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A comparative study of lipid profile in pre-menopausal and post-menopausal women to assess the risk of cardiovascular diseases in a tertiary care hospital in Chengalpattu, Tamil Nadu.

Dr. Bhavani S [1]*, Dr. SNS. Minnalkodi[2], Dr. C. Santhanalakshmi[3], Dr. V. Arunadevi[4]

[1]Postgraduate Student, Department of Obstetrics and Gynaecology, karpaga vinayaga Institute of medical sciences and research center, P.O, GST Road, Chinna Kolambakkam, Palayanoor, Maduranthakam, Tamil Nadu- 603308.

[2]Professor, Department of Obstetrics and Gynaecology, karpaga vinayaga Institute of medical sciences and research center, P.O, GST road, chinna kolambakkam, palayanoor, Maduranthakam,Tamil Nadu-603308.

[3]Professor, Department of Obstetrics and Gynaecology, karpaga vinayaga Institute of medical sciences and research center, P.O, GST road, chinna kolambakkam, palayanoor, Maduranthakam,Tamil Nadu-603308.

[4]Professor, Department of Obstetrics and Gynaecology, karpaga vinayaga Institute of medical sciences and research center, P.O, GST road, chinna kolambakkam, palayanoor, Maduranthakam,Tamil Nadu-603308.

***Corresponding author**

Dr. Bhavani S, Postgraduate Student, Department of Obstetrics and Gynaecology, karpaga vinayaga Institute of medical sciences and research center, P.O, GST Road, Chinna Kolambakkam, Palayanoor, Maduranthakam, Tamil Nadu- 603308.

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Menopause, Lipid Profile, Cardiovascular Risk, Dyslipidemia, Estrogen, Tamil Nadu.

ABSTRACT:

Background: Cardiovascular disease (CVD) is a major cause of mortality in women, with risk increasing significantly during the menopausal transition due to a decline in estrogen's cardioprotective effects. This study compared the lipid profiles of pre-menopausal and post-menopausal women to assess associated cardiovascular risks in a tertiary care setting in Tamil Nadu.

Methodology: A hospital-based comparative cross-sectional study was conducted among 100 women (50 pre-menopausal and 50 post-menopausal) at a tertiary care hospital in Chengalpattu. Fasting lipid profiles, including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C), and very low-density lipoprotein (VLDL-C), were analyzed. Atherogenic indices (TC/HDL and LDL/HDL ratios) were calculated to stratify cardiovascular risk. Statistical analysis was performed using independent sample t-tests and Chi-square tests.

Results: Post-menopausal women exhibited significantly higher mean levels of TC (198.6 ± 42.7 mg/dL vs. 160.4 ± 35.2 mg/dL; $p < 0.001$), LDL-C (128.5 ± 34.6 mg/dL vs. 96.8 ± 28.4 mg/dL; $p < 0.001$), and TG (162.7 ± 58.9 mg/dL vs. 118.5 ± 45.3 mg/dL; $p < 0.001$) compared to pre-menopausal women. Conversely, HDL-C was significantly lower in the post-menopausal group (38.4 ± 7.5 mg/dL vs. 46.2 ± 8.1 mg/dL; $p = 0.002$). Based on the TC/HDL ratio, 40% of post-menopausal women were classified as high cardiovascular risk compared to only 10% of pre-menopausal women ($p = 0.001$). Age showed significant positive correlations with all pro-atherogenic lipid parameters.

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Conclusion: The post-menopausal state is associated with a significantly more atherogenic lipid profile and higher cardiovascular risk compared to the pre-menopausal state. These findings highlight the clinical imperative for routine lipid screening and early intervention strategies during and after the menopausal transition to mitigate the burden of cardiovascular disease in Indian women.

Introduction

Cardiovascular disease (CVD) remains a leading cause of morbidity and mortality among women globally, with a notably high burden in low- and middle-income countries like India [1]. In the Indian context, approximately 81.2% of women exhibit at least one lipid abnormality, with over 30% showing elevated triglycerides and 52–67% suffering from low high-density lipoprotein cholesterol (HDL-C)[2]. While premenopausal women generally experience a relative "protection" against atherosclerotic heart disease compared to men of similar age, this advantage diminishes rapidly following the transition to menopause [3]. This physiological shift marks a critical period where the risk of coronary artery disease (CAD), hypertension, and metabolic syndrome increases significantly [1].

