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# The effect of Atherogenicity index in Type 2 Diabetes mellitus patients and it is association with chronic cardiovascular complications of the disease

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**ABSTRACT:** Atherosclerotic cardiac disease (ASCVD) is a significant health issues among people who have Type 2 diabetes mellitus (T2DM). Diabetic patients experience ASCVD-related consequences 14.6 years faster than non-diabetic individuals. The main goal of the study was to assess the relevance of the atherogenic index of plasma (AIP) and other lipid-related indicators in predicting ASCVD risk in Iraqi T2DM patients.
Material and method: The Diabetes Research Centre at Mustansiriyah University in Baghdad compared 50 individuals with T2DM (25 males and 25 females) to 50 healthy controls. We measured anthropometrics, fasting blood sugar (FBS), HbA1c, and lipid profiles
Results: T2DM patients had significantly greater levels of FBS, HbA1c, TC, TG, LDL, and VLDL, as well as lower levels of HDL than controls ($p < 0.001$). AIP, computed as log(TG/HDL), was likewise raised in diabetes individuals. Female T2DM patients had greater FBS and HbA1c values than males. Patients and controls showed significant disparities in anthropometric measurements, including waist-to-hip ratio (WHR) ($p < 0.001$). Conclusion: These documented results show the crucial impact of AIP and lipid profiles in determining cardiovascular risk in T2DM patients, emphasizing the importance of early intervention and management measures in this high-risk population.

**Keywords:** Atherogenicity, T2DM, AIP, lipid profile, CVD

## 1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) consider is a chronic illness marked by insulin resistance and hyperglycemia, which raises the risk of cardiovascular problems. Atherosclerosis is very common in T2DM patients due to metabolic abnormalities such dyslipidemia and systemic inflammation. Atherosclerotic cardiovascular disease (ASCVD) is characterized by cholesterol build up in the arteries, which can cause cardiovascular disease, cerebrovascular accident, and peripheral artery disease [1]. ASCVD is a main cause of morbidity and mortality among diabetic patients. Around the world. The early onset of ASCVDs has been linked to type 2 diabetes. Individuals with diabetes mellitus (DM) develop cardiovascular problems 14.6 years earlier than individuals without DM [2]. dyslipidemia and Hypertension, famous as a common in people with type 2 diabetes, are harm factors for ASCVDs. Research revealed that people who were preconditioning with dys lipidemia had abnormal glucose and lipid anabolism like (insulin resistance), which resulted in a poor prognosis for ASCVDs [3]. Although the frequency of T2DM complication has decreased over time due to medical breakthroughs, over 382 million individuals worldwide now have diabetes, which renders them more prone to ASCVD-related impairment and death [4].

As a result, there is a dire need for ASCVD protection in diabetics. Effective methods for reliably predicting and diagnosing T2DM-related ASCVDs at an early stage must first be developed to attain this goal. Cardiovascular diseases (CVDs) have been diagnosed and prognoses using a number of indicators [5]. One sensitive indicator of lipoprotein profiles is the atherogenic index of plasma (AIP), which is a logarithmically modified quantity of TG to HDL-C as molar concentration [6]. AIP was specifically able to forecast the mass of lipo-protein particle, that were positively correlated with the risk of CVDs.

Furthermore, the level of insulin resistance connected with damaged glucose metabolism can be determined by AIP. In addition to known risk factors, AIP was recently discovered to be a distinct independent prediction biomarker for heart disease and arterial stiffness [7]. AIP was found to be associated with severe cardiac events in T2DM studies, and a high AIP score might clarify a more severe type of T2DM. AIP may be utilized as a simple-to-mathematize the parameter in the prediction of T2DM, according to a recent meta-analysis of 4010 individuals. Additionally, it was discovered that diabetic individuals with elevated AIP had a much higher risk of atherosclerosis and arterial stiffness. 2356 T2DM individuals were enrolled in another investigation, found that AIP had the greatest impact on the pro gnosis of T2DM following coronaries intervention, a treatment utilized to unblock blood channels after the onset of atherosclerosis [3]. Therefore, AIP may be a helpful predictor for the advancement of T2DM in people with it, mainly after they receive therapy for blood vessels stenosis [8]. It is unclear if AIP can predict the emergence of CVDs such as atherosclerosis and diabetes at an earlier stage [9]. Although there are a lot of papers and research that talk about the effect of DM on Atherogenicity and lipid elevation on the complications of Atherogenicity, there are few papers in Iraq that study these effects and join it with the elevated situations and raised patients in Iraq. Therefore, this study aims to focus on Iraqi patients suffering from T2DM and most susceptible to atherosclerosis by studying the level of glucose, HbA1c, and lipid profile tests, along with equations to estimate the major factors of Atherogenicity.

