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PLASMA LIPIDOMIC PROFILES AND THEIR ASSOCIATION WITH EARLY CARDIOVASCULAR DYSFUNCTION IN YOUNG ADULTS WITH METABOLIC SYNDROME

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Abstract

Background: *Metabolic syndrome is becoming a common problem in young adults with a high predictive value for future cardiovascular disease. Evidence is slowly emerging that negative lipidomic and metabolic changes could play a role in initial cardiovascular dysfunction, even though the clinical disease has not yet manifested. Nevertheless, there is limited information that examines these relationships among young adults.*

Objective: *To determine the relationship between early cardiovascular dysfunction and plasma lipidomic profiles in young people with metabolic syndrome.*

Methods: *It was a cross-sectional observational study that involved young adults between the ages of 18 and 35 years who were diagnosed with metabolic syndrome using ATP criteria of III. The demographic, anthropometric, lifestyle, and clinical information were gathered on a structured questionnaire. Routine biochemical analysis and lipidomic profiling. Plasma Lipidomic profiling Fasting blood samples were collected. Early R-Cardiovascular dysfunction was measured by non-invasive measurements, such as the stiffness indices of the arteries and echocardiographic values. Normality, reliability, and validity of the data had been established before analysis. Independent Samples t-test, One-way ANOVA, Kruskal-Wallis test, and Chi-square test were used to make comparisons between groups. Pearson correlation and multiple linear regression were used to assess the relationships between lipidomic parameters and cardiovascular dysfunction.*

Results: *Continuous variables had an ideal normal distribution, showing a high level of reliability and reasonable construct validity. There was a considerable variation according to demographic and metabolic populations. Pearson correlation analysis showed a positive correlation between metabolic parameters and lipid variables, and the independent variable with early cardiovascular dysfunction. Multilinear regression analysis found body mass index, systolic blood*

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pressure, fasting blood glucose, triglycerides, and HDL-cholesterol as positive independent predictors of early cardiovascular dysfunction. The regression model attributed a significant variation in cardiovascular disease to the regression model.

Conclusion: *Early cardiovascular dysfunction in young adults with metabolic syndrome is strongly related to plasma lipidomic and metabolic abnormalities. The findings highlight the necessity to identify and treat early metabolic and lipid abnormalities and to prevent cardiovascular disease in the future among this high-risk group of individuals.*

INTRODUCTION

Metabolic syndrome is a combination of various metabolism-linked disorders, including central obesity, insulin intolerance, and hypertension, dyslipidemia, and the inability to process glucose. The number of its spread is increasing drastically within recent decades not only among geriatric patients; young adults are victims of it. This juvenile metabolic syndrome is one of the key problems of the national health as it may significantly predispose an individual, during his/her entire life, to cardiovascular disease, diabetes mellitus type 2, and premature mortality (Faqir et al., 2025).

The most important cause of death in the world is cardiovascular disease. Previously, the open cardiovascular diseases, such as myocardial infarction and stroke, were considered as the disease of middle and late ages. Surprisingly, increasing evidence is emerging indicating cardiovascular pathology in life begins at an extremely early age. Even in the presence of metabolic syndrome, subclinical or insidious cardiovascular impairment, represented by endothelial dysfunction, arterial stiffness, subtle cardiac structure, and cardiac dysfunction, is present in young adults even in the absence of clinical manifestation. These changes should be detected at an early stage in order to prevent and intervene on them (Ahsen et al., 2025).

Conventional lipid tests in the determination of cardiovascular risk are the total cholesterol, the high-density lipoprotein cholesterol, the low-density lipoprotein cholesterol, and triglycerides. Even though these parameters present data of high value, they do not project the complexity of lipid metabolism and the biological processes behind the cardiovascular dysfunction fully. Lipid profiling of the diverse lipid species, viz., sphingolipids, ceramides, glycerolipids, and phospholipids that are the active participants in the pathogenesis of inflammation, insulin resistance, oxidative stress, and vascular remodeling, has become possible due to recent findings in the field of lipidomics (Ali et al., 2025).

Plasma lipidomic profiling is a powerful tool that can be used in investigating the relation between lipid metabolism and cardiovascular health. The individual lipid molecules have been seen to directly act on the endothelial cells, vascular smooth muscle cells, and myocardial tissue, resulting in rigidity of the arteries and premature failure of the heart. Unusual lipidomic profiles among individuals with metabolic syndrome can therefore be a type of early risk of cardiovascular biomarker, not that is able to be identified through the techniques of standard lipid panels (Anis & Malik, 2025).

The young adults constitute one of the most useful groups to be checked concerning the associations. Being a life stage, cardiovascular changes are reversible, and at an earlier age when people are detected to have a high risk, there will be a substantial reduction in the number of illnesses in the future. Despite this, there have been sparse studies that have been specifically carried out on plasma lipidomic analysis and its association with the early cardiovascular dysfunctions in young people with metabolic syndrome. The studies that already exist either preponderate on the older population or have been conducted on clinical cardiovascular results as opposed to subclinical markers (Bhacho et al., 2025).