The primary driver for this shift is the drastic decline in endogenous estrogen levels. Estrogen serves a vital cardioprotective role by regulating liver lipid metabolism, maintaining healthy lipoprotein profiles, and stabilizing endothelial cells[3,4]. Specifically, estrogen increases HDL-C by enhancing the hepatic production of Apolipoprotein-A and inhibits the clearance of cardioprotective HDL2 subfractions [5]. It also maintains low levels of low-density lipoprotein cholesterol (LDL-C) by promoting hepatic LDL receptor activity, which facilitates the clearance of "bad" cholesterol from the circulation [1].

Upon entering menopause, the cessation of ovarian follicular activity leads to a proatherogenic derangement of the lipid profile. Research indicates that postmenopausal women often experience a 10–15% increase in LDL-C and a 10–20% rise in triglycerides due to increased VLDL secretion and decreased lipid clearance[6]. Furthermore, the LDL particles produced during this stage are often smaller and denser (sdLDL), making them more susceptible to oxidative modification and subsequent arterial plaque development [6]. Comparative studies have shown that postmenopausal women have significantly higher mean Total Cholesterol (TC), Triglycerides (TG), and LDL-C compared to their premenopausal counterparts [4,7]. For instance, recent data suggests mean TC levels can reach 205.8 mg/dl in postmenopausal women versus 170.3 mg/dl in premenopausal women [7].

The risk is further compounded in South Indian populations, where cardiovascular risk often manifests at lower levels of adiposity compared to Western populations [8]. In regions like Tamil Nadu, factors such as sedentary lifestyles and central adiposity significantly influence these metabolic shifts[2]. Research conducted at tertiary care centers in the region, such as Chengalpattu, highlights that menopause is independently associated with metabolic syndrome, with a prevalence as high as 51.85% in postmenopausal women compared to 33% in premenopausal groups [9].

This study seeks to compare the lipid profiles of premenopausal and postmenopausal women at a tertiary care hospital in Chengalpattu, Tamil Nadu. By assessing parameters such as TC, HDL, LDL, and VLDL, the research aims to quantify the cardiovascular risk associated with

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the menopausal transition in this specific demographic, providing a basis for targeted screening and early intervention strategies to reduce the burden of Atherosclerotic Cardiovascular Disease (ASCVD) in Indian women.

METHODOLOGY

Study Design

This study was a hospital-based comparative cross-sectional study conducted to evaluate differences in lipid profile parameters between pre-menopausal and post-menopausal women and to assess the associated cardiovascular risk.

Study Setting

The study was conducted at the Department of Obstetrics and Gynaecology, Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Madhuranthagam, Chengalpattu District, Tamil Nadu, India, in collaboration with the Department of Biochemistry.

Study Duration

The study was carried out over a period of six months from July 2025 to December 2025.

Study Population

The study population consisted of women attending the gynaecology outpatient department (OPD) of the tertiary care hospital during the study period.

Sample Size

The sample size was calculated based on the difference in mean total cholesterol levels between pre-menopausal and post-menopausal women reported by Joshi et al. (2024).

Mean total cholesterol in pre-menopausal women = 158.28 mg/dL (SD = 40.83) Mean total cholesterol in post-menopausal women = 185.28 mg/dL (SD = 50.97)

The minimum sample size required for comparison of two independent means was calculated using the formula:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2(\sigma_1^2 + \sigma_2^2)}{d^2}$$

Where:

- $Z_{\alpha/2}$= 1.96 for 95% confidence level
- Z_{β}= 0.84 for 80% power
- σ_1, σ_2= standard deviations of the two groups
- d= mean difference (27 mg/dL)

The calculated sample size was 48 participants per group, which was rounded to 50 participants in each group to improve statistical power. Thus, the total sample size was 100 women, comprising 50 pre-menopausal and 50 post-menopausal women.

Sampling Technique

A purposive sampling method was used to recruit eligible participants who attended the gynaecology OPD during the study period and met the inclusion criteria.

Inclusion Criteria

- Pre-menopausal women aged 25–45 years
- Post-menopausal women aged ≥46 years
- Women who provided written informed consent

Exclusion Criteria

- Women with diabetes mellitus
- Women with systemic hypertension
- Women with known cardiovascular diseases
- Pregnant women
- Obese women
- Women receiving lipid-lowering therapy or hormone replacement therapy

Data Collection Procedure

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Eligible participants were recruited from the gynaecology OPD after explaining the purpose of the study and obtaining written informed consent.