## 2. MATERIAL AND METHOD

### 2.1 THE STUDY POPULATION

In this study, 50 patients with T2DM, with ages between 39-60 years old, were chosen, and samples were taken from Diabetes center Research at Mustansiriyah University in Baghdad / Iraq. The patients were split into two main groups: 25 males and 25 females. The patient subgroups were compared with two subgroups of healthy participants, males and females, and each group contained 25 participants.

### 2.2 INCLUSION CRITERIA

The patients included in this study were chosen as they have T2DM and high lipid levels.

### 2.3 EXCLUSION CRITERIA

Patients with other diseases like heart failure or renal dysfunctions were excluded. The study even excluded smokers.

### 2.4 ANTHROPOMETRIC STUDY

Both control and patients were given their age and gender. The participants were asked to measure their weight and height to estimate their body mass index (BMI). BMI is calculated by the equation (BMI= W/H2) [10]. They also underwent to measure waist circumference and hip circumference to estimate waist-to-hip ratio (WHR). WHR is calculated by the equation (WHR= waist circumference/ hip circumference).

### 2.5 SAMPLE COLLECTION

All Participants (patients and control) gave blood samples for the coming work. 10 mL of blood were taken from participants, 3.5 mL of blood was put in EDTA tubes for the HbA1c% test, 6.5 mL of blood was placed in a plane tube or gel tube to and centered in the centrifuge at 4000 rpm for 8 mins to segregate serums. The segregated serums was then utilized to estimate the bio-chemical parameters for (FBS, HbA1c%, TC, TG, HDL, LDL, VLDL, AIP, TC / HDL, and LDL / HDL).

### 2.6 BIOCHEMICAL TESTS

HbA1c%, FBS, TC, TG, HDL, and LDL was estimated using Roche – Cobas C111 fully automated technique (Roche kit Germany).

### 2.7 STATISTICAL ANALYSIS

The study was conducted using version 25.00 of SPSS Statistics (IBM Corporations, New-York, USA). Description statistics were utilized to analyses the data, and the results were presented as means ± SD. The mean differences between the patient and normal groups were compared utilizing an independent samples T-Test. A 95% CI for $p < 0.05$ was treated as a statistically significant, while a 99% CI for $p \leq 0.01$ was considered extremely significant [11].

# 3. RESULTS AND DISCUSSION

## 3.1 ANTHROPOMETRIC AND BIOCHEMICAL MARKERS FOR MALES

T-tests were performed on the analyzed parameters to determine mean and SD and compute the P-value. The study found that male T2DM patients had a significantly higher age (51.0±5.28) compared to control (38.4±7.2), a non-significant difference in BMI (30.3±5.91) compared to control (26.66±3.01), a significant increase in WHR (1.0±0.072) compared to control (0.88±0.048), and a significant increase (P<0.05) in FBS level (178.4±45.3). The lipid profile results show a significant increase (P<0.05) in TC, TG, LDL, and VLDL between patient (222.8±40.64, 256.95±50.7, 134.4±45.82, 53.9±13.89) as compared with control (154.1±30.16, 93.6±11.08, 85.65±31.06, 18.7±2.15). However, there is a significant decrease (P<0.05) in the concentration of HDL between patient (34.45±1.1) as compared with control (49.75±4.6) for lipid profile equation tests. The result of the current study is shown in Table 1.

**Table 1. - T-test calculations for the used parameters for control and T2DM patients for Males**

| Mean ±SD For the studied parameters | Control (Male) (N=25) | patient (Male) (N=25) | p-value (T-Test) |
|---|---|---|---|
| Age, years | 38.4±7.2 | 51.0±5.28 | < 0.001 |
| BMI, Kg/m2 | 26.66±3.01 | 30.3±5.91 | 0.19 |
| WHR | 0.88±0.048 | 1.0±0.072 | < 0.001 |
| FBS mg/dl | 101.2±6.31 | 178.4±45.3 | < 0.001 |
| HbA1c % | 4.95±0.37 | 8.03±1.11 | < 0.001 |
| TC mg/dl | 154.1±30.16 | 222.8±40.64 | < 0.001 |
| TG mg/dl | 93.6±11.08 | 256.95±50.7 | < 0.001 |
| HDL mg/dl | 49.75±4.6 | 34.45±1.1 | <0.001 |
| LDL mg/dl | 85.65±31.06 | 134.4±45.82 | < 0.001 |
| VLDL mg/dl | 18.7±2.15 | 53.9±13.89 | < 0.001 |
| AIP | 0.27±0.031 | 0.86±0.12 | < 0.001 |
| TC\HDL | 3.11±0.65 | 6.46±1.12 | <0.001 |
| LDL\HDL | 1.73±0.66 | 3.88±1.27 | <0.001 |