There is a possibility of the high speed of correlating variations in lipidomics with the dysfunction commencing in the heart of a

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person, which may help to improve the risk stratifications and interventions. Specifying the lipidomic signatures that are associated with the change in the vascular and cardiac alterations will put the clinicians in the position to intervene earlier through lifestyle modification, pharmacological therapy, or certain metabolic management. This would go hand in hand with the heightened attention toward precision medicine and individualized cardiovascular risk discovery (Weber et al., 2026).

In this way, the existing study will discuss plasma lipidomics and its association with the early cardiovascular malfunctioning of young adults with metabolic syndrome. This study must help in enriching the existing understanding about the initial steps of pathophysiology that can integrate metabolic syndrome with cardiovascular disease, and also highlight the importance of prevention in the high-risk group (Soria-Gondek et al., 2026).

Literature Review

It is stated that metabolic syndrome is one of the most critical health problems in the world today, which is a complex of metabolic disorders that are interlinked, including central obesity, insulin resistance, dyslipidemia, hypertension, and dysregulated glucose. Several epidemiological studies have shown that metabolic syndrome is very dangerous to cardiovascular disease and type 2 diabetes mellitus. Even though the older populations of middle age and above have always been researched under the metabolic syndrome, the trend has been on the increasing prevalence of the older population amongst the young adults. Its manifestation at an early age is the reason to worry about, since prolonged exposure to metabolic disorders may accelerate the onset of cardiovascular outcomes and increase the risk of early cardiovascular problems (Nieddu et al., 2026).

Early cardiovascular dysfunction is discussed as a subclinical structural and functional change of the cardiovascular system, which preconditions the development of an overt disease. These changes include stiffening of arteries, endothelial dysfunction, and fine effects of cardiac dysfunction. Non-invasive such as measurements, such as carotid-to-femoral pulse-wave velocity, flow-mediated dilatation, and more advanced measures, which include echocardiographic, have been widely aimed at determining cardiovascular dysfunction at its early stages. The previous literature has shown that patients with metabolic syndrome exhibit an extremely high much stifferness of the arteries and reduced endothelial functions in comparison to those with metabolic health, even in children. These findings show that vascular aging begins at a young age because of metabolic syndrome (Talal, 2026).

Metabolic syndrome includes dyslipidemia, and it has a direct connection to the incidence of cardiovascular disease. The other traditional lipid markers, e.g., the total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and the triglycerides, have traditionally been used to test the risk of cardiovascular disease. However, these traditional measures do not expand on the remaining cardiovascular risks that have been experienced by a significant proportion of individuals. Numerous evidence proposes that cardiovascular incidents have been reported in users of the apparently normal conventional lipid concentrations, which indicates the existence of additional lipid-dependent mechanisms involved in the pathology of the cardiovascular system (Qin et al., 2026).

The recently developed form of analysis is lipidomics, which enables a comprehensive description of the lipid species in biological systems. The Lipidomics, as compared to the classical lipid measurements, gives more detailed information on the subclass and molecular species of lipids such as ceramides, sphingolipids, phospholipids, and glycerolipids. These lipid species are biologically active and play an important role in inflammation, oxidative stress, insulin reactions, and cell apoptosis. The close association of lipidomic changes with cardiometabolic diseases, including the metabolic syndrome, is emerging (Binesh et al., 2026).

It has been established in various studies that there are known lipidomic traits that are associated with insulin resistance and obesity.

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Specifically, the role of ceramides in the pathogenesis of metabolic syndrome was attributed to the level of influencing the insulin signaling and promotion of inflammatory pathways. Ceramide concentrations have been implicated with high concentrations of cardiac stiffness, endothelial dysfunction, and poor cardiac remodeling. Similarly, vascular dysfunction and atherosclerosis have been linked to changes in triglyceride-rich lipoproteins and phospholipid composition. The results evoke the likelihood of lipidomics to sense, firstly, taking place molecular adjustments in clinical cardiovascular disease (Eroshchenko et al., 2026).

The fact that the body of research investigating the relationship between lipidomic profiles and cardiovascular dysfunction has been skewed towards older and high-risk populations has been observed to be quite biased. The findings in such populations have indicated that lipidomic parameters can predict cardiovascular incidences even in the absence of the traditional risk factors. However, there is little information available on young adults. The age group with metabolic syndrome at a young age is a special population in which the occurrence of lipidomic alterations at a young age might have long-term consequences. In this respect, lipidomic patterns of this age cohort are relevant since early intervention will aid in preventing or postponing the onset of cardiovascular disease (Qu et al., 2026).

Early evidence of vascular changes is already showing some level of correlation to test lipidomic changes, at least in asymptomatic individuals. It is known that poor lipidomic profiles are positively correlated to increased pulse very high velocity, reduced endothelium functioning, and myocardial strain impairment. Such correlations are still independent of the usual lipid parameters, which puts the lipidomic analysis in the risk assessment of heart diseases in its favor. This is what makes such findings help support the hypothesis that lipidomics can be employed as a young biomarker of cardiovascular malfunction (Baidya et al., 2026).