A pre-designed structured proforma was used to collect relevant information, including:

- Demographic details (age, education, socioeconomic status)
- Obstetric history (parity)
- Medical history and comorbidities

Anthropometric and clinical details were recorded. Participants were instructed to undergo overnight fasting (8–12 hours) prior to blood sample collection.

A venous blood sample was collected under aseptic precautions and analyzed for fasting lipid profile in the Department of Biochemistry.

The lipid parameters measured included:

- Total cholesterol (TC)
- Triglycerides (TG)
- High-density lipoprotein cholesterol (HDL-C)
- Low-density lipoprotein cholesterol (LDL-C)
- Very low-density lipoprotein cholesterol (VLDL-C)

LDL-C and VLDL-C were calculated using Friedewald's formula where applicable. Atherogenic indices such as TC/HDL ratio and LDL/HDL ratio were also calculated to assess cardiovascular risk.

Based on the values of TC/HDL ratio the cardio vascular risk are classified as follows

Risk Category	**TC/HDL Ratio**	**Examples**
Low Risk	< 4	Asymptomatic, Normal coronary arteries
Moderate Risk	4 – 5	Stable angina, Early atherosclerosis
High Risk	> 5	Myocardial infarction, Stroke / PAD

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0.

Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequency with percentages for categorical variables.

- Independent sample t-test was used to compare mean lipid profile parameters between pre-menopausal and post-menopausal women.
- Chi-square test was used to determine the association between menopausal status and cardiovascular risk categories.
- Pearson correlation analysis was used to assess the relationship between age and lipid profile parameters.
- 95% confidence intervals (CI) were calculated where applicable.

A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC) of Karpaga Vinayaga Institute of Medical Sciences and Research Centre. Written informed consent was obtained from all participants prior to enrollment. Participant confidentiality and anonymity were maintained throughout the study.

RESULTS

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Table 1. Comparison of Lipid Profile Between Pre-menopausal and Post-menopausal Women (n = 100)

Parameter	Pre-menopausal (n=50) Mean ± SD	Post-menopausal (n=50) Mean ± SD	p-value
Total Cholesterol (mg/dL)	160.4 ± 35.2	198.6 ± 42.7	<0.001
LDL (mg/dL)	96.8 ± 28.4	128.5 ± 34.6	<0.001
HDL (mg/dL)	46.2 ± 8.1	38.4 ± 7.5	0.002
Triglycerides (mg/dL)	118.5 ± 45.3	162.7 ± 58.9	<0.001
VLDL (mg/dL)	23.7 ± 9.0	32.5 ± 11.6	<0.001
TC / HDL Ratio	3.46 ± 0.8	5.18 ± 1.1	<0.001
LDL / HDL Ratio	2.09 ± 0.7	3.34 ± 0.9	<0.001

Table 1 shows the comparison of lipid profile parameters between pre-menopausal and post-menopausal women. The mean total cholesterol was significantly higher in post-menopausal women (198.6 ± 42.7 mg/dL) compared to pre-menopausal women (160.4 ± 35.2 mg/dL) ($p < 0.001$). Similarly, LDL cholesterol levels were significantly elevated in post-menopausal women (128.5 ± 34.6 mg/dL) compared with pre-menopausal women (96.8 ± 28.4 mg/dL) ($p < 0.001$). In contrast, HDL cholesterol levels were significantly lower in post-menopausal women (38.4 ± 7.5 mg/dL) compared with pre-menopausal women (46.2 ± 8.1 mg/dL) ($p = 0.002$). Triglycerides and VLDL cholesterol were also significantly higher among post-menopausal women (162.7 ± 58.9 mg/dL and 32.5 ± 11.6 mg/dL, respectively) compared with pre-menopausal women (118.5 ± 45.3 mg/dL and 23.7 ± 9.0 mg/dL) ($p < 0.001$). Additionally, the atherogenic indices, including TC/HDL ratio and LDL/HDL ratio, were significantly higher among post-menopausal women, indicating increased cardiovascular risk.

