DOI: https://doi.org/10.54393/pjhs.v7i7.3953

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 7, Issue 07 (July 2026)

Original Article

OPEN ACCESS

Role of Vitamin D in Prevention of Preeclampsia Recurrence in Pregnant Women with Previous History of Preeclampsia: A Randomized Controlled Trial

Tehseen Aslam[1*], Saima Abdul Jabbar[1], Mehnaz Khakwani[1], Fatima Arshad[1] and Amna Razzaq[1]

[1]Department of Obstetrics and Gynecology, Nishtar Hospital, Multan, Pakistan

ARTICLE INFO

Keywords:
High-Risk Pregnancy, Pre-Eclampsia, Pregnancy, Recurrence, Vitamin D

How to Cite:
Aslam, T., Jabbar, S. A., Khakwani, M., Arshad, F., & Razzaq, A. (2026). Role of Vitamin D in Prevention of Preeclampsia Recurrence in Pregnant Women with Previous History of Preeclampsia: A Randomized Controlled Trial: Vitamin D in Prevention of Preeclampsia Recurrence in Pregnant Women. Pakistan Journal of Health Sciences, 7(7), 21-26. https://doi.org/10.54393/pjhs.v7i7.3953

***Corresponding Author:**
Tehseen Aslam
Department of Obstetrics and Gynecology, Nishtar Hospital, Multan, Pakistan
tehseenaslam451@gmail.com

Received Date: 10th February, 2026
1st Revision Received: 6th March, 2026
Acceptance Date: 30th March, 2026
Published Date: 31st July, 2026

ABSTRACT

Vitamin D deficiency may contribute to abnormal placentation and endothelial dysfunction leading to preeclampsia (PE). **Objectives:** To compare the recurrence of preeclampsia in pregnant females having a previous history of PE receiving vitamin D supplementation versus placebo. **Methods:** This double-blind randomized controlled trial was done at the Department of Obstetrics and Gynecology, Nishtar Hospital, Multan, over six months from August 2025 to February 2026. A total of 146 pregnant ladies, 20-45 years old, with singleton pregnancy, gestational age ≥20 weeks, and previous preeclampsia were enrolled. Women with chronic hypertension, cardiac diseases, renal disease, and thyrotoxicosis were excluded. Participants were randomized to receive either oral vitamin D 4000 IU daily or a placebo. Follow-up continued until 36 weeks. Preeclampsia recurrence was defined as hypertension ≥140/90 mmHg with proteinuria ≥+1 on spot urine test. Data were analyzed through SPSS version 27.0, descriptive statistics were run, group comparisons were done through chi-square and independent sample t-test as required, and a p-value<0.050 was considered significant. **Results:** Mean age was 27.9 ± 4.6 years, and mean gestational age was 30.5 ± 2.8 weeks. Age and gestational age differed between the groups. Overall recurrence of preeclampsia was 21.9%. Recurrence was markedly less in the vitamin D compared to placebo (13.7% vs. 30.1%, relative risks 0.46, p=0.016) groups. Significant reductions were observed among women aged <30 years, gestational age 24-30 weeks, and non-obese participants. **Conclusions:** Vitamin D therapy decreased recurrence of preeclampsia in high-risk pregnant females, supporting its potential role as an effective preventive strategy in antenatal care.