## 3.2 ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS BETWEEN FEMALES

T-tests were done for the studied parameters to evaluate the mean and SD and to calculate the P-value. The findings show that female T2DM patients and control patients have significantly higher ages (P<0.05) (45.2±8.82) compared to control (37.3±3.26), significantly different BMIs (31.0±3.66) compared to control (25.34±3.49), significantly higher WHRs (1.0±0.062) compared to control (0.82±0.059), significantly higher FBS levels (233.6±66.76) compared to control (100.85±5.13), and significantly higher HbA1c percentages (8.95±1.85) compared to control (4.76±0.28). the result of lipid profile shows that there is a significant increase (P<0.05) in TC, TG, LDL, VLDL between patient (222.57±56.12, 273.85±74.1, 134.71±29.7, 52.52±16.72) respectively as compared with control (159.15±29.68, 91.8±3.69, 86.25±29.7, 18.4±0.82) respectively, while there is a significant decrease (P<0.05) in the level of HDL between patient (35.33±3.59) as compared with control (54.5±5.61), for lipid profile equation tests ( AIP, CT\HDL, and LDL\HDL) there are a significant increase (P<0.05) in patients ( 0.9±0.092, 6.35±1.67, 3.83±1.55) respectively as compared with control (0.22±0.041, 2.94±0.56, 1.6±0.54) respectively. The result of the current study is shown in Table 2.

**Table 2. - T-test calculations for the used parameters for control and T2DM patients for females**

| Mean ±SD For the studied parameters | Control (Female) (N=25) | patient (Female) (N=25) | p-value (T-Test) |
|---|---|---|---|
| Age, years | 37.3±3.26 | 45.2±8.82 | < 0.001 |
| BMI, Kg/m2 | 25.34±3.49 | 31.0±3.66 | < 0.001 |
| WHR | 0.82±0.059 | 1.0±0.062 | < 0.001 |
| FBS mg/dl | 100.85±5.13 | 233.6±66.76 | < 0.001 |
| HbA1c % | 4.76±0.28 | 8.95±1.85 | < 0.001 |

| | | | |
|---|---|---|---|
| TC mg/dl | 159.15±29.68 | 222.57±56.12 | < 0.001 |
| TG mg/dl | 91.8±3.69 | 273.85±74.1 | < 0.001 |
| HDL mg/dl | 54.5±5.61 | 35.33±3.59 | <0.001 |
| LDL mg/dl | 86.25±29.7 | 134.71±29.7 | < 0.001 |
| VLDL mg/dl | 18.4±0.82 | 52.52±16.72 | < 0.001 |
| AIP | 0.22±0.041 | 0.9±0.092 | < 0.001 |
| TC\HDL | 2.94±0.56 | 6.35±1.67 | <0.001 |
| LDL\HDL | 1.6±0.54 | 3.83±1.55 | <0.001 |

### 3.3 ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS FOR T2DM PATIENTS (MALES AND FEMALES)

T-tests were done for the studied parameters to evaluate the mean and SD, calculate the P-value, and find the difference between male and female patients. The results clarify that in T2DM patients for males and females, there is a significant increase in age (P<0.05) between males (51.0±5.28) as compared with females (45.2±8.82), there is significant increase in FBS between female (233.6±66.76) as compared with male (178.4±45.3), all the other parameters evaluated in this study shows that there are non-significant differences between all the other parameters. The result of the current study is shown in Table 3.

**Table 3. - T-test calculations for the used parameters for male and female T2DM patients**

| Mean ±SD For the studied parameters | patient (Male) (N=25) | patient (Female) (N=25) | p-value (T-Test) |
|---|---|---|---|
| Age, years | 51.0±5.28 | 45.2±8.82 | < 0.005 |
| BMI, Kg/m2 | 30.3±5.91 | 31.0±3.66 | 0.519 |
| WHR | 1.0±0.072 | 1.0±0.062 | 0.966 |
| FBS mg/dl | 178.4±45.3 | 233.6±66.76 | 0.007 |
| HbA1c % | 8.03±1.11 | 8.95±1.85 | 0.161 |
| TC mg/dl | 222.8±40.64 | 222.57±56.12 | 0.701 |
| TG mg/dl | 256.95±50.7 | 273.85±74.1 | 0.366 |
| HDL mg/dl | 34.45±1.1 | 35.33±3.59 | 0.273 |
| LDL mg/dl | 134.4±45.82 | 134.71±29.7 | 0.722 |
| VLDL mg/dl | 53.9±13.89 | 52.52±16.72 | 0.792 |
| AIP | 0.86±0.12 | 0.9±0.092 | 0.816 |
| TC\HDL | 6.46±1.12 | 6.35±1.67 | 0.541 |
| LDL\HDL | 3.88±1.27 | 3.83±1.55 | 0.616 |

### 3.4 CORRELATION BETWEEN THE STUDIED PARAMETERS FOR MALES AND FEMALES

Correlation study was done for the studied parameters to evaluate the correlations that connect each parameter with the others. The results recorded as a positive correlation and negative correlation and each correlated parameter has it is results marked with star and highlighted to show the results. Table 4 shows the results and confirm that there is a positive correlation and negative correlation between the studied parameters.

