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Association of Dyslipidemia, Atherogenic Index and some Biochemical Markers with Cardiovascular Risk in Postmenopausal Women

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Abstract

Background: Cardiovascular disease (CVD) is the leading cause of morbidity and mortality in women around the world.

Objectives: To identify the link between dyslipidemia, atherogenic index and some other biochemical parameters in postmenopausal women.

Materials and Methods: all participants of women aged from 53-70 years. A total 60 postmenopausal women have cardiovascular diseases and 30 healthy women participants enrolled in the present study as a control group. Blood samples were collected are prepared and for assessment of lipid profile, myosin and renal function tests.

Results: Mean Cholesterol levels were significantly increased in the CVD group compared to controls (207.7 ± 20.4mg\dl vs control 173.8 ± 21.0 mg\dl). Similarly, triglycerides concentrations were markedly higher in the CVD group (207.6 ± 74.2mg\dl) vs control group (167.6 ± 21.8mg\dl), as were LDL level in CVD group (149.6 ± 20.7mg\dl) vs control group (97.9 ± 21.0mg\dl). While HDL level was significantly reduced in CVD group (22.2 ± 10.4mg\dl) vs control group (48.4 ± 7.8mg\dl). VLDL level show higher level in CVD group (41.6 ± 15.1mg\dl) vs control group (33.5 ± 4.3mg\dl). Atherogenic index (CVD: 1.0 ± 0.3 vs. control: 0.5 ± 0.1), while cardiac risk observed (CVD: 10.6 ± 3.2 VS. 3.6 ± 0.7). Myosin level between groups (CVD: 2289.8±1087.6pg\ml vs. control: 2943.1±2326.2pg\ml; p value >0.05). Mean urea levels were significantly increased in the CVD group compared to controls group (44.1 ± 9.6mg\dl) vs control (33.9 ± 7.4mg\dl). Similarly, creatinine level was significantly higher in CVD group (1.750 ± 0.760mg\dl) vs (0.452 ± 0.02mg\dl).

Conclusions: In postmenopausal women cardiovascular risk rises as obesity increased, lipid profile, atherogenic index and aging may lead to renal function disturbance and increase level of urea and creatinine.

علاقة اضطراب الدهون ومؤشر التصلب العصيدي وبعض المؤشرات الكيميائية الحيوية الأخرى بأمراض القلب والأوعية الدموية لدى النساء بعد انقطاع الطمث

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الخلاصة

تعد امراض القلب والاوعية الدموية السبب الرئيسي للمراضة والوفيات بين النساء في جميع انحاء العالم. هدف الدراسة: أجريت هذه الدراسة في مدينة تكريت - العراق لأجل تحديد العلاقة بين اضطراب دهون الدم ومؤشر التصلب العصيدي وبعض المعايير البايوكيميائية لدى النساء بعد انقطاع الطمث المصابات بأمراض القلب والاوعية الدموية. شملت الدراسة المشاركات من النساء اللواتي تتراوح اعمارهن بين 53 الى 70 سنة. 60 امرأة بعد سن اليأس مصابات بأمراض القلب والاوعية الدموية و30 امرأة سليمة كمجموعة ضابطة. تم جمع عينات الدم و حضرت لأجل تقييم مصورة دهون الدم, والميوسين, ووظائف الكلى. كانت مستويات الكولسترول الكلي اعلى بشكل ملحوظ لدى مجموعة مرضى القلب (207.7 ± 20.4 ملغ/دل) مقارنة بالمجموعة الضابطة (173.8 ± 21.0 ملغ/دل). كذلك كانت تراكيز كل من الدهون الثلاثية ومستويات LDL وVLDL اعلى في مجموعة مرضى القلب (207.6 ± 74.2 ملغ/دل) و(149.6 ± 20.7 ملغ/دل) و(41.6 ± 15.1 ملغ/دل) على التوالي مقارنة بالمجموعة الضابطة (167.6 ± 21.8 ملغ/دل) و(149.6 ± 20.7 ملغ/دل) و(33.5 ± 4.3 ملغ/دل) على التوالي. في المقابل كانت مستويات HDL منخفضة بشكل كبير في مجموعة مرضى القلب (22.2 ± 10.4 ملغ/دل) مقارنة مع المجموعة الضابطة (48.4 ± 7.8 ملغ/دل). كان مؤشر التصلب العصيدي اعلى في مجموعة مرضى القلب (1.0 ± 0.3) مقارنة مع بالمجموعة الضابطة (0.5 ± 0.1) , كما لوحظ ارتفاع في معامل الخطر القلبي لدى المرضى (10.6 ± 3.2) مقارنة بالمجموعة الضابطة (3.6 ± 0.7). اما مستوى الميوسين فلم يظهر فرقا معنويا بين المجموعتين (2289.8 ± 1087.6 بيكوغرام/مل) مقارنة بالمجموعة الضابطة (2943.1 ± 2326.2 بيكوغرام/مل). وكان متوسط مستوى اليوريا اعلى بشكل ملحوظ في مجموعة مرضى القلب (44.1 ± 9.6 ملغ/دل) مقارنة بالمجموعة الضابطة (33.9 ± 7.4 ملغ/دل). وكذلك كانت مستويات الكرياتينين اعلى بشكل كبير في مجموعة المرضى (1.750 ± 0.760 ملغ/دل)) مقارنة مع المجموعة الضابطة (0.452 ± 0.02 ملغ/دل). يزداد خطر الإصابة بأمراض القلب والاوعية الدموية في النساء بعد سن اليأس نتيجة لزيادة السمنة واختلال دهون الدم وارتفاع مؤشر التصلب العصيدي. ومع تقدم العمر يؤدي ذلك الى اضطرابات في وظائف الكلى وزيادة في مستويات اليوريا والكرياتينين.