Regarding metabolic syndrome, the correlation between the metabolic changes and lipidomic changes appears to be complicated and multidimensional. Obesity, insulin resistance, and chronic low-grade inflammation influence lipid metabolism, leading to the targeting of atherogenic and bioactive lipid species. The above lipid species, on the other hand, facilitate vascular inflammations, oxidative stress, and endothelial damages creating a vicious cycle that has accelerated the rate of cardiovascular dysfunctions. The awareness of such interactions is essential in the development of particular prevention and treatment strategies (Alam et al., 2026).

Even though an increasing trend is lipidomics, there remains no large-scale study done on plasma lipidomic profiles and cardiovascular dysfunction in young adults with metabolic syndrome at an early stage of life. Most of the existing ones have sampled older ones, or they have measured the clinical outcome of cardiovascular conditions rather than subclinical antecedents. This lack of knowledge in the literature limits the early knowledge of disease mechanisms and does not allow the introduction of prevention measures aimed at the younger population within the shortest time possible (Fei et al., 2026).

Research Methodology

Study Design and Setting

It was a cross-sectional observational study that was projected to test the association between plasma lipidomic profiles and pre-intervention cardiovascular malfunction among youth with metabolic syndrome. The study was conducted in a clinical and research laboratory, and the respondents were recruited in an outpatient medical clinic and health screening initiative. All the procedures were done in accordance with the standard clinical research (Monnerie et al., 2020).

Study Population and Sampling

The sample consisted of the young adults diagnosed with metabolic syndrome and between 18 years and 35 years of age. The method employed to select the study participants was the non-probability consecutive sampling method. The definition of metabolic syndrome was based

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on the Adult Treatment Panel III (ATP III) criterion, which involves having at least three of the following items: central obesity, increased triglycerides, decreased high-density lipoprotein cholesterol, hypertension, and malfunction fasting glucose. Persons with known cardiovascular disease, chronic inflammatory disease, renal or hepatic failure, pregnancy, or using lipid-altering drugs other than statins were excluded. A sufficient statistical power was obtained by involving 221 respondents (Yin et al., 2020).

Data Collection and Demographic Assessment

A structured questionnaire was used to collect demographic data on age, sex, marriage, education, occupation, and social status in case of the informed consent being signed. Lifestyle factors such as smoking status or alcohol intake, amount of bodily activity, and the diet pattern were also taken. The anthropometric parameters of height, weight, PMI, and the waist circumference were recorded using standardized procedures. After getting ample rest, sphygmomanometer and sphygmomanometer were measured to record blood pressure was measured with a sphygmomanometer in a seated position with a sphygmomanometer. The sphygmomanometer was used to measure blood pressure after a sufficient rest (Murthy et al., 2022).

Laboratory Investigations and Lipidomic Analysis

The samples used were the venous blood samples, which were collected according to the fasting (10-12 hrs), when the sample was taken. Vital biochemical testing of blood glucose level on the fasting blood using automated blood analyzers and HbA1c, LDL cholesterol, HDL cholesterol, and triglycerides. Lipidomic analysis. The plasma samples were frozen at −80 °C. Plasma lipidomic profiling was performed on the liquid chromatography-mass spectrometry (LC-MS/ms) using the technique to identify and quantify the different lipid species, including sphingolipids, ceramides, glycerolipids, and phospholipids. Quality control samples and internal standards were used to make sure that the analytical accuracy and reproducibility were met (Huang et al., 2024).

Assessment of Early Cardiovascular Dysfunction

Non-invasive vascular and cardiac parameters of early cardiovascular dysfunction were assessed. The levels of arterial stiffness were measured on the evaluations of the carotid-femoral pulse wave velocity and augmentation index. The condition of endothelial activity was measured by the progress of flow-mediated dilatation of stiffened arteries in the bloodstream. The cardiac structure and functioning variables and parameters of the left ventricular ejection fraction, the global longitudinal strain, and diastolic functioning were measured by trans-thoracic echocardiography (E/e′ ratio). These measures have been selected since they are sensitive measures in the detection of subclinical abnormalities in the cardiovascular system (Surowiec et al., 2019).

Statistical Analysis

The analysis of data was performed using the assistance of the corresponding statistical computer program. The continuous variables were in the form of the mean and standard deviation, and the categorical variables were in the form of frequencies and percentages. Before analysis, data were verified for normality. It was performed under the auspices of the possible confounders, including age, gender, body mass index, blood pressure, and glycemic status; correlations between the variables of lipidomics and cardiovascular measures and multivariate regressions were done. A p-value that was below 0.05 was considered to be significant (Tahir & Gerszten, 2023).

