DOI: https://doi.org/10.47648/jswmc2025v15-01-112

**Original Article**

# Association of Atherogenic Index of Plasma and Lipid Profile Among the Women of Different Grades of Obesity

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**Abstract:**

**Background:** Obesity is linked to an elevated risk of developing atherosclerosis and coronary artery disease due to the presence of atherogenic dyslipidemia. The presence of dyslipidemia serves as a significant connection between obesity and the onset of cardiovascular disease. This study aimed to determine the relationship of the Atherogenic Index of Plasma (AIP) and lipid indices with body mass index (BMI) among women employees of Sylhet MAG Osmani Medical College, Sylhet.

**Methods:** This was a cross-sectional study. The duration of this study was January 2022 to December 2022. Female employees of Sylhet MAG Osmani Medical College participated in the study. With this objective, a total of two hundred women were enrolled utilizing a convenient sampling technique. Participants in the study included female employees, ages 18 to 45, who appeared healthy and whose BMI was 18.5 kg/m2 or higher. BMI was calculated from height and weight. Waist hip ratio (W:H ratio) was measured. Serum total cholesterol (TC), high-density lipoprotein (HDL), and triglyceride (TG) levels of individual participants were measured. Low-density lipoprotein (LDL-C) concentrations and atherogenic index of plasma were calculated. The simple linear regression analysis was used to test to identify the level of prediction of TC, LDL-C, TG, HDL and AIP by the BMI.

**Results:** There were no statistically significant differences were observed between the mean age, BMI, and W:H ratio of the subjects ($p>0.05$). The mean of the Atherogenic Index of Plasma (AIP) was found to be statistically significant ($p<0.001$) among the groups. There was a moderate positive correlation of TC and LDL with BMI. There was a strong positive correlation of TG and AIP with BMI. But HDL-C showed a significant negative correlation with BMI.

**Conclusion:** Lipid indices were significantly correlated with BMI.

Received date: 11 Sept. 2024

Accepted date: 22 March 2025

**Key words:** lipid indices, correlation, atherogenic index, BMI

**How to cite this article:** Paul T, Begum RA, Deb KK, Bhattacharjee T, Sharmin J, Nath GRD, et al. Association of Atherogenic Index of Plasma and Lipid Profile Among the Women of Different Grades of Obesity. Journal of Sylhet Women's Medical College. 2025 Jan; 15(01):11-15. https://doi.org/10.47648/jswmc2025v15-01-112

**JSWMC 2025 [15(01)] P: 11-15**

## Introduction:

Overweight and obesity are regarded as persistent threats in many countries during the last ten years.

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These have turned into a major global public health concern.[1] Obesity is a form of malnourishment. It is not limited to developed nations; rather, it is rapidly spreading to low- and middle-income nations. There is a clear relationship between the increased incidence of

co-morbidities associated with obesity and the prevalence of overweight and obesity.[2] Obesity exacerbates a wide range of co-morbidities, such as dyslipidemia, type 2 diabetes mellitus (T2DM), hypertension, cardiovascular disease (CVD), liver dysfunction, respiratory diseases, musculoskeletal disorders, sub-fertility, psychosocial problems, and certain types of cancer, depending on the extent and duration of weight gain.[3] Obese people are frequently diagnosed with dyslipidemia. About 50–60% of patients who are overweight and 60–70% of patients who are obese also have dyslipidemia.[4]

In most clinical contexts, body mass index (BMI) is more practical and has a relatively good correlation with laboratory-based markers of adiposity for population studies.[4] It is well-recognized that atherogenic dyslipidemia contributes significantly to the pathogenesis of CVD in obese people. When determining a patient's overall risk of CVD, atherogenic dyslipidemia and increased levels of lipoprotein (a) or C-reactive protein (CRP) may also be significant factors. Low levels of HDL-C (high-density lipoprotein cholesterol) and a rise in lipoproteins rich in triglycerides are the hallmarks of obesity-associated dyslipidemia. Typical dyslipidemic indicators in clinical contexts, the TC/HDL, HDL/LDL, and LDL/HDL ratios, have been used in recent years. Instead of using the traditional lipid profile, clinical research aims to develop a more accurate marker of atherogenic dyslipidemia that can predict the risk of CVD and be used to assess therapy response.[5]

Atherogenic index of plasma (AIP) is a logarithmically converted ratio of triglyceride molar concentrations to HDL cholesterol.[6] It is a significant predictor of cardiovascular disease (Khazaal et al., 2013).[7] Greater the athreogenic index, the greater the risk of cardiovascular risk. Cardiovascular risk is higher when the atherogenic index score is greater than 0.24. If AIP is 0.1 to 0.24, it indicates medium risk, and -0.3 to 0.1 indicates low risk.[8]It has been observed that women who are obese had significantly higher levels of TG, LDL-C, and TC and lower HDL-C. The strongest association was observed in women aged 35-54.[9] Oladipo et al. (2009) reported that women's Atherogenic Index data were much higher than men's.[10] Therefore, this study aimed to observe the association of atherogenic Index of Plasma (AIP) and lipid profile among women of different grades of obesity.