الكلمات المفتاحية: الأمراض القلبية الوعائية، ما بعد انقطاع الطمث، خلل الدهون في الدم، معامل التصلب العصيدي.

Introduction

Menopause is the word used to describe the natural and permanent cessation of menses due to an estrogen deficiency; it is not associated with any pathological condition. When amenorrhea persists for a full year, a woman's reproductive and childbearing years are over [(1)]. Menopause is an important event in women's lives, possibly contributing to the development of CVD, which is associated with changes in the cardiovascular risk profile, markers of metabolic health, and subclinical atherosclerosis [(2)]. Significant increases in blood pressure, body mass index (BMI), obesity, and the distribution of body fat are linked to menopause [(3)]. The most prevalent risk factors for CVD in menopausal women, according to epidemiological research, are central obesity, atherogenic dyslipidemia, glucose intolerance, and hypertension [(4)].

Women who are obese are more likely to develop cardiovascular disease and the cardiovascular-kidney-metabolic syndrome. Hormonal changes throughout life increase the risk of cardiovascular disease by contributing to weight gain and patterns of fat distribution that are unique to women. Strategies for managing obesity in women that are effective must take these sex-specific differences into consideration. Complications from obesity disproportionately afflict postmenopausal women [(5)].

For example the distribution of BMI in the United States has changed recently, making the percentage of people with morbid obesity higher than the percentage of people who are overweight or mildly obese, it is critical approved that obesity as a significant risk factor for CVD [(6,7)].

It should be mentioned that although BMI is extensively used and accessible, it does not directly measure adiposity because it takes into account both muscle and fat mass. Lower cut-offs are advised for South Asian, Chinese, and Japanese populations because BMI varies significantly by race/ethnicity in addition to age and sex [8]. Within each BMI category, waist circumference is linked to outcomes and is a crucial indicator of abdominal obesity [9]. One modifiable risk factor for cardiovascular diseases (CVDs) is dyslipidemia. Dyslipidemia is caused by hormonal changes associated with menopause. The prevention and timely management of CVDs are facilitated by the early identification of such risk factors. Higher serum lipids and lipid ratios in post-menopausal women could lead to increased CVD risks and other related complications in the long term. [10]. Because of its many functions, estrogen has cardio-protective properties that are particularly noticeable when taken insufficiently. Postmenopausal women who experience a drop in estrogen levels also have a decrease in subcutaneous fat and an increase in belly fat [11].

Materials and Methods

Study design

The case-control study included 90 female participants a ratio 2:1 (60 patients and 30 control) is used to increase statistical power when a control group is readily available this lead to increase the clinical significance of the results. The sample size determined by G Power. The age of participants were 53-70 years old, the samples were collected from August 2024 till the end of December 2024 from Tikrit Teaching Hospital in Tikrit city and from Al-alam Hospital. The investigator prepared a data collection sheet form that was used for the interviews with the participants. It contains questions about the age, weight, length and illness history.