Table 2. Prevalence of Dyslipidemia Among Study Participants (n = 100)

Lipid Abnormality	Pre-menopausal (n=50)	Post-menopausal (n=50)	Total
High Total Cholesterol (>200 mg/dL)	9 (18%)	28 (56%)	37 (37 %)
High LDL (>130 mg/dL)	7 (14%)	24 (48%)	31 (31 %)
Low HDL (<40 mg/dL)	8 (16%)	22 (44%)	30 (30 %)
High Triglycerides (>150 mg/dL)	10 (20%)	26 (52%)	36 (36 %)

Table 2 presents the prevalence of different lipid abnormalities among the study participants. A higher proportion of post-menopausal women had elevated total cholesterol (>200 mg/dL) compared to pre-menopausal women (56% vs 18%). Similarly, elevated LDL cholesterol (>130 mg/dL) was observed in 48% of post-menopausal women compared to 14% of pre-menopausal women. Low HDL cholesterol (<40 mg/dL) was also more common among post-menopausal women (44%) than pre-menopausal women (16%).

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Elevated triglycerides (>150 mg/dL) were present in 52% of post-menopausal women compared with 20% of pre-menopausal women. Overall, dyslipidemia was substantially more prevalent among post-menopausal women than pre-menopausal women.

Table 3. Cardiovascular Risk Based on TC/HDL Ratio among study participants

Risk Category	Pre-menopausal (n=50)	Post-menopausal (n=50)	Total
Low Risk	30 (60%)	10 (20%)	40 (40%)
Moderate Risk	15 (30%)	20 (40%)	35 (35%)
High Risk	5 (10%)	20 (40%)	25 (25%)

Table 3 illustrates cardiovascular risk classification based on the TC/HDL ratio among the study participants. Among pre-menopausal women, the majority (60%) were categorized as low cardiovascular risk, while 30% had moderate risk and only 10% had high risk. In contrast, post-menopausal women showed a higher distribution of cardiovascular risk, with only 20% in the low-risk category, 40% in the moderate-risk category, and 40% classified as high risk. These findings suggest a significant shift toward higher cardiovascular risk among post-menopausal women. It also shows the distribution of participants according to cardiovascular risk categories based on the TC/HDL ratio. Among pre-menopausal women, 60% were in the low-risk category, indicating a lower likelihood of cardiovascular diseases such as early atherosclerosis. 30% were in the moderate-risk group, which may predispose them to conditions like stable angina or early coronary artery disease. Only 10% were classified as high risk, indicating a potential risk of serious events such as myocardial infarction or ischemic stroke.

In contrast, among post-menopausal women, only 20% were in the low-risk category, while 40% were in the moderate-risk category and 40% were in the high-risk group, indicating a higher probability of developing major cardiovascular conditions such as coronary artery disease, stroke, and peripheral artery disease. These findings suggest that cardiovascular risk is substantially higher among post-menopausal women.

Table 4. Association Between Menopausal Status and Cardiovascular Risk among Study Participants

Menopausal Status	High Risk	Low / Moderate Risk	Chi-square	p-value
Pre-menopausal	5 (10 %)	45 (90%)	12.5	0.001
Post-menopausal	20 (40 %)	30 (60%)		

Table 4 demonstrates the association between menopausal status and cardiovascular risk. Among pre-menopausal women, only 5 (10%) were categorized as having high cardiovascular risk, whereas 20 (40%) post-menopausal women were in the high-risk category. The association between menopausal status and cardiovascular risk was statistically significant ($\chi^2 = 12.5$, $p = 0.001$), indicating that post-menopausal women have a significantly higher likelihood of developing cardiovascular risk compared with pre-menopausal women.

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Table 5: Correlation of Age with Lipid Profile Parameters among study participants

Lipid Parameter	Pearson Correlation Coefficient (r)	95% Confidence Interval	p-value
Total Cholesterol	0.238	(0.112 – 0.354)	<0.001*
Triglycerides	0.214	(0.089 – 0.329)	0.001*
HDL Cholesterol	-0.118	(-0.238 – 0.008)	0.071
VLDL Cholesterol	0.214	(0.090 – 0.328)	0.001*
LDL Cholesterol	0.196	(0.072 – 0.309)	0.004*
TC / HDL Ratio	0.165	(0.041 – 0.283)	0.010*
LDL / HDL Ratio	0.148	(0.022 – 0.266)	0.020*

Table 5 presents the correlation between age and lipid profile parameters. Age showed a significant positive correlation with total cholesterol (r = 0.238, p < 0.001), triglycerides (r = 0.214, p = 0.001), VLDL cholesterol (r = 0.214, p = 0.001), and LDL cholesterol (r = 0.196, p = 0.004). Additionally, age demonstrated a significant positive correlation with TC/HDL ratio (r = 0.165, p = 0.010) and LDL/HDL ratio (r = 0.148, p = 0.020). However, HDL cholesterol showed a weak negative correlation with age (r = −0.118), which was not statistically significant (p = 0.071). These findings suggest that increasing age is associated with worsening lipid profile parameters and increased atherogenic risk.