**Methods:**

This cross-sectional comparative study was conducted at Sylhet MAG Osmani Medical College, Sylhet, in cooperation with the Department of Biochemistry. This study was conducted from January 2022 to December 2022. Ethical clearance was taken from "Institutional Ethical Review Board" of Sylhet MAG Osmani Medical College. The study's participants were female employees (18–45 years old) of Sylhet MAG Osmani Medical College. By using a convenient sample technique, two hundred women in total were registered for this purpose. A thorough assessment of the literature was conducted before creating the questionnaire. All the participants were apparently. The study excluded participants who had a history of diabetes, hypertension, thyroid disorders, cardiovascular illness, renal disease, or pregnancy. Informed written consent of each participant were obtained. Socio-demographic history of the participants was taken, and a physical examination was done. Height and weight were measured. BMI was calculated from height and weight. Based on their BMI, all of the participants were divided into four groups. Participants in Group A had BMIs ranging from 18.5-22.9 kg/m2 (normal weight). Participants in Group B had an overweight BMI of 23.9–24.9 kg/m2. The BMIs of participants in Group C ranged from 25.0 to 29.9 kg/m2, indicating Grade I obesity. Individuals in Group D had a BMI of more than 30.0 kg/m2, which is considered Grade II obesity. Serum total cholesterol (TC), high-density lipoprotein (HDL), and triglyceride (TG) levels of individual participants were measured. Low-density lipoprotein (LDL) concentrations were calculated. Atherogenic index of plasma (AIP) was calculated from serum TC and HDL cholesterol levels. A person's risk of developing cardiovascular diseases was divided into one of three groups based on their AIP value: Groups at low risk are −0.3 to 0.1, medium risk are 0.1 to 0.24, and high risk are greater than 0.24. One-

way ANOVA (Analysis of Variance) followed by Tukey post-hock test was done to compare the variables between study subjects. Linear Regression analysis was used to assess the correlation between two quantitative data.

**Results:**

Mean age of Group-A was 39.42±4.39 years, Group-B was 40.04±4.13 years, Group-C was 39.18±4.47 years, and Group-D was 38.16±4.18 years (Figure 1). Mean age of different groups were not statistically significant (p = 0.116).

The mean of the BMI of Group-A was 22.28±0.94 kg/m$^2$, Group-B was 23.96±0.55 kg/m$^2$, Group-C was 26.85±1.19 kg/m$^2$ and Group-D was 32.49±2.18 kg/m$^2$ in this study subjects (Table 1). The differences were found statistically significant (p<0.001). The post-hoc test also showed similar statistically significant (p<0.001) differences between study groups.

The mean of the waist hip ratio of Group-A was 0.97±0.03, Group-B was 0.99±0.06 kg/m2, Group-C was 1.02±0.04 and Group-D was 1.06±0.07 in this study subjects (Table 1). The differences were found statistically significant (p = <0.001). The post-hoc test showed similar statistically significant (p<0.001) differences between the groups.

The mean of the Atherogenic Index of Plasma (AIP) in Group-A was -0.13±0.06, Group-B was -0.04±0.08, Group-C was 0.40±0.08 and Group-D was 0.49±0.08 (Table 1). The differences were found statistically significant (p<0.001). The post-hoc test showed similar statistically significant (p<0.001) differences between the groups.

Linear regression analysis showed that, there were moderate positive correlation of TC and LDL with BMI (R=0.541, p<0.001; R=0.398, p<0.001) (Figure 2). There were strong positive correlation of TG and AIP with BMI (R=0.848, p<0.001; R=0.841, p<0.001) (Figure 2). But HDL-C showed significant negative correlation with BMI (R=-0.634, p<0.001) (Figure 2).