Study population

Inclusion criteria

Postmenopausal women with cardiovascular diseases aged from 53-70 years were included in the study.

Exclusion criteria

Men were excluded from this study and patients who take warfarin and melatonin.

Study groups

Patients groups included sixty postmenopausal women and control group included thirty healthy women.

Sampling

The antecubital vein was venipuncture using a disposable syringe to take blood samples, yielding roughly five milliliters of blood, and transferred into a separation gel tube, which allowed the serum to be separated by centrifugation for approximately ten minutes at 3000 rpm. Clear, dry Eppendrof tubes with the resultant clear serum were kept at -20°C until measuring lipid profile, myosin and renal function tests were done.

Materials

Serum lipid profile and renal function test measured by using BIOLABO kits while Myosin measures by using specific enzyme-linked immunosorbent assay (ELISSA) kits from Sunlong, Bitotech.

Atherogenic index calculated by using this equation:

Atherogenic index= log (Triglycerides / HDL-C)

Cardiac risk can be calculated by the following equation:

Cardiac risk= Total cholesterol/ HDL-C

Ethical consideration

The study was submitted to the Scientific Committee of Tikrit University College of Medicine and approval was received on 6/29/2025 for this study, which indicated that it complied with all of the study ethics standards outlined in the Declaration of Helsinki. The Salah Al-den Health Directorate approved research at Tikrit Teaching Hospital and Al-Alam Hospital. All participants had to provide their informed consent before they could be included in the study. All participant data was treated with the utmost

confidentiality and utilized exclusively for research purposes.

Statistical analysis

All statistical analyses were performed using R version 4.4.2 (R Core Team, 2025) and RStudio (RStudio Team, 2025). Before the analysis, data was checked for missing values, outliers and inconsistencies. Descriptive statistics were computed for all variables. Continuous variables were showed as mean Mean ± SD. Boxplots were used to visualize the association between study groups and characteristic of interest. Group comparisons were performed using independent samples t-tests for continuous variables, after checking for homogeneity of variance.

Results

A total of (90) participants were included in this study. The demographic characteristics of the study population are presented in Table (1). All the participants were female with age (53-70) years.

Table (1) Demographic characteristic of study groups

Characteristic	CVD group	Control group
Total participants	**60**	**30**
Gender	**Female**	**Female**
Age	**53-70**	**53-70**
BMI	**35.822±3.8**	**30.466±3.03**

Relation of BMI to CVD in postmenopausal women

Body mass index value trended higher in the CVD group (CVD: 35.822±3.8 kg\m2 vs. Control: 30.466±3.03 kg\m2). These finding reveal significant differences p value< 0.05 in BMI between patient and control groups. As shown in table (2).

Table (2) Comparison between patients and controls in BMI

GROUP	Mean ± SD
	BMI
Patients	**35.822±3.8**
Controls	**30.466±3.03**
P value< (0.05)	

Comparisons of Lipid Profile Levels of Study Groups

Table (3) shows the mean Cholesterol levels were significantly increased in the CVD group compared to controls (207.7 ± 20.4mg\dl vs control 173.8 ± 21.0 mg\dl). Similarly, triglycerides concentrations were markedly higher in the CVD group (207.6 ± 74.2mg\dl) vs control group (167.6 ± 21.8mg\dl), as were LDL level in CVD group (149.6 ± 20.7mg\dl) vs control group (97.9 ± 21.0mg\dl). While HDL level was significantly reduced in CVD group (22.2 ± 10.4mg\dl) vs control group (48.4 ± 7.8mg\dl). VLDL level show higher level in CVD group (41.6 ± 15.1mg\dl) vs control group (33.5 ± 4.3mg\dl).

Table (3) Comparisons of Lipid Profile Levels of Study Groups

Variable		Study Groups		p-value[2]
		CVD (N = 60)[1]	**Control (N = 30)[1]**	
Total serum cholesterol (mg/dl)		207.7 ± 20.4	173.8 ± 21.0	***<0.05***
Triglyceride levels (mg/dl)		207.6 ± 74.2	167.6 ± 21.8	***<0.05***
Serum cholesterol-HDL (mg/dl)		22.2 ± 10.4	48.4 ± 7.8	***<0.05***
Serum cholesterol-LDL (mg/dl)		149.6 ± 20.7	97.9 ± 21.0	***<0.05***
VLDL (mg/dl)		41.6 ± 15.1	33.5 ± 4.3	***<0.05***
[1]Mean ± SD				
[2]Welch Two Sample t-test				

