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Investigating Risk Factors for ASCVD: The Role of Body Mass Index and Cardiometabolic Parameters

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Abstract. Cardiovascular diseases, particularly atherosclerotic cardiovascular disease, are one of the leading causes of morbidity and mortality worldwide. Understanding major risk factors helps develop effective early intervention strategies and preventive activities. Thus, this research proposes to look into and test the link and the prediction capability of randomized Body Mass Index (BMI) experiments and lipid profiles concerning factors that develop Atherosclerotic Cardiovascular Disease (ASCVD) in normal individuals. Besides, by analyzing the factors (among them), the body mass index (BMI) alone is a strong predictor of cardiovascular risk, and the composition of lipids in the body is essential for assessing overall cardiovascular risk. In a cross-sectional study, the goal was to Lipid profile indices (total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides (TRG) as well as clinical factors such as BMI were the subjects of investigation. Pearson's correlation tests were employed to explore the relationships between lipids, BMI, and ASCVD risk among participants aged 30-80, of whom there were 77. The data resulted in the finding that ASCVD risk was significantly correlated with BMI ($r = 0.904$, $p<0.01$), which means that obesity is one of the main risk factors for cardiovascular diseases. The main discovery was the moderate age-ASCVD% correlation ($r=0.671$, $p<0.01$), which confirms previous studies that linked aging to atherosclerosis. The findings that confirm HDL and LDL are interlinked once again ($r=0.895$, $p<0.01$) show that both are critical for atherosclerosis development and lipid metabolism. TRG and HDL are instead curiously correlated with moderate strength ($r=0.617$, $p<0.01$). In summary, the present research reflects the inherent and complex association of ASCVD risk, lipid profiles, and BMI, thereby providing valuable contributions to the body of knowledge on cardiovascular disease prevention. Furthermore, it is anticipated that this project will progress into the improvement

of clinical decision-making and public health strategies as it furthers the understanding of the disease processes, which in turn will have a global positive impact on the cardiovascular disease burden

Keywords: BMI; Obesity; Cardiovascular Risk; Lipid Profiles; atherosclerosis.

List of Abbreviations

BMI	Body Mass Index
ASCVD	Atherosclerotic Cardiovascular Disease
HDL	High-Density Lipoprotein
TRG	Triglycerides
LDL	Low-Density Lipoprotein
TC	Total Cholesterol

1. Introduction

Cardiovascular Diseases (CVDs) are a significant health problem for humanity since they cause around one-third of global deaths every year (1). Among these diseases, atherosclerotic cardiovascular disease (ASCVD) is one of the most common because of the severe complications it can lead to, for example, peripheral artery disease, myocardial infarction, and stroke (2). To improve prevention and treatment strategies, one first needs to understand the most prevalent risk factors accompanying ASCVD. In other words, biomarkers that might reduce the risk of heart disease, such as lipid profiles and body mass index (BMI), have been considered; however, they are macro-determined too much by lifestyle choices and genetic predispositions (3,4). Body Mass Index (BMI) is a standard metric used to assess obesity, calculated by dividing body weight in kilograms by the square of height in meters (kg/m^2). Even though it was considered that being overweight could lead to an increased risk of cardiovascular disease, a relatively recent study has suggested that BMI may not be really the only factor that matters, as it cannot separate muscle mass from body fat (5). The fact that this question has not been settled is why the researchers are trying to turn to other risk indicators, such as lipid profiles, which would give them a better understanding of cardiovascular issues (6).