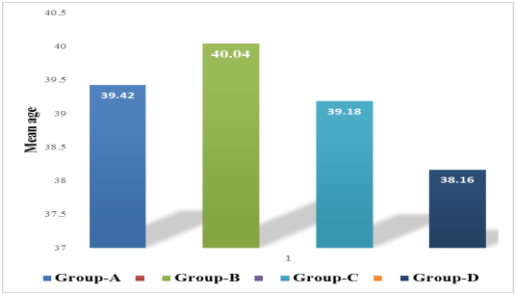



**Figure 1: Comparison of mean Age between the Different Study Groups.** Statistical analysis was done by ANOVA.

**Table 1: Comparison of Mean of Selected Anthropometric Measurement**

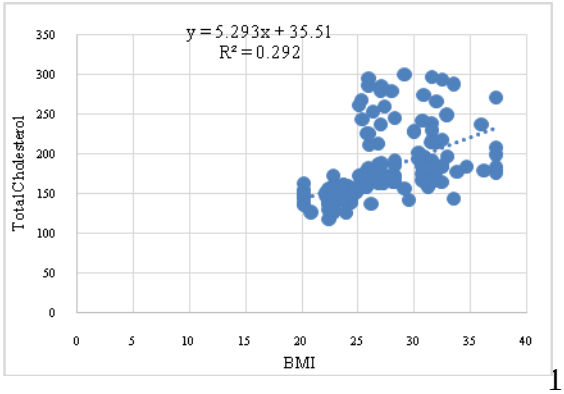
| Variables | Group-A | Group-B | Group-C | Group-D | p-value |
|---|---|---|---|---|---|
| **BMI** | 22.28±0.94 | 23.96±0.55 | 26.85±1.19 | 32.49±2.18 | <0.001 |
| **W:H Ratio** | 0.97±0.03 | 0.99±0.06 | 1.02±0.04 | 1.06±0.07 | <0.001 |
| **AIP** | -0.13±0.06 | -0.04±0.08 | 0.40±0.08 | 0.49±0.08 | <0.001 |

Statistical analysis was done by ANOVA. BMI: Body Mass Index; W:H ratio: Waist Hip ratio; AIP: Atherogenic Index of Plasma.

**Table 4: Correlations of BMI with TC, LDL-C, TG, HDL and AIP (n=200)**

| Variables | R | R² | p value |
|---|---|---|---|
| **TC** | 0.541 | 0.2924 | <0.001*** |
| **LDL-C** | 0.398 | 0.1583 | <0.001*** |
| **TG** | 0.848 | 0.7189 | <0.001*** |
| **HDL-C** | -0.634 | 0.4022 | <0.001*** |
| **AIP** | 0.841 | 0.7088 | <0.001*** |

Statistical analyses were done simple linear regression analysis test. TC- Total Cholesterol; LDL-C- Low Density Lipid Cholesterol, TG- Tryglyceride; HDL-C- High density Lipid Cholesterol; AIP: Atherogenic Index of Plasma; R=correlation coefficient; R²= coefficient of determination; ***- highly significant.



