

Original Research Article

Vitamin D₃ status in pre-menopausal and post-menopausal type 2 diabetes mellitus women

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a metabolic condition that arises from either total or partial deficiency of insulin. It is a multifactorial disorder characterised by abnormal glucose metabolism, persistent high blood glucose levels, and altered insulin release. Recent study suggest that vitamin D may play a protective role against malignancies, cardiovascular conditions, diabetes, osteoporosis, and various other bone-related diseases. Numerous studies have highlighted a high prevalence of vitamin D deficiency among postmenopausal women, with some suggesting an association with diabetes and metabolic syndrome. Therefore, we aim to assess serum vitamin D₃ status in T2DM pre-menopausal and post-menopausal women.

Methods: We conducted a cross-sectional study with 104 T2DM pre-menopausal and 104 T2DM post-menopausal women visiting the OPD of Obstetrics and Gynecology. Study population age ranging between 25 to 70 years were recruited and biochemical analysis was done.

Results: Mean age (mean±SD) of pre-menopausal and post-menopausal women was recorded as 33.03±5.89 years, and 57.23±8.72 years, respectively. Fasting blood glucose levels in pre-menopausal and post-menopausal women were 199.89±61.69 and 195.09±68.85, respectively, similarly HbA1c values in pre-menopausal and post-menopausal women were 8.70±2.01 and 8.63±2.23, respectively. Serum vitamin D₃ levels (mean±SD) were recorded as 43.64±17.91 and 37.08±16.26 in pre-menopausal and post-menopausal women, respectively. A statistically significant ($p<0.002$) decrease in serum vitamin D₃ level was found in post-menopausal women as compared to pre-menopausal women.

Conclusions: Results of our study shows statistically significant decrease in serum vitamin D₃ levels in post-menopausal T2DM women as compared to pre-menopausal T2DM women.

Keywords: Post-menopausal, Pre-menopausal, Type 2 diabetes mellitus, Vitamin D₃

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a metabolic condition that arises from either total or partial deficiency of insulin.¹ It is a multifactorial disorder characterised by abnormal glucose metabolism, persistent high blood glucose levels,

and altered insulin release. This disorder is distinguished by a reduced sensitivity to insulin and dysfunction of the pancreatic β -cells.² Indian T2DM population tends to manifest approximately ten years earlier than in Caucasian populations.³ The global escalation of diabetes mellitus presents a significant health crisis due to its association

with severe vascular complications. Forecasts indicate that by 2030, diabetes will affect around 380 million individuals globally. In India, the number of affected individuals is currently 41 million, with projections showing a rise to 70 million by 2030. More than 90% of diabetes mellitus cases place an enormous financial burden on health systems across the world.⁴

Vitamin D exists primarily in two forms: ergocalciferol (vitamin D₂) and cholecalciferol (vitamin D₃). Vitamin D₂ is synthesized in plants and fungi, while vitamin D₃ is synthesized in human through exposure to UVB radiation from sunlight. The principal source of vitamin D for humans is sunlight, which facilitates its synthesis in the skin. Dietary sources such as dairy products, fatty fish, fortified foods, and supplements also contribute to vitamin D levels.⁵ Vitamin D has been recognized for its essential role in the mineralization of bones and teeth by regulating calcium and phosphate homeostasis. It is a pleiotropic steroid hormone that exerts its biological effects by binding to a specific nuclear receptor known as the vitamin D receptor (VDR).⁶ Vitamin D deficiency or insufficiency determined by circulating 25-hydroxyvitamin D levels is one of the most widespread global health issues, particularly among postmenopausal women. It is also suggested as a potential risk factor for T2DM among European, African-American, and South Asian populations. An inverse association has been observed between vitamin D levels and the risk of T2DM and metabolic syndrome.⁷ Parallel to the growing diabetes epidemic, vitamin D deficiency has also emerged as a global concern. There has been a notable rise in public and scientific interest regarding vitamin D in recent years. It is estimated that nearly one billion individuals worldwide are affected by either vitamin D insufficiency or deficiency.⁸ Recent study suggest that vitamin D may also play a protective role against diabetes, malignancies, cardiovascular conditions, osteoporosis, and bone-related diseases.⁹ Several studies have identified a relationship between vitamin D deficiency and a variety of metabolic abnormalities, including hypertension, diabetes, abnormal lipid profiles, and obesity. Women are more prone than men to experience diabetes-related complications, and vitamin D deficiency is believed to intensify various age-related disorders associated with oxidative stress in females.¹⁰

Menopause is a naturally occurring stage of aging during which women undergo the cessation of menstruation and fertility. Menopause represents a critical period for implementing preventive strategies against cardiovascular disease and maintaining bone, muscular, and urogenital health. Numerous studies have highlighted a high prevalence of vitamin D deficiency among postmenopausal women, with some suggesting an association with diabetes and metabolic syndrome.¹¹

The present research was aimed to assess vitamin D levels in both premenopausal and postmenopausal T2DM women, exploring the intricate relationship among

menopause, vitamin D deficiency, and type 2 diabetes mellitus.