Lipid profiles are the primary source of information on cholesterol metabolism and its effects on the cardiovascular system. Cholesterol, often called bad cholesterol, is low-density lipoprotein (LDL), which increases the risk of atherosclerosis and heart disease via plaque formation in the arteries (7). Opposite to this, high-density lipoprotein (HDL), which is known as good cholesterol, lowers the risk of cardiovascular disease and facilitates the transport of excess cholesterol from the arteries to the liver for removal (8). Another key factor, triglycerides (TRG), are also related to metabolic diseases, and when they are elevated, they can also contribute to cardiovascular problems (9). Furthermore, a prevalent risk measure is the total cholesterol-to-- to HDL (TC/HDL) ratio, where bigger ratios come with more chances of cardiovascular disease (10). Besides some particular biomarkers, the ASCVD risk percentage is a standard clinical tool that computes a person's chance of developing cardiovascular disease within a given time, usually ten years. This tool is more comprehensive as it assesses several factors, including Age, gender, blood pressure, cholesterol, smoking status, and diabetes (11). The ASCVD risk score is a clinical tool for stratifying individuals based on cardiovascular risk, allowing healthcare providers to prioritize preventive strategies for those at the highest risk. This work examines the relationship among BMI, lipid profiles, and ASCVD risk percentage in adults. An analysis of these factors, like the study, is supposed to make risk stratification of the lipid profiles possible by investing on them and assist BMI in accurately determining the cardiovascular risk. Would the pretty new idea of the clinical practice go further with the outcomes of the present work, such that it would make more personalized prevention modes and achieve better public health (12). Managing cardiovascular disease can only be made efficient when proper knowledge of the relationship between BMI, lipid levels, and ASCVD risk exists. The plan's proposals should aim to educate the population about the risks of ASCVD and offer tailored preventive health services. For example, healthcare providers can create personalized plans for patients to help manage the particular patterns of lipids, which are the most common in that individual patient and are connected with a high risk of ASCVD. In addition, determining these risk factors which are population-specific might form the base for public health campaigns that are specifically designed to match the prevalence of cardiovascular diseases (13).

2. Materials and Methods

For this study, a cross-sectional design was chosen with 77 physically fit individuals comprising both males and females aged 30-80. The blood samples were taken from the participants after a 12-hour fasting period, which helped eliminate the influence of food on lipid levels, thereby making the measure of cholesterol and triglyceride concentrations more accurate. Lipid profile measures were performed accurately as participants had to give blood samples after 12 hours of fasting. This duration of fasting was needed to eliminate any food influences on the lipid levels, ensuring that the cholesterol and triglyceride concentrations were measured with higher accuracy.

Ethics Statement

The study conformed to the ethical research protocols and was sanctioned by the Ethics Committee of Al-Iraqia University, College of Medicine. The research was administered adhering entirely to the 2013 Declaration of Helsinki, ensuring the safety, rights, and health of the participants. Before the individuals' inclusion in the study, the informed consent of all participating individuals was taken in writing regarding their voluntary participation and understanding of the study's objectives and procedures.

Body Mass Index (BMI):

BMI was calculated using the formula:

BMI = Weight (kg) / height (m2)

A digital scale with an accuracy of 0.1 kg was used to measure participants' Weight, and a stadiometer with a precision of 0.01 meters was used to measure their height. Each measurement was taken twice for precision, and the average values were used for BMI calculation.

The procedure of obtaining blood samples and laboratory analysis involved using lithium heparin-coated capillary tubes, through which the collected venous blood samples were drawn by a fingerstick method. The Cholestech LDX™ lipid profile cassettes' lipid profile was studied on the CHOLESTECH LDX™ analyzer (Abbott Laboratories). Using this technique was beneficial for the measurement of total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides (TRG) with high accuracy. The data analysis in the study was done using SPSS version 26 to provide the necessary statistical tests to be applied to the mean and standard deviation of individual parameters. Continuous variables were evaluated through independent t-tests. Categorical variables were measured using chi-square tests and Fisher's exact tests. It was determined that the results were statistically significant, with a p-value of < 0.05.

3. Results

Table 1: Descriptive Statistics

	N	Mean	Std. Deviation
Age	77	58.23	10.177
BMI	77	32.117	6.9636
TC	77	169.09	41.655
HDL	77	38.42	12.696
TRG	77	171.78	92.604
LDL	77	96.21	36.833
Valid N (listwise)	77		

The table presents the descriptive statistics for the 77 participants. The results indicate that the average Weight of these individuals is 58.23 kilograms, with a standard deviation of 10.18. In contrast, the average body mass index (BMI) is 32.12 kg/m² with a standard deviation 6.96. Total cholesterol (TC) is 169.09 mg/dL with a standard deviation of 41.66, while high-density lipoprotein (HDL) is 38.42 mg/dL with a standard deviation 12.70. The average triglycerides (TRG) level is 171.78 mg/dL, and the standard deviation is 92.60. Moreover, the average low-density lipoprotein (L) level is 96.21 mg/dL, with a standard deviation 36.83.

