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RESEARCH ARTICLE

Association of Cardiovascular Disease Risk with Vitamin D Status in Reproductive and Menopausal women of South Delhi

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Abstract: ***Background***: Cardiovascular disease (CVD) is a leading cause of morbidity and mortality among women, and vitamin D deficiency has emerged as a potential risk factor. Limited data are available on the relationship between vitamin D status and CVD risk among Indian women in different hormonal phases. ***Objective***: To evaluate the association of vitamin D status with cardiovascular disease risk in reproductive and menopausal women of South Delhi. ***Methods***: A retrospective cross-sectional study was conducted among 300 women (150 in the reproductive age group and 150 in the menopausal age group). Serum vitamin D levels were measured and classified as sufficient, insufficient, or deficient. Lipid parameters and atherogenic indices were assessed to determine CVD risk. Statistical analyses were performed between vitamin D status, AIP, and lipid profile parameters of the two groups using SPSS version 26. ***Results***: Vitamin D levels showed a significant positive correlation with high-density lipoprotein cholesterol (HDL-C) and a significant negative correlation with the atherogenic index of plasma (AIP). The associations were more pronounced among menopausal women compared to reproductive women. Women with vitamin D sufficiency demonstrated a more favorable lipid profile and lower AIP, indicating lower CVD risks. ***Conclusion***: Vitamin D insufficiency and deficiency are associated with an unfavorable lipid profile and increased CVD risk, particularly in menopausal women. Ensuring adequate vitamin D status may play a protective role in cardiovascular health among women.

Keywords: Vitamin D, Cardiovascular risk, Lipid profile, AIP, Reproductive women, Menopausal women.

INTRODUCTION

Cardiovascular diseases continue to pose a significant health burden, with women experiencing unique risk trajectories influenced by reproductive hormones. Estrogen modulates triglyceride and total cholesterol levels, contributing to an overall favorable lipid profile during the reproductive years, but its decline in menopause contributes to an unfavorable metabolic profile, including dyslipidemia [1,2]. Estrogen also has roles in increasing the kidneys' 1-alpha-hydroxylase activity, upregulation of the vitamin D receptor (VDR), and activation of the inactive form of Vitamin D to its active form, calcitriol [3]. Menopausal women often experience a shift toward an atherogenic lipid profile, with elevated LDL-C and non-HDL-C, and decreased HDL-C levels, contributing to their heightened cardiovascular risk [4]. Additionally, vitamin D deficiency, which is prevalent in Indian women due to limited sun exposure, skin pigmentation, and dietary insufficiency, has been associated with dyslipidemia and increased CVD risk [5]. Vitamin D, beyond its role in bone metabolism, has emerged as a modifiable risk factor in cardiovascular diseases (CVD), with deficiency linked to endothelial dysfunction, inflammation, and dyslipidemia [6]. Vitamin D receptors are expressed in vascular endothelial and smooth muscle cells, suggesting their role in vascular health and lipid regulation [7]. Several studies have independently linked vitamin D deficiency and lipid abnormalities to cardiovascular risk [8-13]. The Atherogenic Index of Plasma (AIP), calculated as the log of (Triglycerides/HDL-C), is a marker that can be used to assess cardiovascular disease (CVD) risk without the need for medical history. Generally, an AIP value below 0.1 indicates low risk, between 0.1 and 0.24 suggests moderate risk, and above 0.24 signifies a high risk of developing CVD [14].

However, there is limited literature comparing these associations between reproductive and menopausal women. Given these interrelationships, the present study aims to assess the cardiac risk vulnerabilities in reproductive and menopausal women in South Delhi, examining the association between lipid profile parameters (HDL, LDL, non-HDL), AIP, and vitamin D status to better understand the impact of hormonal and metabolic shifts on cardiovascular risk. This study for comparison of hormonal stages in women with parameters suggestive of cardiac risks provides novel insights that can be helpful for the prevention of the increasing cardiac risk seen, particularly in menopausal women.