INTRODUCTION

Preeclampsia (PE) is characterized by raised blood pressure (BP) and proteins excreted in urine after the 20th week of gestation [1]. It is responsible for one-fourth of all maternal deaths and neonatal morbidity and mortality, and it complicates 2–8% of pregnancies [2]. Excreting >300 mg of protein in a 24-hour collection of urine sample, or a protein-creatinine ratio of minimum 0.3 in a random urine specimen, or consistently having proteinuria of 30 mg/dl in random urine samples (i.e., +1 finding on dipstick) are all indicators of proteinuria [3]. Conditions of calcium homeostasis, e.g., hypocalciuria and decreased vitamin D levels, have been commonly documented in pregnant women who subsequently experienced preeclampsia [4]. The presence of PE in one pregnancy does not guarantee that it will again develop in subsequent pregnancies. However, a larger likelihood of it occurring in later pregnancies is linked to its initial development [5]. Because low maternal vitamin D stores may raise the risk of maternal comorbidities and difficulties, e.g., small for gestational age infants and low birth weight, vitamin D is especially important during pregnancy [6]. According to past observations, preeclampsia patients are more likely to have increased Th1 expression in the presence of vitamin D deficiency [7]. Behjat Sasan *et al.* conducted a randomized controlled trial. While 70 pregnant patients were randomly assigned to the intervention group (vitamin D3), 72 pregnant women were placed in the control group (placebo). Preeclampsia was much less common in the

DOI: https://doi.org/10.54393/pjhs.v7i7.3953

intervention group's patients (15.7% vs. 30.6%, p-value=0.036) than in the control group [8]. Dahma *et al.* Enrolled 139 pregnant females in the cases group, who had a history of PE and who confirmed daily supplementation of vitamin D in 2000 IU or 4000 IU up to the 36th week of gestation, while 59 individuals were enrolled in the control group with no vitamin D addition during pregnancy. Preeclampsia was more prevalent in the control group at 36 weeks of pregnancy (18.6% vs. 9.5% (low dosage) vs. 5.3% (high dose), p=0.041) [9]. Given that the increased need for vitamin D during pregnancy is one of the potential causes of preeclampsia, vitamin supplements are prescribed to meet this increased need. In Pakistan and other South Asian populations, vitamin D deficiency is highly prevalent among pregnant women, with several regional studies reporting deficiency rates exceeding 60–80% [10]. The study's findings will emphasize the necessity of taking vitamin D supplements throughout pregnancy, particularly for women who have previously experienced preeclampsia. By reducing the chances of PE, the associated maternal and neonatal complications and death rate may be reduced.

Pakistan does not have strong data from randomized controlled trials on vitamin D supplementation to prevent recurrence of preeclampsia in women at high risk; most of the evidence in the country is based on observational studies or small, insensitive trials. Although randomized, there were large baseline differences between groups in terms of age (27.2 vs 28.7 years, p=0.038) and gestational age (31.2 vs 29.8 weeks, p=0.002), which might confound even adjusted analysis. This study aims to evaluate how vitamin D may help prevent preeclampsia recurrence in our community.

METHODS

This double blind, parallel-group, randomized controlled trial (Trial Registry No. NCT07288801) was conducted at the Department of Obstetrics and Gynaecology, Nishtar Hospital, Multan, after taking approval from the institutional ethical review committee (No. 14538/NMU; dated 8th August 2025). The study lasted a period of six months from 9th August 2025 to 8th February 2026. A total of 146 pregnant females, gestational age ≥20-weeks, singleton pregnancy, 20-45 years of age, and history of preeclampsia were recruited through non-probability consecutive sampling after taking written informed consent. A minimum sample size of 146 participants was calculated using Open Epi online software through the formula for a randomized controlled trial (https://www.openepi.com/PDFDocs/SS CohortDoc.pdf). $n = (Z_{\alpha/2} + Z_{1-\beta})^2 pq(r+1) / r (p_1 - p2_1^2$. Preeclampsia recurrence of 18.6% in the placebo group, 5.3% in the vitamin D supplementation group [9], with a power of 80% and a significance level of 5%. Women with chronic hypertension, cardiac diseases, renal disease, thyrotoxicosis, and intrauterine fetal demise were excluded. Through simple random sampling using the lottery method, the participants were assigned to the vitamin D supplementation (intervention group) and placebo group in a 1:1 ratio. The group assignment was concealed in sequentially placed numbered and sealed opaque envelopes. The enrolling gynecologist opened the envelopes to assign the participants to allocated groups. Patients' characteristics like age(years), gestational age (weeks), BMI, obesity (yes/no), parity (primiparous/multiparous), and gestational diabetes were recorded. The women in the intervention group were given 4000 IU of vitamin D orally, while women in the placebo group were given the same amount of oil emulsion provided by the hospital pharmacy department. The participants were not aware of the assigned drug. The study medicine was prescribed till 36-weeks of gestation. Patients were followed fortnightly in the outpatient department, and blood pressure was measured according to standard procedure. The researcher measuring blood pressure was not aware of the treatment assigned to participants. If blood pressure was ≥140/90mmHg in sitting posture, a spot urine test to look for proteinuria was advised. Presence of proteinuria (+1 or higher) in the presence of hypertension was used to label preeclampsia. All women with recurrent preeclampsia were managed according to hospital protocol.