Correlation Table

Table 2: Baseline Characteristics of the Participants

Variable	ASCVD%	BMI	Age	TC	HDL	TRG	LDL	TC/HDL
ASCVD%	1	0.904**	0.671**	-0.01	0.068	0.051	-0.042	-0.029
BMI	0.904**	1	-0.139	0.037	0.077	0.01	0.006	-0.02
Age	0.671**	-0.139	1	-0.382**	-0.074	-0.133	-0.329**	-0.029
TC	-0.01	0.037	-0.382**	1	0.078	0.373**	0.895**	0.548**
HDL	0.068	0.077	-0.074	0.078	1	-0.416**	-0.052	-0.708**
TRG	0.051	0.01	-0.133	0.373**	-0.416**	1	0.048	0.617**
LDL	-0.042	0.006	-0.329**	0.895**	-0.052	0.048	1	0.654
TC/HDL	-0.029	-0.02	-0.029	0.548**	-0.708**	0.617**	0.654	1

Notes:
*The "**" symbol indicates that the correlation is statistically significant at the 0.01 level (2-tailed).*
The table shows a strong positive correlation between ASCVD% and BMI (correlation value: 0.904), TC and LDL, and HDL and TRG.

The table shows the Pearson correlation coefficients among significant variables associated with Atherosclerotic Cardiovascular Disease (ASCVD) risk, obesity (BMI), and lipid profile indices. The most important points are as follows:
•ASCVD% and BMI: A strong positive correlation (0.904*, $p < 0.01$) implies that greater BMI is closely related to the increase of ASCVD risk.
•ASCVD% and Age: A moderate positive correlation (0.671, $p < 0.01$) indicates that Age being older is associated with ASCVD risk.
•ASCVD% and lipid profile: A weak negative correlation with TC (-0.01) and LDL (-0.042) but significant positive correlations with HDL (0.068) and TRG (0.051) exist, although the system of correlation is not strong the latter ones are significant among suffered patients.
•BMI and Age: A weak negative correlation (-0.139) implies that there is little to no association between BMI and Age in this dataset.
•Lipid Profile Correlations: Strong correlations between TC and LDL (0.895) and HDL and TC/HDL ratio (-0.708*) demonstrate that the levels of lipids are interrelated and influence the ASCVD risk.

The above-mentioned correlations represent the complex interplay of obesity, lipid levels, and ASCVD risk factors. Among the evaluated variables, body mass index (BMI) and Age emerged as the most significant predictors of cardiovascular risk.

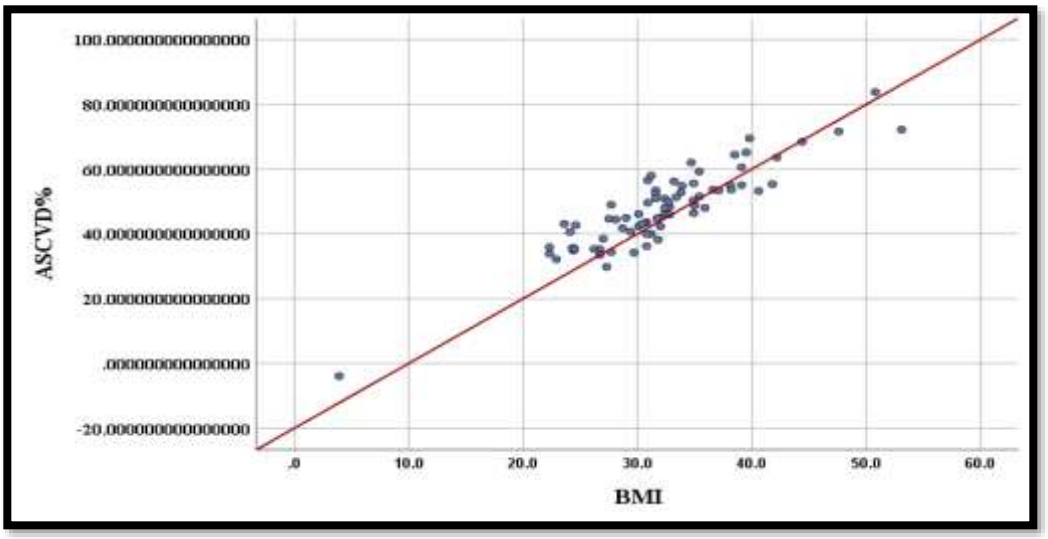


Figure 1: *The Relationship Between BMI and the Risk of Atherosclerotic Cardiovascular Disease (ASCVD%)*

The scatter plot represents the relationship between body mass index (BMI) and the percentage of atherosclerotic cardiovascular disease (ASCVD) risk. The data is drawn to a one-on-one relationship that shows if an indicator is measured at a higher weight, the risk of being ascribed with ASCVD is increased. The red-fitted regression line with an increasing slope is a geometric interpretation of this generalization. The Pearson correlation coefficient, with an index of 0.904, indicates that the statistical analysis provides a significant outcome of the affirmative correlation between BMI and ASCVD%. This assertion shows a high percentage of people who possess high BMI numbers are definitely more likely to get atherosclerotic cardiovascular disease. This fact is in line with the current literature, which asserts that obesity, as represented by a higher BMI, is a primary predisposing factor to heart disease.