METHODOLOGY

This is a retrospective cross-sectional study conducted in the Department of Biochemistry at a tertiary care hospital in South Delhi. Data were retrieved from the hospital information system (HIS) for the period from June 2024 to March 2025. Women aged 18 to 85 years attending the outpatient and inpatient departments were included. A total of 300 subjects were

recruited. Based on menstrual history, the study population was categorized into two groups: Reproductive group: women with regular menstrual cycle and Menopausal group: women who had cessation of menstruation for at least 12 months. Female patients aged 18 – 85 years, with a Clear menstrual history to classify reproductive/ menopausal status, were included in the study. Women with incomplete or missing laboratory/clinical data, a History of known cardiovascular disease, or chronic liver or kidney disease. Patients on lipid-lowering therapy, Pregnant or lactating women were excluded. Demographic details (age, gender) were recoded. Lipid profile parameters: Total Cholesterol, Triglycerides, HDL-C, LDL-C, VLDL-C, and calculated non-HDL cholesterol using Beckman Coulter AU480 and Serum 25-hydroxy vitamin D levels were measured using Chemiluminescent Microparticle Immunoassay (CMIA). Vitamin D status can be classified (General Global Consensus) as:

Vitamin D Status	Value
Sufficient	30-100 ng/dl
Insufficient	20-30 ng/dl
Deficient	≤ 20 ng/dl

Cardiovascular risk based on Atherogenic Index of Plasma (AIP) can be classified (Dobiasova and Frohlich classification) as:

Cardiovascular Risk Status	AIP Value
Low Risk	< 0.1
Moderate Risk	0.1-0.24
High Risk	> 0.24

Statistical Analysis

Data were analyzed using SPSS Version 26. Pearson's correlation coefficients were computed to assess the relationships between variables, and Levene's independent t-tests were performed to compare group means. P-value <0.001 is considered statistically significant.

RESULT:

A total of 300 women were enrolled in the study and categorized into two groups based on their menstrual history: Reproductive group: Women with regular menstrual cycles, and Menopausal group: Women who had attained menopause.

Table 1: Correlation between Vitamin D and Lipid Parameters/AIP in Reproductive Women

Parameter	Correlation with Vitamin D N=150 (r)	p-value
AIP	-0.070	0.393
Total Cholesterol	0.105	0.199
Triglycerides	-0.048	0.563
HDL-C	0.155	0.058
LDL-C	0.069	0.398
VLDL-C	-0.047	0.567
Non-HDL-C	0.072	0.381

In Table 1, no significant correlation is seen between vitamin D and lipid parameters, including AIP, in the above 150 samples from the vitamin D sufficient, Vitamin D insufficient, and Vitamin D deficient Reproductive groups.

Table 2: Correlation between Vitamin D and Lipid Parameters/AIP in Menopausal Women (n=150)

Parameter	Correlation with Vitamin D (r)	p-value
AIP	-0.179*	0.029
Total Cholesterol	0.078	0.345
Triglycerides	-0.106	0.197
HDL-C	0.182*	0.026
LDL-C	0.057	0.485
VLDL-C	-0.106	0.197
Non-HDL-C	0.033	0.684

In Table 2, There is a significant negative correlation between Vitamin D and AIP (r= -0.179; p= 0.029) and a significant positive correlation between Vitamin D and HDL (r= 0.182; p=0.026), but no other significant correlations were seen between vitamin D and other lipid parameters in the above 150 samples of the vitamin D sufficient, insufficient, and deficient Menopausal group.

Table 3: Comparison of Lipid Parameters, Vitamin D, and AIP between Reproductive and Menopausal Women

Parameter	Reproductive (Mean ± SD)	Menopausal (Mean ± SD)	t-value	p-value
Vitamin D	27.45 ± 17.13	26.91 ± 14.64	0.294	0.769
AIP	0.49 ± 0.32	0.57 ± 0.31	-2.223	0.027*
Total Cholesterol	150.29 ± 43.81	154.26 ± 56.63	-0.678	0.498
Triglycerides	137.86 ± 88.04	156.89 ± 89.47	-1.857	0.064
HDL-C	40.92 ± 12.66	40.29 ± 15.44	0.391	0.696
LDL-C	98.99 ± 33.34	101.67 ± 40.01	-0.630	0.529
VLDL-C	27.64 ± 17.58	31.38 ± 17.89	-1.828	0.069
Non-HDL-C	109.61 ± 36.42	113.97 ± 47.38	-0.894	0.372

There is a significant negative correlation between Vitamin D and AIP (R=-0.129; p=0.026) and a significant positive correlation between Vitamin D and HDL (r=0.179; p=0.002). No other significant correlations were seen between vitamin D and other lipid parameters in the above 300 samples of vitamin D sufficient, insufficient, and deficient Reproductive and Menopausal groups (Table 3).