METHODS

Study design and place

Present study is a cross-sectional study. Study was conducted in the department of Biochemistry in collaboration with department of obstetrics and gynecology and physiology, at Era's Lucknow Medical College and Hospital, Lucknow. Prior approval from Institutional ethics committee was taken for the study (ELMC&H/R Cell/2025/531).

Study period

Study was conducted during October 2024 to May 2025.

Subject recruitment

208 type 2 diabetes mellitus women, attending the OPD of obstetrics and gynecology, Era's Lucknow Medical College, Lucknow, fulfilling the criteria were recruited. Out of 208 T2DM women, 104 were pre-menopausal and 104 were post-menopausal women. Informed consent was obtained from all study participants.

Inclusion criteria

Clinically diagnosed T2DM women with more than six months duration. Pre-menopausal women with age between 25- 40 years. Post-menopausal women with age above 40 years.

Exclusion criteria

Patients with osteoporosis, renal failure (renal osteodystrophy), and liver disease. Patients on medication such as phenytoin, rifampin, isoniazid, and ketoconazole. Patients on calcium supplementation.

Biochemical analysis

3 ml blood was drawn from all the study participants for biochemical analysis. Whole blood was used to estimate HbA1c, fasting blood glucose and serum vitamin D were estimated using fully automated analyser VITROS 5600 in the Hospital Lab service of institute.

Statistical analysis

Comparisons were made between pre-menopausal and post-menopausal women. Data has been represented as numbers and percentages for categorical and as mean \pm standard deviation for continuous data. Independent samples 't'-test, ANOVA and Mann Whitney U test were performed for continuous evaluations.

RESULTS

We have recruited T2DM women (n=208) and categorised them into 104 pre-menopausal and 104 post-menopausal women, fulfilling the inclusion criteria and willing to participate in the study. Mean age (mean±SD) of pre-

menopausal and post-menopausal women was recorded as 33.03±5.89 years, and 57.23±8.72 years, respectively. The increased age in post-menopausal women was found statistically significant (p<0.001) as compared to pre-menopausal women.

Table 1: Comparison of biochemical parameters between premenopausal and postmenopausal T2DM subjects.

Variables	Premenopausal diabetics (n=104)	Postmenopausal diabetics (n=104)	Mann Whitney U test
Age (years)	33.03±5.89	57.23±8.72	U=0.000; p<0.001
Fasting blood glucose (mg/dl)	199.89±61.69	195.09±68.85	U=4948.500; p=0.290
HbA1c (%)	8.70±2.01	8.63±2.23	U=5109; p=0.491
Vitamin D ₃ (ng/ml)	43.64±17.91	37.08±16.26	U=4059.000; p=0.002

We investigated all the blood samples from pre-menopausal and post-menopausal women for biochemical parameters such as fasting blood glucose, HbA1c and vitamin D. All the values are expressed as (mean±SD). Fasting blood glucose levels in pre-menopausal and post-menopausal women were 199.89±61.69 and 195.09±68.85, respectively. No significant change was found among pre-menopausal and post-menopausal women. Similarly, non-significant change in HbA1c values was recorded among pre-menopausal (8.70±2.01) and post-menopausal women (8.63±2.23) (Table 1, Figures 1 and 2).

Serum vitamin D levels were recorded as 43.64±17.91 and 37.08±16.26 in pre-menopausal and post-menopausal women, respectively. A statistically significant (p<0.002) decrease in serum vitamin D levels was found in post-menopausal women as compared to pre-menopausal women (Figure 3).

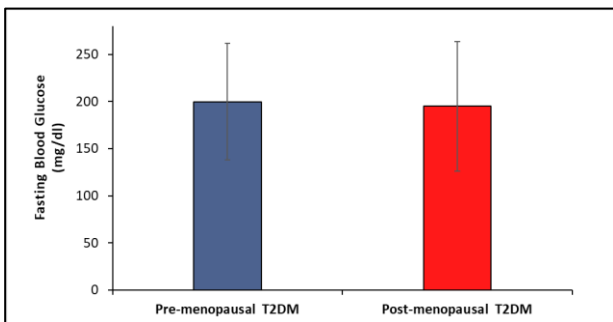


Figure 1: Comparison of fasting blood glucose levels between pre-menopausal and post-menopausal T2DM women.

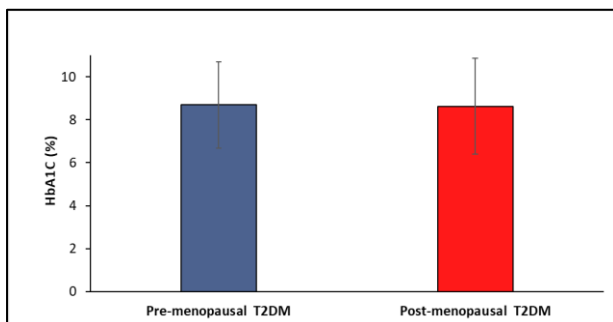


Figure 2: Comparison of HbA1c value between pre-menopausal and post-menopausal T2DM women.