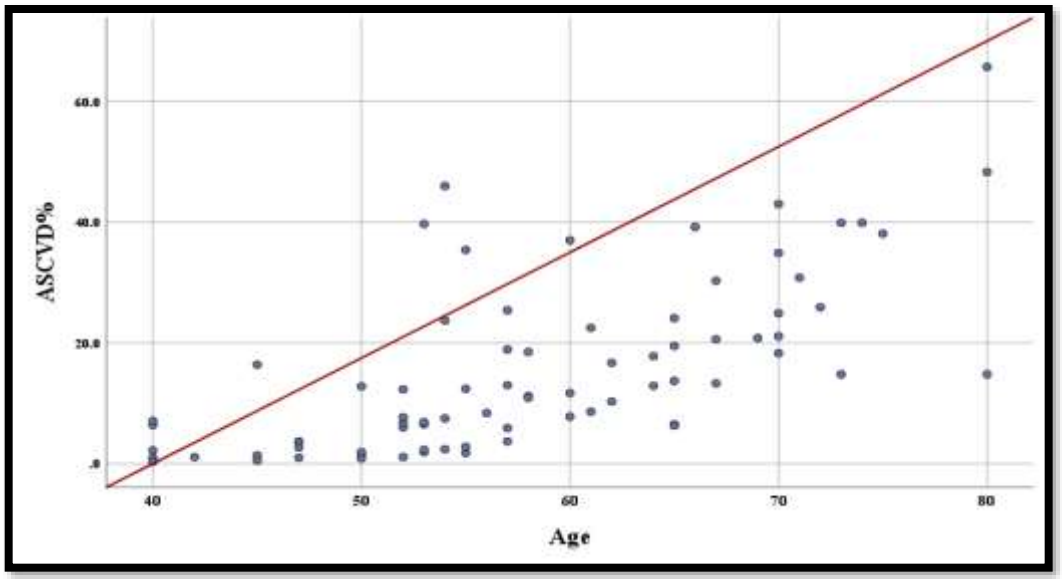
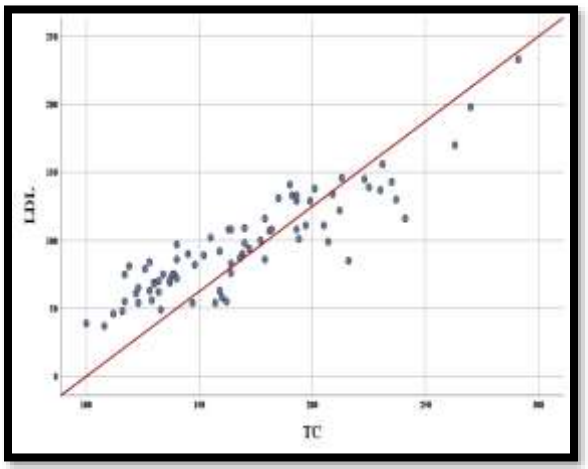
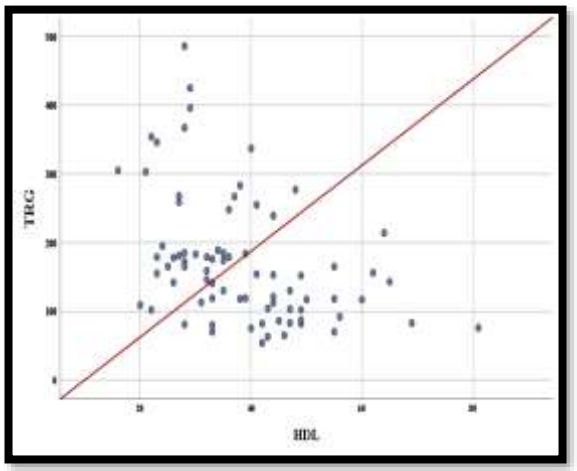


Figure 2: *The Relationship Between Age and the Risk of Atherosclerotic Cardiovascular Disease (ASCVD%)*

A scatterplot matrix is a visual representation of all the variable pairs that are being studied in the scientific experiment along with their relationship in a particular variable such as Body Mass Index (BMI), Age, Atherosclerotic Cardiovascular Disease Risk Percentage (ASCVD%), High-Density Lipoprotein (HDL), Triglycerides (TRG), Low-Density Lipoprotein (LDL), and the Total Cholesterol to HDL Ratio (TC/HDL). Each specific cell in the scatter plot matrix shows the scatter plot for the variable pair where (X) is the first horizontal (X) variable and (Y) is the second vertical (Y) variable, respectively.