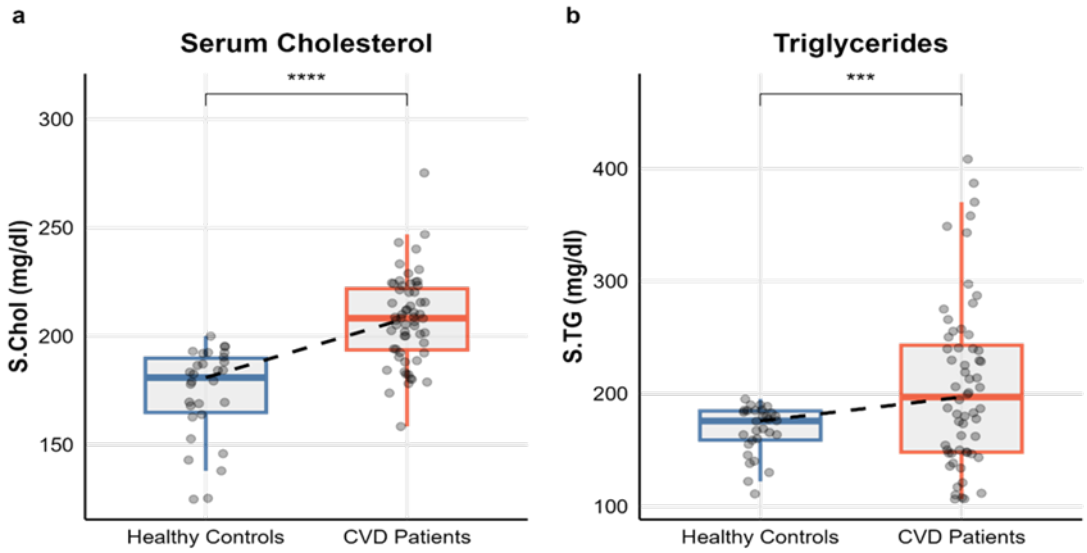

Fig (1) Comparison of cholesterol and triglycerides between patients and control group.

