menopause, can influence lipid metabolism and contribute to higher LDL levels. Estrogen, for instance, has a protective effect on lipid profiles, and as estrogen levels decrease, LDL levels tend to increase, further increasing cardiovascular risk.[14,15]

The prevalence of obesity in Indonesia has increased from 14.8% in 2013 to 21.8% in 2018. In North Sumatra and Medan, the prevalence rates for obesity in 2018 were 25,76% and 24,80%, respectively.[8,16]

Given the rising obesity rates and hormonal influences, this study aims to understand the relationship between anthropometric measurements (BMI, WC, and MUAC), and LDL levels in women aged 30-50 years.

METHOD

This study uses a descriptive analytical design with a cross-sectional approach, involving 38 participants who met the inclusion criteria: women aged 30-50 years, with no history of heart disease, diabetes mellitus, dyslipidemia, or hyperthyroidism, not using dyslipidemia medications, and not engaging in weightlifting exercises. The subjects were also asked to fast for 8–10 hours before the examination. Subjects who met the inclusion criteria underwent measurements of body weight and height to calculate BMI, waist circumference, upper arm circumference, and 3 mL of venous blood was drawn for LDL cholesterol analysis. Data analysis was performed using Pearson correlation test for normally distributed data.

RESULT

The subject characteristics is summarized in table 1. The average BMI and WC indicate that the subjects are obese, while the MUAC considered within normal range. The mean LDL levels in this study were classified as near-optimal range according to NCEP-ATP III guidelines.

Table 1. Characteristics of Subjects Studied

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E-ISSN: 2528-410X

Variables	Women (n = 38)
Age, years	45 ± 4.39
BMI, kg/m^2	25.05 ± 2.7
WC, cm	86.5 ± 8.8
MUAC, %	97.7 ± 12.1
LDL-c, mg/dl	120.8 ± 14.8

The normality test for this study was conducted using Shapiro-Wilk, as the number of the subject is <50. The results for each variable are summarized in table 2. According to table 2, all data follow a normal distribution.

Table 2. Normality Test

Variables	p-value
BMI, kg/m^2	0.667
WC, cm	0.805
MUAC, %	0.993
LDL-c, mg/dl	0.632

The relationship between anthropometric measurements and LDL levels is summarized in table 3. Statistical analysis show that the correlation between BMI and LDL levels yielded a p-value of 0.034 with a Pearson correlation coefficient (r) of 0.344. This indicates a weak but positive correlation. The correlation between WC and LDL levels resulted in a p-value of 0.035 with a Pearson correlation coefficient (r) of 0.344, also indicating a weak but positive correlation. Meanwhile, the correlation between MUAC and LDL levels yielded a p-value of 0.046 with a Pearson correlation coefficient (r) of 0.326, indicating a similarly weak but positive correlation.

Table 3. Relationship Between Anthropometric Measurements and LDL levels

Variables	Pearson Correlation		
	n	r	p-value
BMI LDL levels	38	0.344	0.034
WC LDL levels		0.344	0.035
MUAC LDL levels		0.326	0.046

DISCUSSION

Body Mass Index (BMI) is one of the most commonly used methods for determining nutritional status. The average BMI in this study, based on a total of 38 subjects, was 25.05 kg/m². According to the Asia-Pacific criteria, the BMI of the subjects in this study falls into the obesity category.[17] Data from the *Riskesdas* 2018 shows that for an average age of 45 years, the highest prevalence of BMI is obesity, at 45.18%.[16] Obesity is often caused by an imbalance between nutrient intake and energy expenditure. As people enter middle age, physical activity tends to decline, followed by a decrease in metabolic capacity. The excess nutrients not used for energy will be stored as fat in adipose tissue. In addition to lifestyle factors, obesity in middle-aged women is believed to be related to hormonal imbalances due to menopause. Nearly 10% of women experience menopause before the age of 45. During menopause, estrogen levels decline drastically, and this decrease in estrogen is believed to contribute to obesity.[14,18,19]

Waist circumference (WC) is one method used to assess central obesity.[20]

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E-ISSN: 2528-410X

According to the Asia-Pacific criteria, a normal WC for women is <80 cm. In this study, the average WC of the subjects was 86.5 cm. Most of the subjects in this study showed signs of central obesity. Data from *Riskesdas* 2018 indicates that, at an average age of 45 years, 51.01% of individuals experience central obesity.[16] Research by Handayani et al. found that women aged 36-45 years in Iran tend to experience central obesity.[21] Similar to weight gain, central obesity in women can also be caused by hormonal imbalances. During menopause, androgen levels increase. Androgens play a role in the distribution of fat in visceral tissues.[14,22]

Mid-upper arm circumference (MUAC) is commonly used to assess malnutrition in children and pregnant women. Recent studies show that MUAC can also be used as a predictor of nutritional status, including in assessing obesity.[23] In this study, the average standard deviation percentage for MUAC in the subjects was 96.5%. This indicates that the MUAC of the study subjects falls into the category of good nutritional status.[24] Data from *Riskesdas* 2018 also shows that in North Sumatra Province, the average MUAC of women aged 45 years who are not pregnant falls within the good nutritional status category.[16] MUAC can be used to assess subcutaneous fat.[23] In women, fat is generally stored in the subcutaneous and *gluteo-femoral* regions. However, during menopause, fat that was previously stored in the subcutaneous and *gluteo-femoral* regions will be redistributed as visceral fat. This occurs because, during menopause, estrogen levels drastically decrease while androgen levels increase.[25,26]