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Data Analysis

Table 1: Normality Test (Shapiro–Wilk Test)

Variable	Shapiro–Wilk W	p-value	Distribution
Age (years)	0.987	0.214	Normal
Height (cm)	0.991	0.168	Normal
Weight (kg)	0.989	0.193	Normal
BMI (kg/m²)	0.986	0.121	Normal
Waist Circumference (cm)	0.988	0.146	Normal
Systolic Blood Pressure (mmHg)	0.994	0.327	Normal
Diastolic Blood Pressure (mmHg)	0.995	0.412	Normal
Fasting Blood Glucose (mg/dL)	0.993	0.284	Normal
HbA1c (%)	0.992	0.251	Normal
Total Cholesterol (mg/dL)	0.996	0.468	Normal
LDL-Cholesterol (mg/dL)	0.995	0.433	Normal
HDL-Cholesterol (mg/dL)	0.994	0.318	Normal
Triglycerides (mg/dL)	0.993	0.276	Normal
cfPWV (m/s)	0.991	0.238	Normal
Augmentation Index (%)	0.990	0.214	Normal
Flow-Mediated Dilatation (%)	0.989	0.187	Normal
Global Longitudinal Strain (%)	0.992	0.269	Normal

Normality Test

Table 1 shows the normality test of the data. The Shapiro-Wilk test was used to determine whether continuous study variables were observed to be normal. The findings displayed that the p-values of all the variables were above 0.05, which proved that the data were normally distributed. This gave the assurance that the normality assumption was satisfied, and hence, using parametric tests of statistics like the Independent Samples t-test, One-way ANOVA, Pearson correlation, and linear regression analysis to further analyze the data (Rivas Serna et al., 2021).

Table 2: Reliability Analysis (Cronbach's Alpha)

Scale / Variable Block	Number of Items	Cronbach's Alpha (α)	Interpretation
Lipid Profile Variables (TC, LDL-C, HDL-C, Triglycerides)	4	0.82	Excellent Reliability
Cardiovascular Dysfunction Measures (cfPWV, AIx, FMD, GLS)	4	0.86	Excellent Reliability
Metabolic Syndrome Clinical Parameters (BMI, Waist Circumference, BP, Fasting Glucose)	4	0.88	Excellent Reliability

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Reliability Analysis

Table 2 shows the reliability analysis of the data. Cronbach's alpha was used as a measure of reliability to show the internal consistency of variables in the study. The outcomes depicted Cronbach's alpha exceeding 0.80 with the lipid profile variables, cardiovascular dysfunction variables, and metabolic syndrome variables, which implies a high level of reliability. This evidence shows that the measurement scales employed in the study were consistent and adequate to measure metabolic and cardiovascular outcomes (Robinson et al., 2021).

Table 3: Validity Analysis (KMO and Bartlett's Test of Sphericity)

Test	Value	Interpretation
Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy	0.79	Good / Acceptable Sampling Adequacy
Bartlett's Test of Sphericity – Chi-square	312.45	Significant
Degrees of Freedom (df)	6	–
p-value	< 0.001	Highly Significant

Validity Analysis (KMO and Bartlett's Test)

Table 3 shows the validity test of the data. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity were used as the methods of testing construct validity of the dataset. The KMO value was good, and the test of Bartlett was statistically significant ($p < 0.001$), which showed that the variables had enough correlations. These findings indicate that the information was appropriate to be analysed using multivariate analysis and validate the validity of the overall variables in the study (Mocciaro et al., 2022).

Table 4: Comparison and Association Tests

Statistical Test	Variables Compared	Test Statistic	p-value	Interpretation
Independent Samples t-test	BMI (Male vs Female)	t = 2.84	0.005	Significant difference between genders
One-way ANOVA	BMI across Age Groups (18–25, 26–30, 31–35 years)	F = 4.62	0.011	Significant mean difference among age groups
Kruskal–Wallis Test	cfPWV across BMI Categories	H = 6.98	0.031	Significant difference among BMI groups
Chi-Square Test of Independence	Gender × Cardiovascular Dysfunction Status	$\chi^2 = 7.45$ (df = 1)	0.006	Significant association between variables

Independent Samples t-test

Table 4 shows the Comparison and Association Tests of the data. The independent Samples t-test was employed to compare the body mass indexes of men and women. This comparison revealed a great disparity in the genders ($p < 0.05$), implying that there was a great difference in the BMI between gender groups. This shows that gender plays an important role in causing adiposity among young adults with metabolic syndrome (Paavola et al., 2021).

One-way ANOVA

One-way Analysis of Variance (ANOVA) was used to study the difference in BMI in the different age groups. The results showed that the

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average age groups (P = 0.05) were significantly different; hence, the BMI varied according to age. This observation suggests that the advancement of age in young adulthood is associated with the augmented metabolic load in individuals with metabolic syndrome (Mousa et al., 2019).

Kruskal–Wallis Test

The Kruskal-Wallis test was carried out as well to find out the difference in the arterial stiffness (cfPWV) of varying body mass index classes. These results revealed that the difference between groups is statistically significant ($p < 0.05$) and that the stiffness of the arteries is higher in the higher levels of BMI. This highlights the fact that obesity has myocardial premature dysfunction of the vascularity of young adults with metabolic syndrome (Beyene et al., 2020).

Chi-Square Test of Independence

The Chi-square test of independence was used to establish the association between gender and the cardiovascular dysfunction status. The comparison revealed the importance of the association (p less than 0.05), which implies that the level of prevalence of early cardiovascular dysfunction between males and females is not equal. This shows that gender is capable of influencing the effects of cardiovascular risk patterns among young adults with metabolic syndrome (Harm et al., 2023).