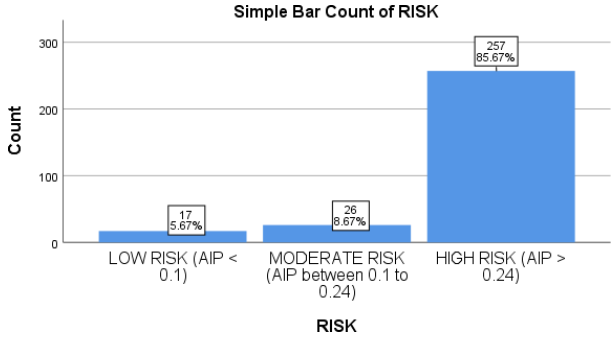

Fig. 1: Showing frequency distributions of AIP-based levels of cardiovascular risk in Reproductive and Menopausal groups.

Out of the total 300 samples, 257 (85.67%) had AIP > 0.24, which comes under high cardiovascular risk, 26 (8.67%) had AIP between 0.1 and 0.24, which is moderate cardiovascular risk, and only 17 (5.67%) had AIP < 0.1, which is low cardiovascular risk. The current study shows that there is a very high prevalence of "high cardiovascular risk" among both reproductive and menopausal women in South Delhi.

DISCUSSION:

In the present study, we examined the relationship between vitamin D and cardiovascular risk markers across the Reproductive and Menopausal groups of women. Our findings revealed that the association of vitamin D with lipid parameters was more prominent in menopausal women compared to reproductive women. Among reproductive women, no significant correlation was observed between vitamin D and lipid parameters or AIP. This may be explained by the protective role of estrogen during the reproductive years, which maintains a relatively favorable lipid profile irrespective of vitamin D status. Estrogen enhances HDL cholesterol and reduces LDL cholesterol, thereby buffering the effects of vitamin D insufficiency [15,16]. Consequently, the lack of significant associations in reproductive women may reflect the hormonal influence overshadowing vitamin D's independent role in lipid metabolism.

In contrast, our findings in menopausal women highlighted the importance of vitamin D status. In the subgroup of 50 vitamin D-insufficient menopausal women, vitamin D showed a significant positive correlation with HDL cholesterol. Moreover, in the larger cohort of 150 menopausal women, vitamin D demonstrated a significant positive correlation with HDL

and a significant negative correlation with the atherogenic index of plasma (AIP). The observed negative correlation between vitamin D and AIP further strengthens the evidence of its protective role against CVD risk. Since AIP is derived from the log ratio of triglycerides to HDL cholesterol, lower AIP values reflect a balance toward anti-atherogenic lipid profiles. This aligns with existing literature indicating that vitamin D deficiency is associated with dyslipidemia, metabolic syndrome, and higher cardiovascular risk in postmenopausal women. These observations suggest that higher vitamin D levels are associated with a more favorable lipid profile and reduced CVD risk in menopausal women. The positive association with HDL cholesterol is consistent with prior studies indicating that vitamin D may stimulate apolipoprotein A-I synthesis, improve reverse cholesterol transport, and exert anti-inflammatory effects on vascular endothelium [17,18]. The negative correlation with AIP further supports its cardioprotective role, as lower AIP values represent reduced atherogenic burden and are a strong predictor of CVD risk [19,20]. The menopausal transition is associated with estrogen decline, leading to unfavorable lipid changes such as decreased HDL and increased triglycerides [21]. Our results indicate that vitamin D may partly counterbalance these changes by maintaining HDL and lowering AIP, thereby providing an additional protective mechanism against cardiovascular risk in the postmenopausal state. These findings highlight a differential role of Vitamin D: it showed no significant associations in reproductive women but clear links with lipid-related CVD risk markers in menopausal women. This underscores the importance of screening and correcting vitamin D insufficiency in menopausal women to help reduce CVD risk.

This study highlights the association of Vitamin D with lipid parameters and cardiovascular disease risk markers in reproductive and menopausal women, with the inclusion of the Atherogenic Index of Plasma adding clinical relevance. Its strengths include a large menopausal sample and direct life-stage comparisons, but its cross-sectional design, single-point vitamin D measurement, and potential confounders (diet, activity, sun exposure, medications) limit causal inference and generalizability. Larger longitudinal and interventional studies are needed to confirm these findings and assess vitamin D supplementation as a preventive strategy for CVD in menopausal women.

CONCLUSION

This study demonstrates that vitamin D has a significant positive association with HDL cholesterol and a negative association with AIP in menopausal women, whereas no significant correlations were observed in reproductive women. These findings suggest that vitamin D plays a more critical role in modulating lipid-related cardiovascular risk factors during menopause, when estrogen's protective influence is diminished. Regular screening and correction of vitamin D insufficiency in menopausal women may serve as a potential strategy to reduce cardiovascular risk.

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