**Table 4. - Correlation for the used parameters for male and female T2DM patients**

| | | age | BMI | WHR | FBS | HBA1C | TC | TG | HDL | LDL | VLDL | ALP | TC/HDL | LDL/HDL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | R | 1 | -.006 | .638** | -.574** | -.517** | .304 | -.073 | .236 | .278 | .044 | -.134 | .270 | .260 |
| | P | | .970 | .000 | .000 | .001 | .056 | .653 | .142 | .082 | .786 | .411 | .092 | .105 |
| **BMI** | R | -.006 | 1 | .366* | -.121 | .001 | .082 | .090 | .155 | .067 | .032 | .072 | .062 | .057 |
| | P | .970 | | .020 | .457 | .994 | .617 | .579 | .338 | .682 | .844 | .660 | .704 | .726 |
| **WHR** | R | .638** | .366* | 1 | -.191 | -.122 | .003 | -.118 | .370* | .051 | -.205 | -.189 | -.057 | .018 |
| | P | .000 | .020 | | .239 | .452 | .985 | .470 | .019 | .753 | .205 | .243 | .727 | .911 |
| **FBS** | R | -.574** | -.121 | -.191 | 1 | .696** | .000 | -.109 | -.109 | .076 | -.264 | -.060 | .023 | .097 |
| | P | .000 | .457 | .239 | | .000 | .998 | .502 | .504 | .643 | .100 | .714 | .886 | .552 |
| **BA1C** | R | -.517** | .001 | -.122 | .696** | 1 | -.077 | -.151 | -.054 | .027 | -.362* | -.113 | -.061 | .045 |
| | P | .001 | .994 | .452 | .000 | | .638 | .353 | .739 | .867 | .022 | .488 | .707 | .784 |
| **TC** | R | .304 | .082 | .003 | .000 | -.077 | 1 | .016 | .263 | .964** | .012 | -.057 | .986** | .969** |
| | P | .056 | .617 | .985 | .998 | .638 | | .923 | .101 | .000 | .940 | .726 | .000 | .000 |
| **TG** | R | -.073 | .090 | -.118 | -.109 | -.151 | .016 | 1 | -.52* | -.189 | .778** | .982** | .107 | -.139 |
| | P | .653 | .579 | .470 | .502 | .353 | .923 | | .001 | .243 | .000 | .000 | .512 | .392 |
| **HDL** | R | .236 | .155 | .370* | -.109 | -.054 | .263 | -.52** | 1 | .387* | -.55** | -.65** | .099 | .292 |
| | P | .142 | .338 | .019 | .504 | .739 | .101 | .001 | | .014 | .000 | .000 | .541 | .068 |
| **LDL** | R | .278 | .067 | .051 | .076 | .027 | .964** | -.189 | .387* | 1 | -.253 | -.259 | .928** | .995** |
| | P | .082 | .682 | .753 | .643 | .867 | .000 | .243 | .014 | | .115 | .107 | .000 | .000 |
| **VLDL** | R | .044 | .032 | -.205 | -.264 | -.362* | .012 | .778** | -.55* | -.253 | 1 | .784** | .106 | -.209 |
| | P | .786 | .844 | .205 | .100 | .022 | .940 | .000 | .000 | .115 | | .000 | .514 | .197 |
| **ALP** | R | -.134 | .072 | -.189 | -.060 | -.113 | -.057 | .982** | -.65* | -.259 | .784** | 1 | .055 | -.196 |
| | P | .411 | .660 | .243 | .714 | .488 | .726 | .000 | .000 | .107 | .000 | | .737 | .225 |
| **C/HDL** | R | .270 | .062 | -.057 | .023 | -.061 | .986** | .107 | .099 | .928** | .106 | 0.055 | 1 | 950** |
| | P | .092 | .704 | .727 | .886 | .707 | .000 | .512 | .541 | .000 | .514 | 0.737 | | 0.001 |
| **L/HDL** | R | .260 | .057 | .018 | .097 | .045 | .969** | -.139 | .292 | .995** | -.209 | -.196 | .950** | 1 |
| | P | .105 | .726 | .911 | .552 | .784 | .000 | .392 | .068 | .000 | .197 | .225 | .000 | |