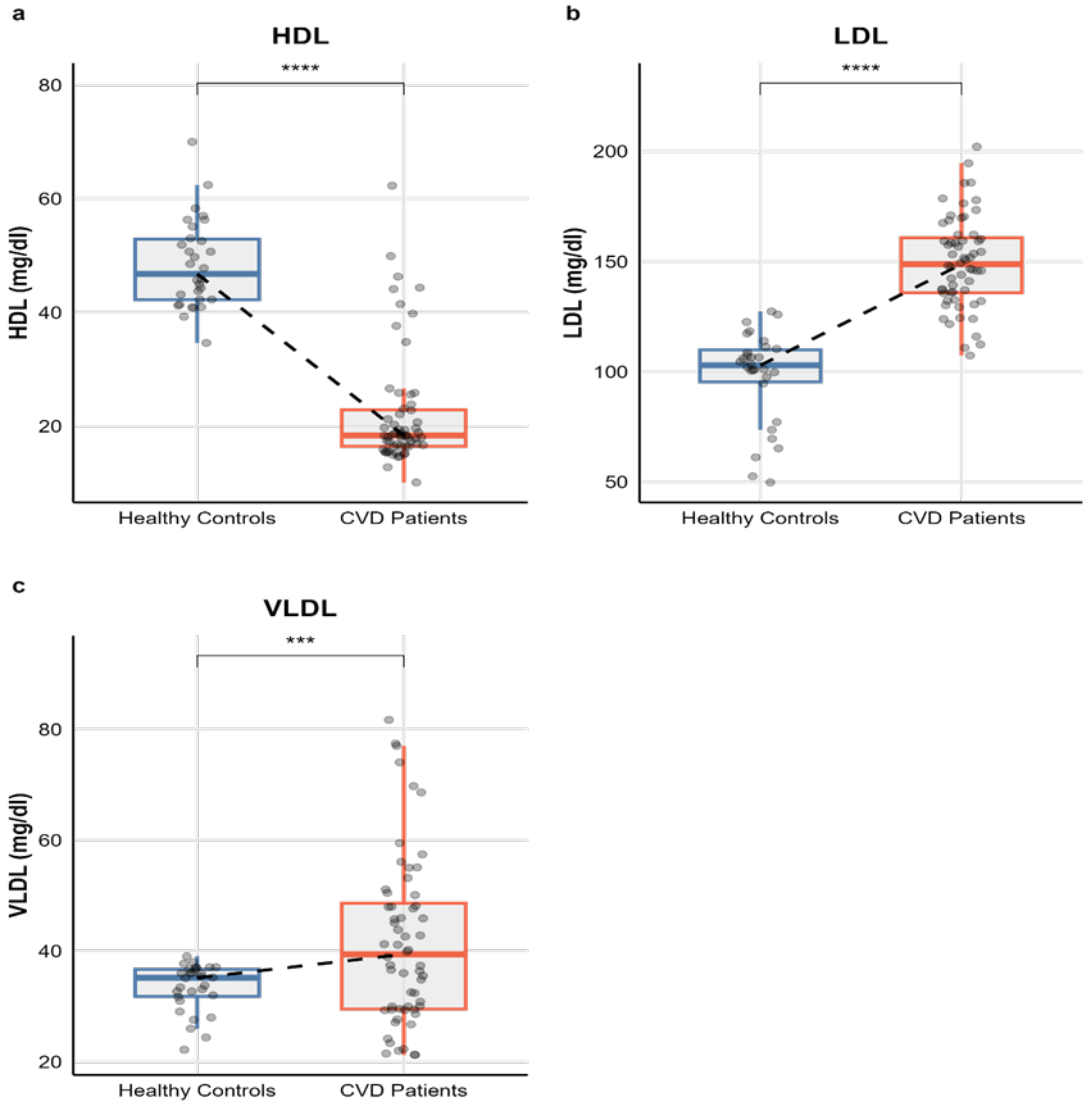

Fig (2) Comparison of HDL, LDL and VLDL between patients and control group.

Relation of atherogenic index and cardiac risk to CVD in postmenopausal women

Atherogenic index and cardiac risk show that there is statistically significant differences between CVD group and control group were observed in atherogenic index level between groups (CVD: 1.0 ± 0.3 vs. control: 0.5 ± 0.1), while cardiac risk observed (CVD: 10.6 ± 3.2 VS. 3.6 ± 0.7) (Table 4).

Table (4) Comparison of Atherogenic index and cardiac risk of the study groups

Groups	Mean ±SD	
	Atherogenic index	**Cardiac risk**
Patient	**1.0 ± 0.3**	**10.6 ± 3.2**
Control	**0.5 ± 0.1**	**3.6 ± 0.7**
P value <0.05		

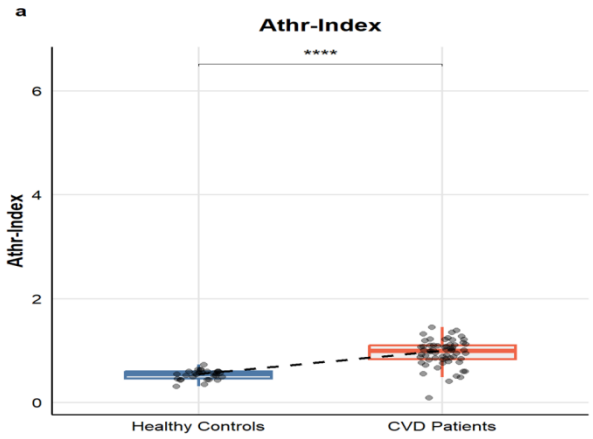

Fig (3a) Comparison of atherogenic index between patients and controls.

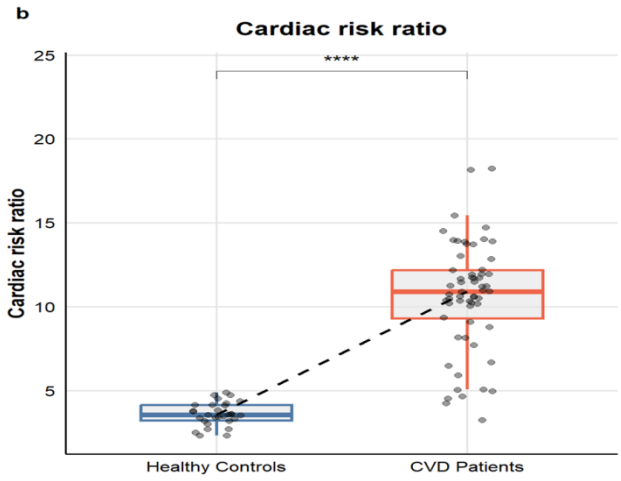

Fig (3b) Comparison of cardiac risk between patients and controls.