Normally distributed numerical data were presented as mean ± SD, and categorical data as frequency and percentages. Preeclampsia recurrence between the groups is compared through a chi-square test, and a p-value<0.050 is taken as significant. The study followed Consolidated Standards of Reporting Trials (CONSORT) guidelines for reporting of randomized controlled trials [11] (Figure 1).

DOI: https://doi.org/10.54393/pjhs.v7i7.3953

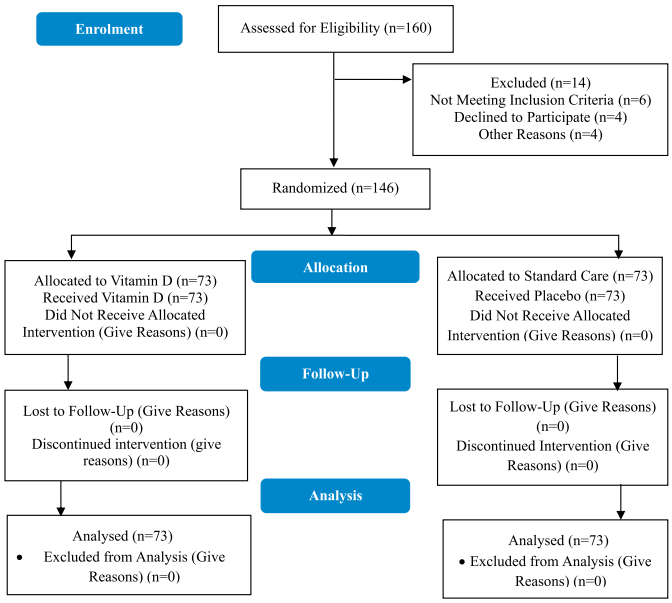

Figure 1: CONSORT 2010 Flow Diagram

RESULTS

The mean age of patients was 27.9 ± 4.6 years, and 91 (62.3%) were below 30-years of age. The mean body mass index (BMI) was 24.6 ± 3.2, and 24 (16.4%) were obese. The mean gestational age was 30.5 ± 2.8 weeks, and 80 (54.8%) were between 31 and 36 weeks of gestation. In 110 (75.3%) of the cases, women were multiparous. In 27 (18.5%) of the cases, women had gestational diabetes. Women were significantly younger in the vitamin D supplementation group in contrast to the placebo group (27.2 ± 4.3 vs. 28.7 ± 4.8 years, p-value=0.038). The mean gestational age was remarkably high in the vitamin D group in comparison to the placebo (31.2 ± 2.5 vs. 29.8 ± 3.1 weeks, p-value=0.002) (Table 1).