Cardiovascular diseases (CVD) are a leading cause of death and morbidity worldwide. Many physicians still use standard lipid profile tests (TG, TC, HDL-C, and LDL-C) to verify the clinical diagnosis of CVD [12]. There is a significant difference in age among the groups. The difference in age between control and patients confirms that cardiac diseases are age-dependent. The results collected in this study agree with the study of Dhingra et al., who said that CVD is age-related and that people of higher age are usually more susceptible to infection with heart disease and Atherogenicity [13] BMI. WHR is also elevated in patients with T2DM and atherosclerosis compared to control, and that elevation ensures that elevation in anthropometric parameters is also a risk factor for CVD [14]. WHR is a more accurate parameter for calculating the right anthropometric for participants because BMI may not reflect the mass distribution in the body.

On the other hand, WHR gives a natural way to determine how mass is distributed in the body [15]. Obesity-related digestive, endocrinologic, immunologic, basic, humoral, hemodynamic, and functional alterations all contribute to the development of cardiovascular disease, according to the study's findings, which are consistent with those of previous research such as Lopez et al. In therapeutic practice, it can be difficult to understand and control the complex, varied features of these systems. Individuals with CVD and obesity often have chronic physical or mental health conditions that require polypharmacy and multidisciplinary treatment pathways [16]. Manrique and his colleagues confirmed the effect of WHR elevation on the high risk of CVD in women. They said that the elevation of anthropometrics is associated with high levels of adipose tissues and lipid accumulation, which causes CVD infections [17]. Obesity is one of the first signs for more serious complications such as insulin resistance, T2DM, heart diseases and Atherogenicity, so elevated level of BMI and WHR shows that obese patients are more vulnerable to CVD and could suffer from stronger stages of Atherogenicity [18]. The mean and SD for age BMI and WHR are shown in Figure 1.

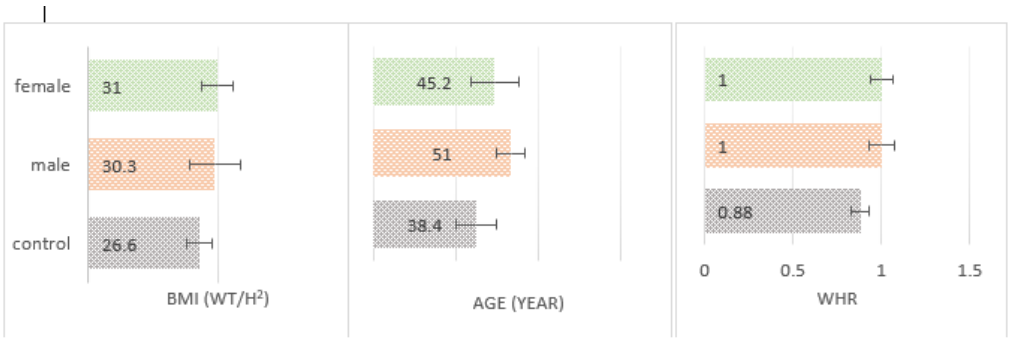


**FIGURE 1. - Mean and SD for age, BMI, and WHR among males, females, and control**

Elevated levels of FBS and HbA1c develop the complications of CVD and Atherogenicity [19]. Raised concentrations of FBS and HbA1c in this study confirm the effect of high glucose on the heart's health. The high level of FBS and HbA1c is in agreement with many studies like Hasan et al., who said that the elevation of glucose parameters is the main reason for CVD and has a significant effect on Arteriosclerosis [20], & Akasha et al., which discover that dyslipidemia in diabetes individuals may be predicted using HbA1c. An atherogenic lipid profile and HbA1c have a strong correlation, highlighting the need of glycaemic management in reducing the risk of cardiovascular disease [21]. High levels of HbA1c occur because of insulin resistance, and high levels of glucose make the body unable to digest glucose and will be forced to transform the excess glucose into lipid that collects on the walls of arteries and causes real complications that end with Arteriosclerosis [22]. The amount of coronary atherosclerosis lesions and the prognosis for diabetics with coronary atherosclerosis were found to be positively correlated with HbA1c levels [23]. The prognosis for diabetes with coronary atherosclerosis is worse and coronary atherosclerotic disease is more severe the higher the HbA1c level [24]. The mean and SD for both control and type 2 diabetes patients (male and female) are displayed in Figure 2.