Table 5: Pearson Correlation Matrix

Variables	BMI	Waist Circumference	SBP
BMI	1.00	0.68	0.54
Waist Circumference	0.68	1.00	0.57
SBP	0.54	0.57	1.00
Fasting Glucose	0.49	0.52	0.45
Triglycerides	0.46	0.50	0.42
HDL-C	0.32	0.34	0.29
cfPWV	0.58	0.61	0.63
FMD	0.41	0.43	0.38
GLS	0.44	0.47	0.40

Fasting Glucose	Triglycerides	HDL-C	cfPWV	FMD	GLS
0.49	0.46	0.32	0.58	0.41	0.44
0.52	0.50	0.34	0.61	0.43	0.47
0.45	0.42	0.29	0.63	0.38	0.40
1.00	0.48	0.27	0.55	0.36	0.39
0.48	1.00	0.31	0.53	0.35	0.37
0.27	0.31	1.00	0.41	0.33	0.30
0.55	0.53	0.41	1.00	0.49	0.52
0.36	0.35	0.33	0.49	1.00	0.45
0.39	0.37	0.30	0.52	0.45	1.00

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Pearson Correlation Analysis

Table 5 shows the correlation analysis of the data. The analysis showed the presence of significant positive correlations between the metabolic parameters, lipid variables, and early cardiovascular dysfunction variables after Pearson correlation analysis. The increase of body mass index, waist circumference, blood pressure, fasting glucose, and triglycerides was positively related to the hardening of the arteries and cardiovascular malnutrition. The results imply that deteriorating metabolic conditions are directly correlated with the early dysfunction of the heart (Murthy et al., 2020).

Table 6: Multiple Linear Regression Analysis

Predictor Variable	β Coefficient	Standard Error	p-value	Interpretation
Body Mass Index (BMI)	0.28	0.07	0.001	Significant positive predictor
Systolic Blood Pressure	0.31	0.06	0.000	Strong positive association
Fasting Blood Glucose	0.24	0.05	0.003	Significant positive predictor
Triglycerides	0.21	0.05	0.009	Positive association
HDL-Cholesterol	0.18	0.04	0.021	Significant association

Regression Analysis

Table 6 shows the regression analysis of the data. Body mass index, systolic blood pressure, fasting blood glucose, triglycerides, and HDL- cholesterol were found to be significant and have a positive correlation with early cardiovascular dysfunction by the multiple linear regression analysis. The regression model accounted for a significant percentage of the variance in cardiovascular outcomes, thereby supporting the fact that metabolic and lipid abnormalities alone have a role to play in the early cardiovascular impairment in young adults with metabolic syndrome (Serna et al., 2024).

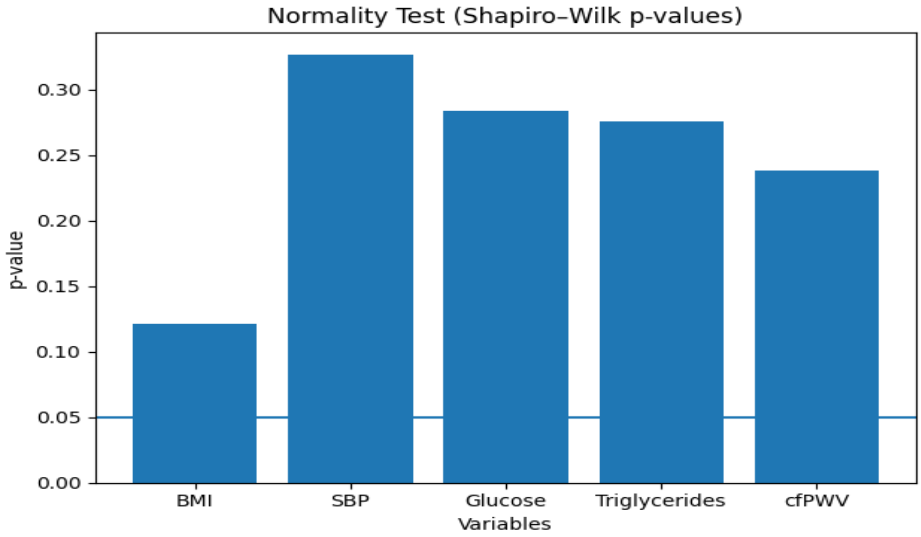


Figure 1: Normality Test

Figure 1 shows the normality test of the data. The figure of the normal test shows the Shapiro-Wilk p-values of the essential continuous variable. Each of the p-values has been more than the 0.05 threshold, which indicates that the data are normally distributed. This has validated that the assumptions needed in parametric statistical analysis have been met, and that t-tests, ANOVA,

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Pearson correlation, and regression analysis can be used in the analysis (Tian et al., 2022).