(A)



(B)

Figure 3: *(A) The Relationship Between LDL and TC* *(B) The Relationship Between TRG and HDL*

The analysis also includes many other indicators like body mass index (BMI), Age, atherosclerotic cardiovascular disease risk percentage (ASCVD%), high-density lipoprotein (HDL), triglycerides (TRG), low-density-lipoproteins (LDL), and total cholesterol to HDL ratio (TC/HDL) which are related to the individual ones. The scatter plot matrix in the diagram (A) is the detailed picture of these links. This is a matrix where each cell corresponds to a scatter plot for a specific variable pair, with the Y-axis (Y) denoting the second variable and the X-axis (X) representing the first one. Apart from this, the scatter plot in diagram (B) illustrates the relationship between levels of low-density lipoprotein (LDL) and total cholesterol (TC) as well. The red regression line on the plot is shown with an upward slope, which indicates the positive association between TC and LDL. This means that as total cholesterol goes high, so do LDL levels. The high Pearson correlation coefficient of 0.895, statistically significant between TC and LDL, also underpins this assertion. This relationship is confirmed by the statistical analysis, which shows this positive relationship. This infers that more LDLs are linked with higher total cholesterol levels, which is supported by this high correlation. This observation aligns with earlier studies emphasizing the critical role of cholesterol monitoring in preventing atherosclerosis and related cardiovascular disorders.

Discussion

The ongoing research into the risk factors of atherosclerotic cardiovascular disease (ASCVD) is one of the significant drivers of science that has led to several views on the topic and the establishment of myocardial health. Age is a permanent risk factor that cannot be changed for the onset of ASCVD, and this has been stressed by Wong et al. (2022), who have elaborated further on this crucial impression. These findings provide additional evidence to the effect that age-related lipid metabolic disorders greatly increase cardiovascular risk, which concurs with our data indicating that the cardiovascular disease risk is elevated with a person's Age. This common notion states that Age should be included in the cardiovascular risk assessment as a prime factor. (11). Similarly, the study by Schoch et al. (2023) supports our data concerning the HDL's antiatherosclerotic action. They have provided the necessary proof for the statement that high HDL concentration is a protective factor for ASCVD's incidence by demonstrating a negative correlation between HDL and the rate of cardiovascular events. This cross-study affirmation highlights the essential role of HDL in implementing preventive activities against cardiovascular disease. (12) Chen et al. (2023) have put forward their doubts about whether body mass index (BMI) can adequately serve as an independent predictor for cardiovascular disease risk. They argue for a model that considers the body mass index (BMI) and the wide array of biomarkers that interact with one another. This point of view is significant since it contends that the simultaneous employment of various diagnostic markers gives a more reliable evaluation of the risk. (13) In contrast, Salcedo-Cifuentes et al. (2020) make a more sophisticated argument that BMI is still a valid predictor of cardiovascular risk if employed with other standard biomarkers like the Castelli Risk Index. This point of view infers that while BMI alone may not yield fruitful results, its utility is acknowledged when measured along with a wider spectrum of assessments. (14) Often, the topic of LDL levels and TC/HDL ratio being the same is a context Adorni et al. (2021) have taken the lipid spectrum to a whole new level and have provided solid proof for the central role of LDL in atherosclerosis. Thus, their article has accentuated the detrimental effects of elevated LDL on the arterial system and their major part as a predictor for Atherosclerotic Cardiovascular Disease (ASCVD) risk, which elucidates the necessity for low LDL levels in everyday medical practices. (15) At the end of the same context, Zibaeenejad et al. (2022) included ethnic and geographic disparities as one of the significant risk assessment factors. Inasmuch, they stressed that fighting obesity through tailored, cost-effective public health interventions is a must-have, and such studies manifest the need for local and population-specific investigations. (16) The studies enumerate the many areas reaffirmed by studies that have strong arguments about Age and HDL being on top of the cardiovascular risk ladder. The studies expound on the reasons for the inquiry into the key elements of BMI and lípid profile overall prognosis. This dynamic scholarly debate proves how intricate cardiovascular risk assessment is and the consequently looming necessity for a more broad and specific medical approach to be adopted in today's medical practice. By the individual or population specifics examined and/or the selection of the varied biological markers used, we might be able to improve and enhance cardiovascular health management and prognosis. The findings stem from an exhaustive examination of the relationships among different clinical variables such as Age, body mass index (BMI), lipid profile characteristics, and the factors that lead to atherosclerotic cardiovascular disease (ASCVD). The demographic information is shown in Table 1. The study group had an average age of 58.23 years, while a BMI above the average was the reason for the group to be classified as at risk for cardiovascular problems. The primary clinical characteristic illustrates that the group is at high risk for cardiovascular problems; this is because it is composed of individuals who are classified as having an average BMI that falls in the obese category. In connection with the fact that a line of obesity is linked with possible adverse health outcomes, including metabolic and cardiovascular diseases, it has been a proven fact. Table 2 and Figure 1 demonstrate a statistically significant association ($r = 0.904$, $p < 0.01$) between BMI and ASCVD percentage. This indicates that