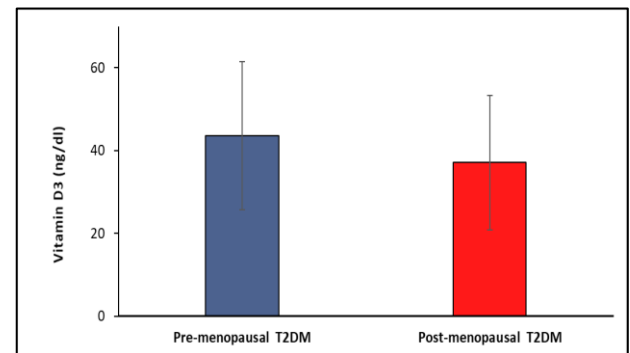


Figure 3: Comparison of vitamin D₃ between pre-menopausal and post-menopausal T2DM women.

DISCUSSION

The present study was undertaken to assess the fasting blood glucose, HbA1c and vitamin D₃ level in premenopausal and postmenopausal women diagnosed with type 2 diabetes mellitus.

No statistically significant differences were found in fasting blood glucose level and HbA1c value. Fasting blood glucose was recorded as 199.89±61.69 mg/dl in premenopausal women and 195.05±68.85 mg/dl in postmenopausal women (p=0.290), while HbA1c values were 8.70±2.01% and 8.63±2.23%, respectively (p=0.491). However, a statistically significant difference was observed in serum Vitamin D₃ levels: premenopausal women showed higher values (43.64±17.91 ng/ml) compared to postmenopausal women (37.08±16.26 ng/ml), with a p value of 0.002.

The observed lack of significant variation in fasting blood glucose and HbA1c between the two groups suggests that menopausal status alone may not exert a strong independent influence on glycemic control among T2DM patients. Although HbA1c levels were slightly lower in the postmenopausal group, the difference was not statistically significant.

These findings contrast with study conducted by Vasdeki and workers which associates estrogen deficiency in postmenopausal women with worsened glycemic outcomes due to decreased insulin sensitivity. Such discrepancies may be due to unmeasured variables such as medication adherence, diabetes duration, or lifestyle habits etc.¹²

The low serum vitamin D₃ levels in postmenopausal women supports the hypothesis that hormonal changes related to menopause may exacerbate micronutrient deficiencies. While no direct correlation between vitamin D₃ levels and glycemic markers was observed, existing literature points toward vitamin D's broader metabolic influence.¹³

Vitamin D plays a recognized role in improving insulin sensitivity, as well as reducing inflammation and oxidative stress, as shown in studies by Ishikawa and workers. Moreover, its systemic benefits extend to reducing the risk of complications such as diabetic nephropathy and cardiovascular disease.¹⁴

Our findings on fasting blood glucose and HbA1c align with research conducted by Kanchana et al which also found no significant glycemic difference across menopausal status when treatment regimens were consistent.⁶ Further, studies of Mozaffari et al reported an association between vitamin D deficiency and poorer glycemic control, but such a relationship was not observed in our study. This discrepancy may be attributed to the cross-sectional design and lack of control for confounding variables.¹⁵

The observed reduction in vitamin D₃ levels in postmenopausal women corresponds with earlier findings from Singh et al. who reported a decline in vitamin D levels following menopause.¹⁰ Estrogen deficiency is also believed to disrupt vitamin D metabolism, as explained by Mei et al.¹⁶ Recommendations for routine vitamin D screening and supplementation, especially for hormonally vulnerable populations, have also been emphasized.¹⁷

Further, mechanistic studies exploring the interaction between estrogen, vitamin D metabolism, and insulin resistance could enhance the understanding of metabolic changes in postmenopausal women. Additionally, large-scale investigations evaluating the cost-effectiveness of routine vitamin D screening and supplementation in diabetes care, are warranted.

First, the cross-sectional design restricts the ability to infer causality between menopausal status and biochemical

parameters. Second, important confounding factors such as dietary intake, duration of diabetes, physical activity, body mass index (BMI), and adherence to medication were not accounted for. These variables may significantly influence glycemic control and vitamin D status.

CONCLUSION

Present study and its results, provide important insight into the biochemical profile differences between premenopausal and post-menopausal women with T2DM. This finding highlights the potential role of vitamin D deficiency as an additional risk factor in post-menopausal women with T2DM. Regular screening and management of vitamin D levels may be beneficial in this population. Further, longitudinal studies are recommended to assess the long-term implications of menopause on glycemic control and vitamin D status in T2DM women.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee vide letter no ELMC&H/R Cell/2025/531.

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