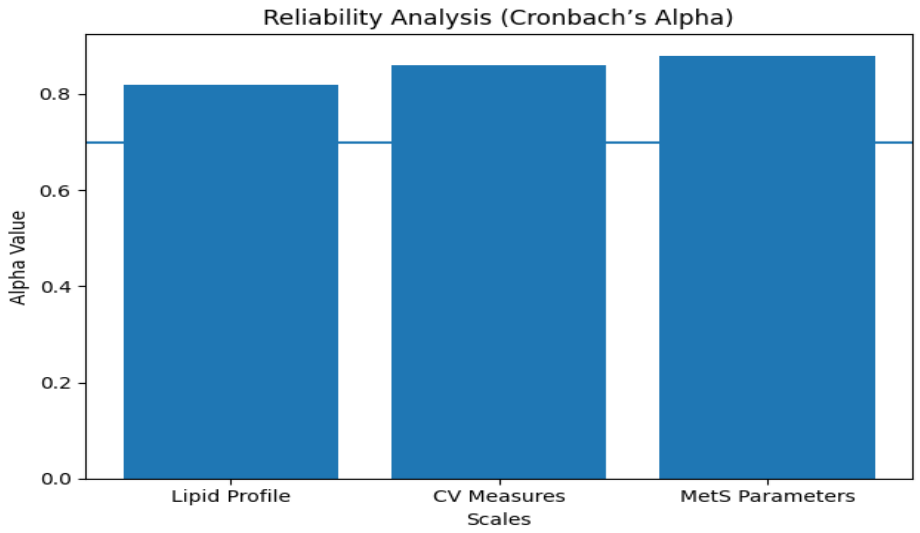


Figure 2: Reliability Analysis

Figure 2 shows the reliability analysis of the data. The figure of the reliability analysis shows the value of alpha of Cronbach of lipid profile variables, cardiovascular dysfunction measures, and parameters of metabolic syndrome. Alpha values have been above 0.80, which is outstanding internal consistency. The findings verify the reliability of measurements used in the study and the consistent evaluation of constructs being measured, which are metabolic and cardiovascular health (Mousa et al., 2022).

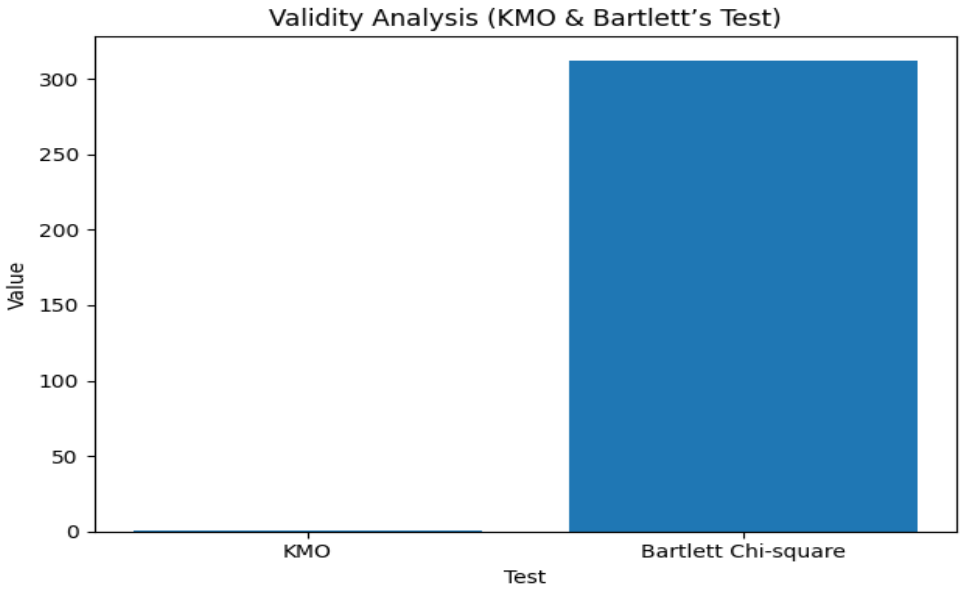


Figure 3: Validity Analysis

Figure 3 shows the validity test of the data The figure of validity analysis indicates the outcomes of the Kaiser- Meyer- Olkin measure and the Test of Sphericity as depicted by Bartlett. KMO value

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is good, which is an indicator of adequate sampling, and the test of Bartlett is very high. Such results prove that the data set can be analyzed in a multivariate manner and that the variables exhibit adequate construct validity (Sojo et al., 2023).