individuals with higher BMI values are at greater risk for developing atherosclerotic cardiovascular disease. The present study complements earlier findings on the link between obesity as a causal agent of vascular disease. Oxidative stress, and atherosclerotic plaque accumulation (13). obesity still leads to dyslipidemia, systemic inflammation, and insulin resistance, but it also directly affects the ASCVD risk. In addition, the age factor had a slight positive correlation with the ASCVD% ($r=0.671$, $p<0.01$); this means that older individuals are more likely to develop atherosclerosis. The correspondence is depicted in Figure 2. One of the consequences of Age on the arteries is that they grow more rigid, which is associated with atherosclerosis and high blood pressure accompanied by the vessels' greater resistance (14). The point that these developments are long-term processes shows the need for early intervention to prevent high-risk groups from bothering the health system. As a matter of fact, no significant correlations were found between ASCVD% and the levels of total cholesterol (TC) and low-density lipoprotein (LDL) (-0.01 and -0.042, respectively). At the same time, Figure 3(A), on the other side, has presented a very important finding-that is the correlation between TC and LDL ($r=0.895$, $p<0.01$). Prior research agrees with the conclusion that elevated LDL levels are related to more cardiovascular disease risk due to increased plaque and inflammatory development (15). The weak correlations between ASCVD% and HDL levels and triglyceride (TRG) levels mean their actions might be influenced by other biological factors that need further study. A strong inverse relationship was found between HDL levels and the TC/HDL ratio ($r = -0.708$, $p < 0.01$), highlighting HDL's protective influence against cardiovascular events. Contrary to the conventional assertion of an inverse relationship existing between the two markers, Fig. 3 (B) gives us the correlation between TRG and HDL ($r=0.617$, $p<0.01$). In fact, the most recent findings elaborate that the variances in lipid interactions would likely not have occurred without the involvement of lifestyle choices, hereditary factors, and metabolic disorders (16). Also, more studies are needed to validate the hypotheses that cause the associations. Also, the findings illuminate the importance of Age and BMI in determining the risk for ASCVD, thus reiterating the need for preventive measures targeting the fight against obesity and the monitoring of cardiovascular health (17). The relation between the lipid profiles shows that while LDL is the leading culprit in atherosclerosis, it may overshadow its main actions through the contributions of other metabolic factors. The discoveries lay the groundwork for childhood intervention by including longitudinal studies and suggesting widening the sample set and in-depth tests on additional human characteristics to understand these interplays correctly (18). This study reiterates the prior results about the connections between ASCVD risk, Age, lipid levels, and obesity. The need for finer inquiries that factor in genetic and environmental determinants is buttressed by the discrepancies in the relationships between the lipid profiles. Future studies should scout out a larger sample and a more varied population not only for the sake of these details but also to better understand the full range of consequences.

Conclusion

This study highlights the significant association between elevated body mass index and key cardiometabolic risk factors contributing to ASCVD. The positive correlations with LDL and triglycerides and the inverse relationship with HDL support the role of BMI as a practical indicator for early risk detection. Public health interventions focusing on weight control and metabolic health may substantially reduce the burden of ASCVD in at-risk populations.

Conflict of Interest: None

Ethical Consideration: The ethics committees of the Iraqi University- Faculty of Medicine approved the study. NO:FM.SA.154, date: 22\8\2023

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