Relation of myosin to CVD in postmenopausal women

Myosin concentration showed that there was no statistically significant differences were observed in myosin level between groups (CVD: 2289.8±1087.6pg\ml vs. control: 2943.1±2326.2pg\ml; (p value >0.05) (Table 5).

Table (5) Comparison of myosin between patients and controls

GROUP	Mean ± SD
	Myosin
Patients	**2289.8±1087.6**
Controls	**2943.1±2326.2**
P value> (0.05)	

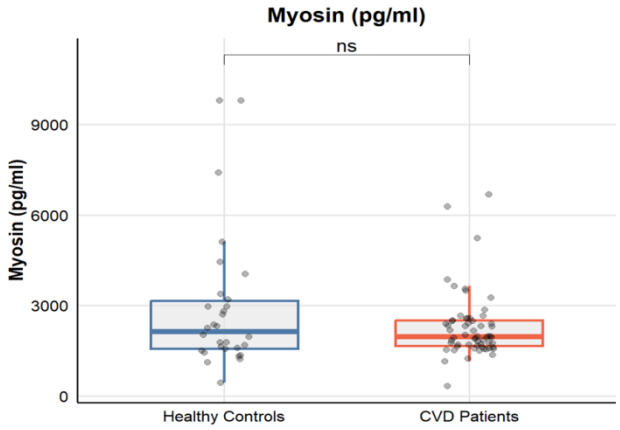

Fig (4) Comparison of Myosin between CVD and control groups

Comparisons of Renal function tests Levels of Study Groups

Mean urea levels were significantly increased in the CVD group compared to controls group (44.1 ± 9.6mg\dl) vs control (33.9 ± 7.4mg\dl). Similarly, creatinine level was significantly higher in CVD group (1.750 ± 0.760mg\dl) vs (0.452 ± 0.02mg\dl) (Table 6).

Table (6) Comparisons of Urea and Creatinine Levels by Study Groups

Groups	Mean ±SD	
	Urea mg/dl	**Creatinine mg/dl**
Patient	**44.1 ± 9.6**	**1.750 ± 0.760**
Control	**33.9 ± 7.4**	**0.452 ± 0.02**
P value (<0.05)		