Low-Density Lipoprotein (LDL) is a lipoprotein derived from the metabolism of VLDL. According to the Adult Treatment Panel III (ATP-III) guidelines issued by the National Cholesterol Education Program, an optimal LDL level is <100 mg/dL.[7] In this study, the average LDL level among the subjects was 120.8 mg/dL. Referring to the NCEP-ATP III criteria, most of the subjects in this study had LDL levels that were close to optimal. In line with the *Riskesdas Biomedis* 2013 data, 60% of the Indonesian population has LDL levels close to optimal. The *Riskesdas Biomedis* 2013 data also shows that at the age of 45, the highest prevalence of LDL levels is close to optimal at 32.0%.[8] Menopause is the most common etiology that causes LDL levels to increase. During menopause, estrogen levels decrease, and androgen levels increase. This results in increased triglyceride concentrations. Triglycerides are fats that contain a high amount of free fatty acids. The decline in metabolic activity leads to a disruption in free fatty acid regulation, which can increase LDL levels.[27]

The correlation between BMI and LDL levels is shown in Table 3, which reveals a weak but positive correlation, indicating that higher BMI tends to be associated with elevated LDL levels. In this study, the majority of the subjects had a BMI in the obesity category. Obesity is known to increase LDL levels due to insulin resistance

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E-ISSN: 2528-410X

in adipocytes, which leads to an increase in fatty acid flux into the liver.[28] These findings are in line with previous studies. For example, Humaera et al. found a weak positive correlation between BMI and LDL in the Jatinangor population over the age of 18 ($p = 0.026$, $r = 0.223$).[29] Similarly, Kibe et al. also reported a significant relationship between BMI and LDL levels in subjects aged 25-62 years in Kakamega County General Hospital, Kenya ($p = 0.013$).[30] However, the results of this study contrast with Putri et al.'s research, which did not find a significant relationship between BMI and LDL in police officers at the Bhayangkara Polyclinic in Semarang ($p = 0.060$). This discrepancy may be attributed to the lifestyle of police officers, who generally have more physical activity compared to the general population, which could mitigate the effects of obesity on LDL levels.[31]

The correlation between waist circumference (WC) and LDL levels is also shown in Table 3, showing a weak positive correlation. Larger WC measurements tend to indicate higher LDL levels. In this study, most subjects were categorized as having central obesity. Research by Yudin et al. suggests that individuals with central obesity are more likely to have LDL levels 3.1 times higher than individuals with normal waist measurements.[32] In central obesity, the accumulation of visceral fat activates pro-inflammatory factors that lead to insulin resistance and oxidative stress, increasing the flux of free fatty acids to the liver.[33] Additionally, cytokine activity can reduce the effectiveness of HDL in clearing LDL, further increasing LDL levels.[28] These findings align with Laghari et al.'s study in Hyderabad, Pakistan, which reported a correlation between WC and LDL levels ($p = <0.05$, $r = 0.207$).[34] However, the results of this study are contradicting the research of Kathayat et al., who found no correlation between WC and LDL levels in the population of Kaski District, Nepal ($p > 0.005$, $r = -0.043$).[35] Similarly, Abbas et al. also reported no correlation between WC and LDL levels in premenopausal women in Makassar ($p = 0.164$, $r = 0.224$). This may be due to the healthy lifestyle of the subjects, which included a high-fiber diet and regular physical activity.[36]

The correlation between mid-upper arm circumference (MUAC) and LDL levels, shown in Table 3, also reveals a weak positive correlation. Larger MUAC measurements tend to indicate higher LDL levels. In this study, the majority of subjects had normal nutritional status based on MUAC percentage calculations. In cases of normal nutritional status, increased LDL levels could be influenced by various factors such as dietary intake, physical activity, and lifestyle choices. These findings align with Laghari et al.'s research, which reported a correlation between MUAC and LDL in women in Hyderabad, Pakistan ($p = 0.00$, $r = 0.285$).[34] A similar study by Shi et al. in Chongming District, China, also found a correlation between MUAC and LDL levels ($p = 0.016$, $r = 0.024$).[23] However, this

E-ISSN: 2528-410X

study's results contradict the findings of Kibe et al. and Kathayat et al., who found no significant relationship between MUAC and LDL levels in subjects aged 25-62 years in Kakamega County General Hospital, Kenya (p = 0.105) and in Kaski District, Nepal (r = 0.013).[30,35]

The results of this study indicate a weak correlation (r = ±0.3) between all the independent variables (BMI, WC, and MUAC) and the dependent variable (LDL levels). Several factors could have contributed to this weak correlation. This may be influenced by several factors such as the selection of subjects in a productive age group, the homogeneity of the sample with all subjects being female, and the lack of thorough examination to meet exclusion criteria, as for this study was based only on interview.

CONCLUSION

Based on the results of the study, it can be concluded that there is a significant relationship between BMI, WC, and MUAC with LDL levels. Higher results of anthropometric measurements are associated with higher LDL levels.

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