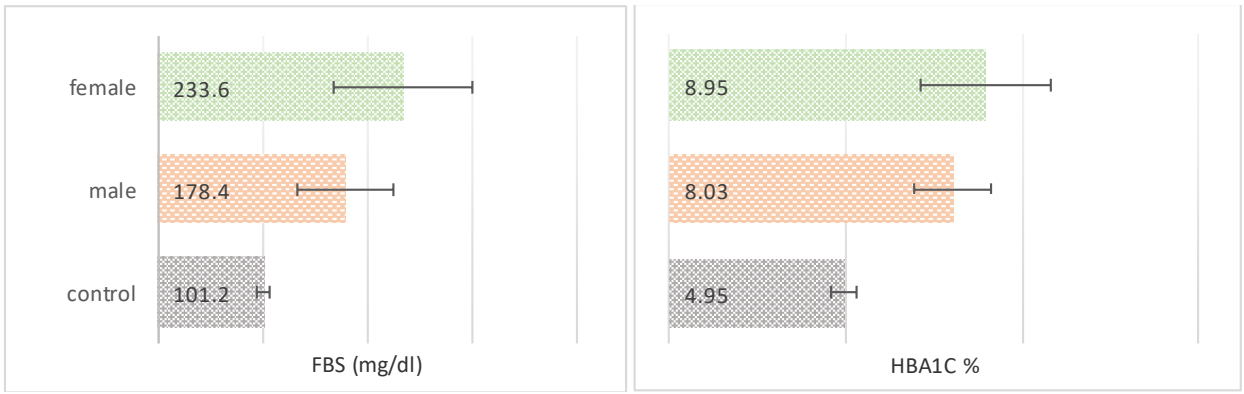


**FIGURE 2. - Mean and SD for FBS and HbA1c among males, females, and control**

Lipid profile results are evaluated among the three groups and show a raised concentration of TC, TG, LDL, VLDL and a lower downed concentrations of HDL in patients (male and female) matched with control. These results agree with many previous studies like Chauhan et al., who show that an elevated level of TC/HDL and TG/HDL in people is a high point and a risk factor for CVD. Even in prediabetes, high TG/HDL levels may aid in the early diagnosis of atherosclerotic problems. This inquiry, which is both easily accessible and affordable, can assist primary care physicians in developing primary preventive measures for ASCVD among individuals with prediabetes and diabetes [25]. Li and his colleagues are talking about the elevation of the triglyceride-glucose index. The TyG index has been given to indicate insulin resistance (IR). The TyG index can predict myocardial and carotid atherosclerosis among individuals with symptomatic CAD, irrespective of diabetes or hyperlipidemia. Compared to FBG or TG levels alone, the TyG index is more useful to identify coronary and cerebral plaques with atherosclerosis [26]. In asymptomatic non-diabetic adults, rising TG/HDL rates are joined to a raised burden of worldwide subclinical coronary atherosclerosis as determined by 18F NaF-PET/CT. Due to the negative consequences of subclinical coronary atherosclerosis, such as death [27], A marker of raised atherosclerotic expansions in prediabetes and new diagnosed type 2 diabetes, TG/HDL can be used to identify people with a better cardiovascular risk profile [28]. Despite having atherosclerosis-related problems, persons with type 2 diabetes rarely have significantly high LDL-c values. Type 2 diabetes causes atherogenic dyslipidemia, characterized by low HDL-c levels, increased TGs, ApoB, and S-LDL. Smaller LDL particles may lead to lipid imbalances and increase the risk of CVD [29]. Figure 3 shows the mean and SD for lipid profile among patients (male and female) and control.