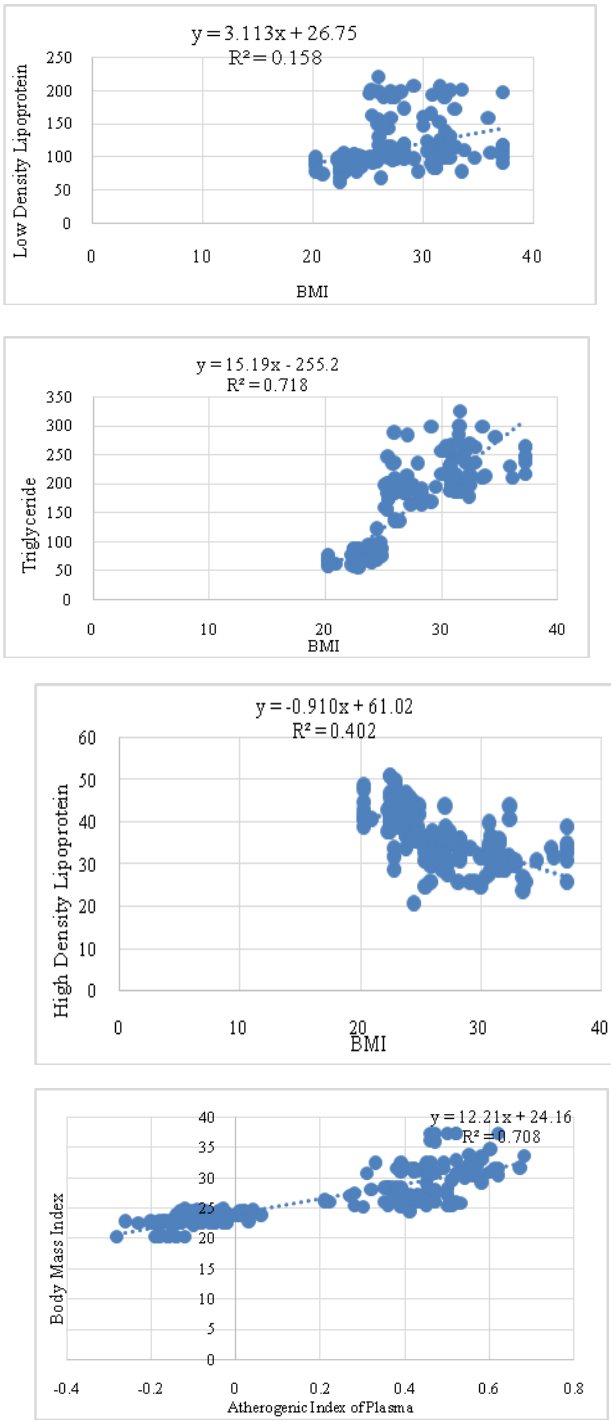



**Figure 2: Linear relationship between Serum TC, LDL, HDL and BMI**

**Discussion:**

Obesity is one of the causes of dyslipidemia.[4]A standard lipid profile is used to determine the Atherogenic index of plasma (AIP). The Atherogenic Index of Plasma (AIP) serves as an indicator for the assessment and prediction of the possibility of developing atherosclerosis and coronary heart disease.[6]The focus of this study was to determine the relationship between Atherogenic Index and obesity among women employees of Sylhet MAG Osmani Medical College, Sylhet.

The mean age differences between the study groups were not statistically significant in the present study. The Body Mass Index (BMI) often serves as an indicator of generalized obesity. The mean BMI of the normal-weight group was 22.28±0.94 kg/m$^2$, the over-weight group was 23.96±0.55 kg/m$^2$, Grade-I obese women was 26.85±1.19 kg/m$^2$ and Grade-II obese women were 32.49±2.18 kg/m$^2$. There was a distinctive BMI difference ($p<0.001$) between the studied groups.

The waist-to-hip ratio is used to assess central adiposity. In this study, the waist-hip ratio also found significant ($p<0.001$) increase along with the BMI; the ratio was 0.97±0.03 in normal-weight women, 0.99±0.06 in over-weight women, 1.02±0.04 in Grade-I obese women and 1.06±0.07 in Grade-II obese women. The mean AIP of the normal-weight women was -0.13±0.06, over-weight women were -0.04±0.08, Grade-I obese women was 0.40±0.08 and Grade-II obese women were 0.49±0.08 in this study. The correlation between the AIP and BMI was found moderately strong ($p<0.001$). Kanthe et al. (2012) observed a significant difference of AIP only between the normal-weight control group and the over-weight group ($p<0.05$).[5]This study found a significant mean difference of AIP between the studied groups as well as a significant positive correlation.

In the present study, TC and LDL showed a moderate positive connection with BMI. TG and AIP showed a significant positive correlation with BMI. However, there was a significant negative correlation between BMI and HDL-C. This finding was consistent with Zhu et al., 2018. They observed strong linear correlation between BMI and four lipid profiles in their study. While HDL-C had a negative correlation with BMI, TG, TC, LDL-C, and AIP had positive correlations. Ofori and Angmorterh, 2019 found that there was a negative, significant, week correlation between HDL and BMI. They also observed a strong and positive correlation between LDL and TC with BMI.[11]

Pekgor et al. (2020) showed a significant weak positive correlation (R = 0.290, p = 0.003) between BMI and AIP.[12]Anandkumar et al. (2020) reported comparison of correlation between BMI with AIP in obese female subjects. They observed weak positive correlation between BMI and AIP (R = 0.277, p = 0.032). The values suggested that AIP may be used as an effluence to ultimate abdominal obesity. In their study, Kanthe et al. (2012) observed a significant elevation in the Atherogenic Index among middle-aged women with a high body mass index (BMI) in comparison to those with a normal BMI.[5] The levels of total cholesterol (TC), triglycerides (TG), and very low-density lipoprotein (VLDL) exhibited a notable rise in obese women when compared to the control group. Additionally, a strong correlation was observed between the atherogenic index and body mass index (BMI) within the obese population.[13]

**Conclusion:**

This study population has revealed an elevated Atherogenic Index of Plasma in correlation with an increase in body mass index. There was a positive correlation of the total cholesterol, LDL, triglyceride, and atherogenic index of plasma with BMI. But HDL cholesterol was negatively correlated with BMI. The utilization of atherogenic lipid indicators may serve as a valuable tool for assessing the potential atherosclerotic consequences associated with obesity in women.

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