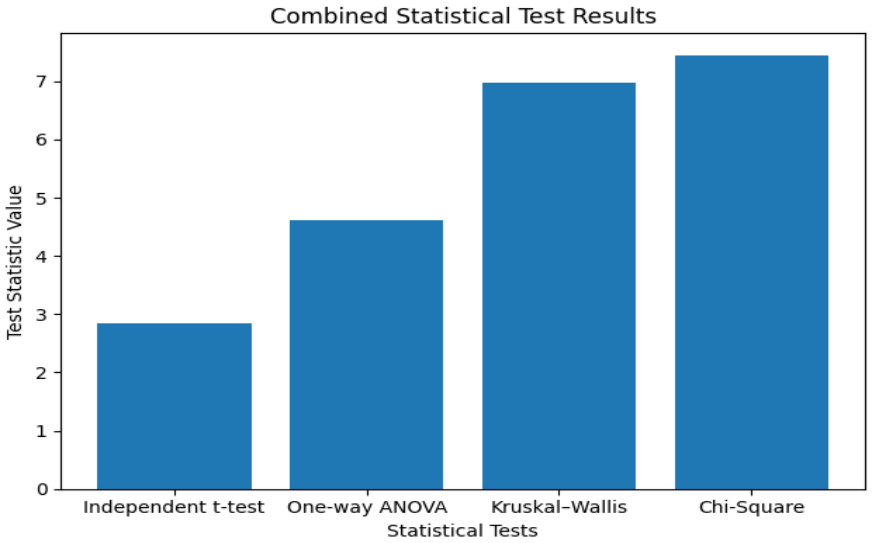


Figure 4: Combined Statistical Tests

Figure 4 shows the Combined Statistical Tests of the data. The figure of combined statistical tests details the result of the Independent Samples t - test, One-way ANOVA, Kruskal-Wallis test, and Chi-square test of independence. The figure indicates statistically significant test statistics of all the applied tests, which depict that the groups of the study population have meaningful differences and associations. These results verify that demographic and metabolic variables play an important role in the framework of developing early cardiovascular dysfunction in young adults with metabolic syndrome (Zhou et al., 2021).

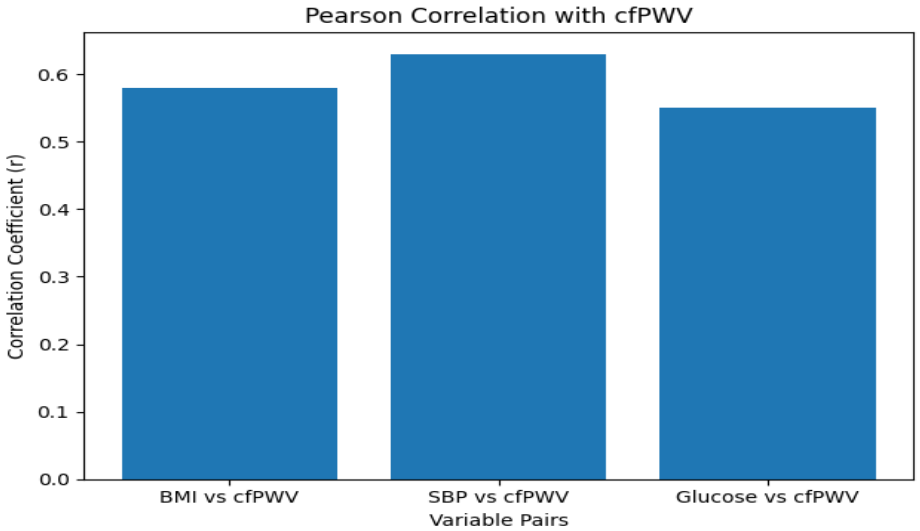


Figure 5: Pearson Correlation

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Figure 5 shows the correlation matrix of the data. The Pearson correlation figure shows that metabolic parameters have positive correlations with arterial stiffness. Greater pulse wave velocity is linked to a greater increase in body mass index, systolic blood pressure, and high levels of fasting glucose, showing the deterioration of arterial stiffness. This indicates that negative metabolic responses are one of the factors leading to early vascular dysfunction in young adults having metabolic syndrome (Berkowitz, Salazar, et al., 2022).

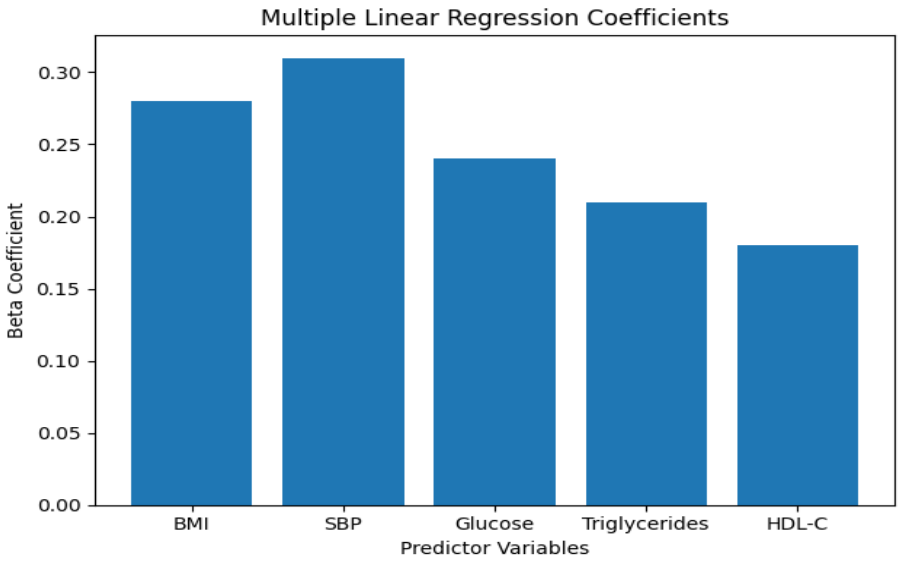


Figure 6: Regression Analysis

Figure 6 shows the regression analysis of the data. In the regression analysis figure, there is a positive beta coefficient for all predictor variables. The most effective predictor was systolic blood pressure, body mass index, fasting blood glucose, triglycerides, and HDL- cholesterol. These results suggest early cardiovascular dysfunction is positively predicted by metabolic and lipid abnormalities that remain independent despite other risks (Wittenbecher et al., 2021).