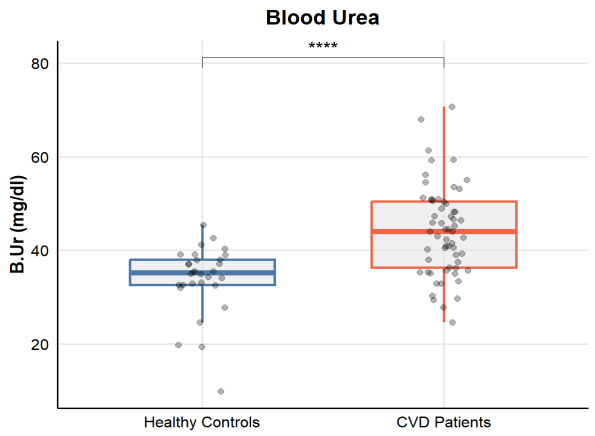

Fig (5) Comparison of Urea between CVD and control groups

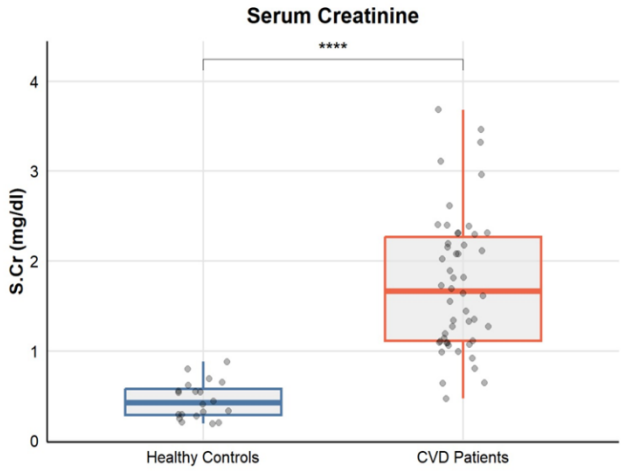

Fig (6) Comparison of Creatinine between CVD and control groups

Discussion

Obesity continues to pose a serious global health threat, associated with numerous negative health impacts, reduced quality of life, and a steady rise in annual mortality rates. A comprehensive UK study with extended follow-up emphasized that postmenopausal women are especially at risk, exhibiting a notably higher incidence of cardiovascular disease and death than other female groups. These outcomes align closely with the findings of our study [12]. After menopause, estrogen levels decline significantly. Estrogen has protective effects on the cardiovascular system, including maintaining healthy cholesterol levels and blood vessel flexibility. Its absence contributes to increased CVD risk. A previous study underscored the value of observing BMI trends over time, showing that postmenopausal women with rising BMI levels were at greater risk for cardiovascular disease. These findings are consistent with those reported in our study [13]. Numerous studies have examined this complex relationship, which emphasizes the significance of taking into account a number of factors when assessing cardiovascular risk in this population. Some studies have demonstrated that both high and low BMI can affect CVD risk, with additional factors like body fat distribution and lifestyle playing significant roles [14,15]. Physiological estrogen withdrawal during menopause is the main cause of dyslipidemia, which is characterized by slightly lower HDL-C and elevated total cholesterol, low density lipoprotein (LDL-C), and triglycerides. Changes in plasma lipid-lipoprotein levels after the menopausal transition may be the reason for the increased risk of cardiovascular diseases (CVD) [16]. Our results are consistent with previous study showing that postmenopausal women are often the focus of studies because they tend to exhibit elevated levels of triglycerides, total cholesterol, and LDL-C [17]. According to previous study conducted in Kirkuk, Iraq, patients' VLDL and triglyceride levels sharply rise, which is associated with an increased risk of atherosclerosis and heart disease. The study also showed a link between obesity and high cholesterol [18]. Cardiovascular disease (CVD) is associated with a number of risk factors, including family history, which cannot be changed, but other risk factors, such as abnormal blood sugar and cholesterol levels, obesity, smoking, and high blood pressure, which can be treated. Research indicates that abnormal blood lipid (fat) levels are clearly associated with the risk of coronary artery disease, heart attack, and coronary death, and that cholesterol has a detrimental effect on the pathophysiology of atherosclerosis and cardiovascular disease [19]. The ratio of triglycerides (TG) to high-density lipoprotein cholesterol (HDL-C), log-transformed, is the composite lipid indicator known as the atherogenic index of plasma (AIP), this index acts as a marker for both in vivo inflammation and compromised plasma lipoprotein metabolism, it is more sensitive than specific lipid indices to the degree of atherosclerosis [20]. Other study conducted in China showed

that sustained elevation of AIP is linked to a heightened risk of CVD in the general population and this finding indicate that AIP can serve as a valuable indicator of dyslipidemia, and continuous monitoring and early intervention targeting AIP may contribute to a further reduction in the incidence of CVD [21]. Another study in Iran, demonstrates the potential of these indices for early detection and risk stratification in clinical settings by finding a positive correlation between higher AIP tertiles and cardiovascular risk factors as well as correlations with central obesity, lipid profiles, and other metabolic risk factors [22]. A recent lineage-tracing study found that smooth muscle cells (SMCs) are important for the development of plaque and that their loss increases the susceptibility of plaque. We examined the connection between SMC-specific myosin heavy chain 11 (myosin-11) and atherosclerosis; circulating myosin-11 levels may be useful in determining the geographic spread of atherosclerotic regions [23]. According to earlier research, heart dysfunction raises the risk of heart failure. Its etiology involves a complex interaction between environmental and genetic factors; changes in myosin affect the cardiomyocytes' ability to contract, which leads to abnormalities in the myocardium's morphology and function [24]. Another study conducted in 2021 on (60 premenopausal and 60 postmenopausal) women found that postmenopausal women had significantly higher levels of urea and creatinine than premenopausal women, and that urea seems to be more sensitive than serum creatinine in assessing renal function in the elderly [25].

Study limitation

The limited number of participants reduce the reliability of results. Therefore, future studies should include large and more diverse samples to enhance statistical power and improve sample size, thereby increasing the statistical significance of the findings.

Conclusions

This is the first study conducted on patients from Salahuddin government. In postmenopausal women, cardiovascular risk increases due to rising obesity, alterations in lipid profiles, and a higher atherogenic index. With aging, these changes may contribute to impaired renal function, reflected by elevated levels of urea and creatinine."

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