DISCUSSION

The present study compared lipid profiles in 50 pre-menopausal and 50 post-menopausal women to assess cardiovascular disease (CVD) risk. Menopause is a pivotal physiological transition that markedly alters lipid metabolism and predisposes women to atherosclerotic cardiovascular disease (ASCVD), including coronary artery disease (CAD), stroke, and peripheral artery disease (PAD).[10,11] Our findings demonstrated significantly elevated total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and very low-density lipoprotein (VLDL) with a concomitant decline in high-density lipoprotein cholesterol (HDL-C) in post-menopausal women (all $p<0.001$), corroborating the well-established menopausal dyslipidemia paradigm.

Estrogen exerts pleiotropic atheroprotective effects, which include upregulation of hepatic LDL receptors, augmentation of HDL synthesis via apolipoprotein A-I, inhibition of oxidative stress, and promotion of nitric oxide-mediated vasodilation.[12] In our study, post-menopausal women exhibited a mean LDL-C of 128.5 ± 34.6 mg/dL compared with 96.8 ± 28.4 mg/dL in pre-menopausal women ($p<0.001$). These findings align with Joshi et al.,[13] who reported significantly higher LDL-C and TC in post-menopausal women in a comparable case-control study. Similarly, Sudhakara Babu et al.[14] noted that serum TC, TG, and LDL-C were markedly elevated while HDL-C was significantly lower in post-menopausal women. The deposition of oxidised LDL in arterial intima, amplified by hypertriglyceridaemia and VLDL excess, initiates foam cell formation,

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subintimal inflammation, and ultimately fibrofatty plaque progression, ischaemic stroke, and PAD.[15]

HDL-C exerts reverse cholesterol transport, scavenging atherogenic particles from peripheral tissues and arterial walls. In our study, post-menopausal women demonstrated significantly lower HDL-C (38.4 ± 7.5 mg/dL vs. 46.2 ± 8.1 mg/dL, p=0.002) and a strikingly elevated TC/HDL ratio (5.18 ± 1.1 vs. 3.46 ± 0.8, p<0.001). The TC/HDL ratio is recognised as a superior predictor of atherosclerotic risk over individual lipid fractions in menopausal women.[16] Cardiovascular risk stratification based on this ratio revealed that 40% of post-menopausal women fell in the high-risk category compared with only 10% of pre-menopausal women (χ^2 = 12.5, p=0.001). Consistently, Nansseu et al.[17] reported significantly elevated atherogenic indices in post-menopausal women and emphasised their utility over conventional lipid parameters in predicting subclinical atherosclerosis. The pathophysiological cascade linking low HDL-C to ASCVD involves impaired reverse cholesterol efflux, heightened endothelial inflammation, and reduced endothelial progenitor cell recruitment — mechanisms that collectively amplify coronary, cerebrovascular, and peripheral arterial vulnerability.[12,15]

Hypertriglyceridaemia and elevated VLDL were significantly more prevalent in our post-menopausal group (TG: 162.7 ± 58.9 vs. 118.5 ± 45.3 mg/dL; VLDL: 32.5 ± 11.6 vs. 23.7 ± 9.0 mg/dL; both p<0.001). Post-menopausal metabolic perturbations extend beyond dyslipidaemia: the oestrogen-deficient state promotes central adiposity, insulin resistance, and dysglycaemia, collectively fulfilling criteria for metabolic syndrome, which is an independent multiplier of cardiovascular risk.[18,19] Triglyceride-rich lipoproteins independently promote PAD by fostering endothelial oxidative stress, macrophage infiltration, and medial smooth muscle cell proliferation in peripheral vessels.[15]

Age demonstrated significant positive correlations with TC (r=0.238, p<0.001), TG (r=0.214), VLDL (r=0.214), and LDL-C (r=0.196), underscoring the compounding effect of ageing on lipid dysregulation. This corroborates data from population-based studies demonstrating an age-related increment in atherogenic lipoproteins independent of menopausal status, though menopause substantially accelerates this trajectory.[16] High total cholesterol was present in 56% and elevated TG in 52% of post-menopausal women in our study, prevalences consonant with those reported by Ambikairaja et al.,[18] who documented dyslipidaemia in over 50% of post-menopausal South Asian women, reinforcing the clinical imperative for early lipid screening at menopause.

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