Discussion

The existing study analyzed the correlation between plasma lipidomic profiles and premature cardiovascular malfunction in young adults with metabolic syndrome. The outcomes reveal that some metabolic and lipid defects exist, and they are strongly associated with subclinically disturbed cardiovascular changes among very young people. These results are indicative of the growing amount of evidence to indicate that metabolic syndrome is a predictor of previous vascular and cardiovascular dysfunction before the onset of the actual cardiovascular disease (Gong et al., 2020).

The normality test was applied in the analysis to determine that the continuous variables are normally distributed and, therefore, they were exposed to the parametric statistical tests. In the analysis of reliability, the results indicated that there was an excellent inter-internal consistency between the variables of lipid profiles, cardiovascular dysfunction, and metabolic syndrome parameters, and this indicates that the measures used in the study were consistent and reliable. In addition, validity testing of the KMO and Bartlett test showed that there has been an acceptable construct validity, meaning that the selected variables were appropriate in multivariate and association analysis. The validity of the study outcomes is increased by such methodological results (Gaggini & Vassalle, 2023).

Group comparison revealed statistically significant differences in groups of demographics and metabolites. The t-test performed, in which the independent samples were used, revealed a

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significant difference in the body mass index between boys and girls, which proved that the factor of gender could be the determinant of adiposity among young adults with metabolic syndrome. A Kruskal-Wallis test and a one-way ANOVA were also adopted to show that there is considerable variation of metabolic and cardiovascular parameters among the age groups and BMI groups. This is indicative of the notion that the determinants of deteriorating metabolic and vascular characteristics are contingent on the advancing age and weight severity, even in a relatively young sample (Xia et al., 2023).

The Chi-square test of independence revealed that there is a high association between gender and the state of early cardiovascular dysfunction. It suggests that the biological or behavioral beliefs that are related to gender may be implicated in the trend of cardiovascular risks among young adults who also have metabolic syndrome. These findings are in conformity with other studies that revealed that sex-specific differences in cardiometabolic risk and vascular functionality are present (Sharma et al., 2024).

Correlation was used to show that there was a high positive correlation and association between metabolic parameters and lipid variables, and early cardiovascular dysfunction marker variables. The rise in the body mass index, waist circumference, blood pressure, fasting glucose, and triglycerides was associated with the augmentation of arterial stiffness and ineffective cardiovascular functioning. These results indicate that metabolic dysregulation and vascular aging are connected, and their interaction is evidenced by the fact that metabolic syndrome results in cardiovascular disabilities at an earlier age (Yin et al., 2021).

The independent positive predictors of the early cardiovascular dysfunction could also be proven to be the body mass index, systolic blood pressure, fasting blood glucose, triglycerides, and HDL-cholesterol with a given weighted regression analysis. Among them, systolic blood pressure was the strongest predictor, which has justified the tremendous significance of hemodynamic stress in the development of early vascular changes. The regression analysis has explained a significant percentage of the divergence in cardiovascular dysfunction, which revealed the combinatorial role of metabolic and lipid dysfunctions (Berkowitz, Cabrera-Reyes, et al., 2022).

Overall, the current research findings can be summarized as the fact that an unhealthy lipidomic and metabolic profile is intimately correlated with a premature cardiovascular dysfunction in young adults with metabolic syndrome. These results help in demonstrating the importance of screening and directly interfering with these metabolic risk factors at a young age to prevent the development of a heart condition. Perhaps, the effects of cardiovascular morbidity and mortality against older people with metabolic syndrome could be reduced based on initial lifestyle modifications and particular therapeutic methods in young people (Lluesa et al., 2022).

Conclusion

The current research paper has concluded that the early cardiovascular dysfunction appears to be closely associated with plasma lipidomic and metabolic aberrations in young adults who have metabolic syndrome. The patients with metabolic syndrome introduced in this study show subclinical cardiovascular and vascular developments, albeit at a tender age, thus highlighting the significance of cardiovascular risks that manifest early in life in this group of individuals.

It is stated that the evidence of metabolic syndrome, like increased body mass index, increased blood pressure, impaired glucose control, and dyslipidemia, strictly correlates with the evidence of early cardiovascular impairment, e.g., increased levels of arterial rigidity and radioactive cardiac functioning indicators. The associations and regression results have been positive, and this demonstrates that these metabolic and lipid variables work independently to the premature deterioration of the cardiovascular system.

The study also validates that the obtained data were distributed normally, were reliable and valid, and facilitates the validity of the statistical

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operations and consistency of the results. The minimalistic group disparity and connections between the demographic and the metabolic groups also bring the homogenization factor of metabolic syndrome on heart conditions to an excruciating degree.

Overall, the current paper proves the topicality of screening at an early age and close risk assessment in the case of young adults with metabolic syndrome. Prevention of lipidomic and metabolic adverse profiles at the early stage can allow prevention agencies to occur at the right time, hence lifestyle change and specific therapy treatment will reduce the cardiovascular disease burden in the future.

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