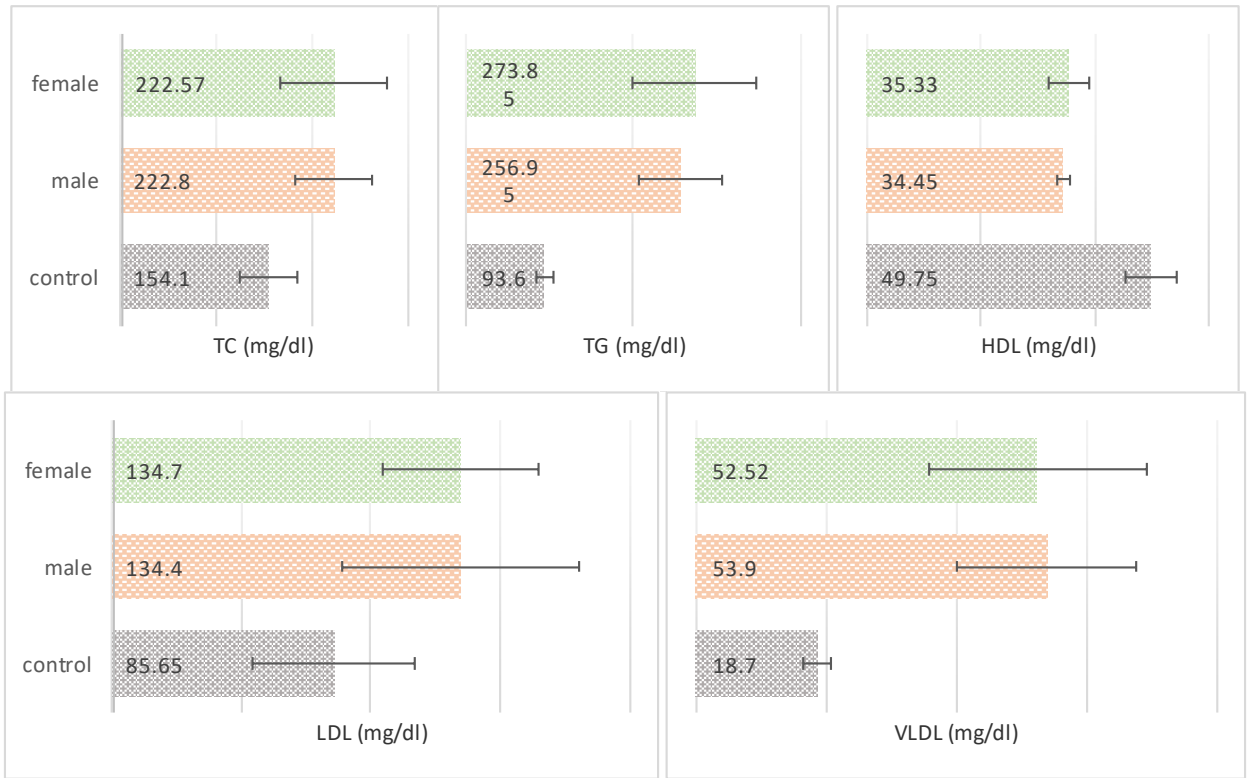


**FIGURE 3. - Mean and SD for TG, TC, HDL, LDL, and VLDL among males, females, and control**

Depending on a more accurate mathematical equation to find the best parameters helps to diagnose and study the effect of lipid profile on patients with T2DM and it is complications on Atherogenicity, AIP (log TG/HDL), TC/HDL, and LDL/HDL have been evaluated. There was a significant change in the concentration of AIP in patients matched with the control group, which agrees with several previous studies. Moustapha et al. found an elevation in AIP levels and said that lipid alterations are significant abnormalities in type 2 diabetes individuals, predisposing them to cardiovascular problems. However, IAP = log (TG / HDL-c) may be regarded as the best sensitive indicator of cardiovascular risk [30]. Zhou and his work team confirmed the elevation of AIP in patients who may develop atherosclerosis. They said that AIP is a reliable biomarker for assessing the risk of CAD and outperforms standard lipid tests. This could help prevent cardiovascular problems [31]. The strong correlation between AIP and other lipid variables linked to atherosclerosis suggests increased plasma Atherogenicity. The AIP risk categories identify people who are more likely to develop cardiovascular disease (CVD) and reflect the existing state of blood Atherogenicity. AIP has a promising future in standard therapeutic practice in this regard [32]. Additionally, patients' TC/HDL levels were noticeably higher than those of the control group. These results agree with studies such as Quispe et al., which said There is a clinically significant discrepancy between TC/HDL cholesterol, known from the conventional lipid profile, and the commonly utilized non-HDL plus LDL cholesterol levels. Particularly in peoples suffering from diabetes, where discordance is more prevalent, such discordance may aid in directing the risk management of atherosclerotic cardiovascular disease [33]. Furthermore, regardless of known risk factors, Manubolu et al. claimed that some aspects of coronary plaque are closely correlated with low HDL-C levels and a rising TC/HDL ratio. The results of this investigation offer molecular support for the protective role of HDL-C and the therapeutic use of the TC/HDL ratio in the treatment of coronary artery disease [34].

According to LDL/HDL data, patients had higher levels than controls, which is consistent with a number of earlier research [35, 36]. The Gensini score method was used to examine the border value of the LDL/HDL ratio based on the degree of coronary artery disease in order to gain a better understanding of the use of LDL/HDL in dicators. The results showed that the LDL/HDL ratio gradually increased in those with higher Gensini scores and increasing degrees of coronary vascular stenosis [37]. The LDL/HDL ratio is more accurate in determining the extent of coronary atherosclerosis and can identify an early imbalance between atherosclerosis and anti-atherosclerotic lipoproteins than a single blood lipid index [38].

As a stand-alone risk factor for CAHD, the LDL/HDL ratio, which includes the two variables, is better than either LDL-C or HDL-C alone at predicting the severity of coronary atherosclerosis [39]. Figure 4 shows the mean and SD for lipid equations (AIP, TC/HDL, and LDL/HDL) among patients (male and female) and control.

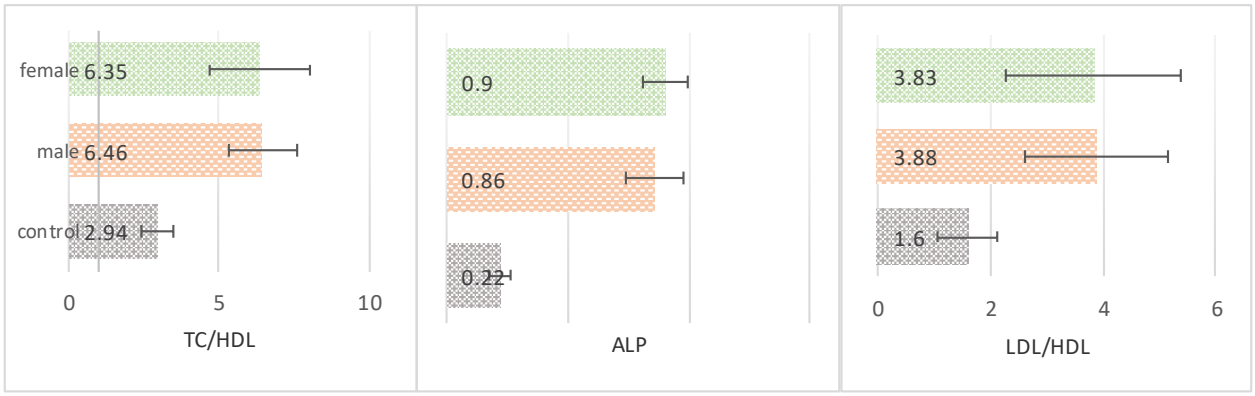


**FIGURE 4. - Mean and SD for AIP, TC/HDL, and LDL/HDL among males, females, and control**

For the study of correlation. positive correlation shown in BMI and WHR ($R = 0.638$, $p < 0.001$): A substantial positive correlation shows that when BMI rises, so does WHR, showing the link between obesity and central fat distribution. This research highlights the importance of central adiposity in metabolic and cardiovascular risk. TC and LDL ($R = 0.964$, $p < 0.001$) The considerable positive link between total cholesterol and LDL levels emphasizes LDL's role in the development of atherosclerosis and the importance of regulating it in patients. TC/HDL and LDL/HDL ratios ($R = 0.986$, $p < 0.001$). This high correlation illustrates the intimate association between these two ratios, which are also important indicators of cardiovascular risk. Monitoring these ratios is critical for identifying lipid profile abnormalities. LDL and WHR ($R = 0.370$, $p = 0.019$): The positive correlation indicates a relationship between central fat distribution and elevated LDL levels, implying that central obesity may lead to lipid abnormalities. The correlation between TG and VLDL is significant ($R = 0.778$, $p < 0.001$). The close link between triglycerides and very low-density lipoprotein emphasizes their shared involvement in lipid transport and contribution to atherogenic processes.

For negative correlation parameters, FBS and BMI ($R = -0.574$, $p < 0.001$): The negative correlation suggests that greater fasting blood sugar levels are related with reduced BMI, possibly due to catabolic effects in poorly controlled diabetes. FBS and HDL ($R = -0.520$, $p = 0.001$): This negative connection indicates that greater fasting blood glucose levels are associated with decreased HDL cholesterol, contributing to an unfavorable lipid profile in diabetes individuals. TG and HDL ($R = -0.520$, $p = 0.001$): A strong negative correlation between triglycerides and HDL suggests that greater triglyceride levels are related with lower HDL, hence increasing cardiovascular risk.

LDL and TG ($R = -0.362$, $p = 0.022$): This inverse association demonstrates the lipid profile's intricate interactions and their impact on cardiovascular health.

This study sheds light on the complicated interactions between metabolic markers and the consequences for cardiovascular health. Positive relationships, such as those observed between TC and LDL or BMI and WHR [29], highlight the need of addressing obesity and dyslipidemia in the prevention of atherosclerosis. Negative correlations, such as those between FBS and BMI or TG and HDL [33], highlight the multidimensional character of metabolic abnormalities in diabetes and their impact on cardiovascular risk. By identifying these relationships, the findings provide significant guidance for targeted therapies and enhanced risk stratification in clinical practice [26].

## 4. CONCLUSION

This study emphasizes the cardiovascular hazards in (T2DM) patients, focusing on the atherogenic index of plasma (AIP) as a crucial measure to predict atherosclerotic cardiovascular disease (ASCVD). T2DM patients frequently have high blood sugar, HbA1c, and unfavorable lipid levels. AIP, which indicates a high triglyceride-to-HDL percentage, adds risk assessment to standard lipid assays. Female patients often have more severe glycemic problems, and higher waist-to-hip ratios are associated with an increased cardiovascular risk. Comprehensive assessments should incorporate AIP to enhance patient outcomes.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest

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