Table 1: Characteristics of Pregnant Women with Previous Preeclampsia History (n=146)

Characteristics	All, (n=146)	Vitamin D Group, (n=73)	Placebo Group, (n=73)	p-value*
Age (Years)	27.9 ± 4.6	27.2 ± 4.3	28.7 ± 4.8	0.038
< 30-Years	91 (62.3%)	51 (56%)	40 (44%)	0.060
> 30-Years	55 (37.7%)	22 (40%)	33 (60%)	
BMI (kg/m^2)	24.6 ± 3.2	24.2 ± 3.1	24.9 ± 3.3	0.164
Obese - Yes	24 (16.4%)	10 (41.7%)	14 (58.3%)	0.372
Gestational Age (Weeks)	30.5 ± 2.8	31.2 ± 2.5	29.8 ± 3.1	0.002
Parity - Primiparous	36 (24.7%)	21 (58.3%)	15 (41.7%)	0.249
Multiparous	110 (75.3%)	52 (47.3%)	58 (52.7%)	
Gestational Diabetes -Yes	27 (18.5%)	11 (40.7%)	16 (59.3%)	0.286

*Independent sample t-test for numeric and chi-square test for categorical comparisons

The incidence of preeclampsia recurrence was 32 (21.9%) in the study participants. Incidence of preeclampsia was remarkably less in patients receiving vitamin D compared to those taking a placebo (13.7% vs. 30.1%, relative risk 0.46(0.23–0.89), p-value=0.016)(Table 2).

Table 2: Pre-Eclampsia Recurrence in Women with Previous Preeclampsia History (n=146)

Treatment Group	Preeclampsia Recurrence, n (%)		Relative Risk (95% CI)	p-value*
	Yes	No		
All (n=146)	32 (21.9%)	114 (78.1%)	–	–
Vitamin D Group (n=73)	10 (13.7%)	63 (86.3%)	0.46 (0.23 - 0.89)	0.016
Placebo Group (n=73)	22 (30.1%)	51 (69.9%)		

*chi-square test

In women < 30-years of age, the incidence of pre-eclampsia was remarkably less in the vitamin D group in contrast to the placebo (9.8% vs. 27.5%, relative risk 0.36 (0.14–0.94), p-value=0.028). In women 24-30 weeks of gestational age, the incidence of pre-eclampsia was significantly lower in the vitamin D supplementation group compared to the placebo group (11.1% vs. 38.5%, relative risk 0.29 (0.09–0.90), p-value=0.023). Incidence of pre-eclampsia was significantly lower in the vitamin D supplementation group compared to the placebo group (3.2% vs. 15.3%, relative risk 0.21 (0.05–0.92), p-value=0.026) only in the non-obese group (Table 3).

Table 3: Effect of Patient Characteristics on Distribution of Preeclampsia Recurrence Between Vitamin D and Placebo Groups (n=146)

Characteristics	Treatment Group	Preeclampsia Recurrence, n (%)		Relative Risk (95% CI)	p-value*
		Yes	No		
Age					
<30 Years	Vitamin D Group	5 (9.8)	46 (90.2)	0.36 (0.14 - 0.94)	0.028
	Placebo Group	11 (27.5)	29 (72.5)		
≥30 Years	Vitamin D Group	5 (22.7)	17 (77.3)	0.68 (0.28 - 1.70)	0.396
	Placebo Group	11 (33.3)	22 (66.7)		
Gestational Age					
24-30	Vitamin D Group	3 (11.1)	24 (88.9)	0.29 (0.09 - 0.90)	0.023
	Placebo Group	15 (38.5)	24 (61.5)		
31-36	Vitamin D Group	7 (15.2)	39 (84.8)	0.74 (0.28 - 1.91)	0.564
	Placebo Group	7 (20.6)	27 (79.4)		

DOI: https://doi.org/10.54393/pjhs.v7i7.3953

Obesity					
Yes	Vitamin D Group	8 (80)	2 (20)	0.86 (0.61 – 1.21)	0.550
	Placebo Group	13 (92.9)	1 (7.1)		
No	Vitamin D Group	2 (3.2)	61 (96.8)	0.21 (0.05 – 0.92)	0.026
	Placebo Group	9 (15.3)	50 (84.7)		
Parity					
Primiparous	Vitamin D Group	0 (0.0)	21 (100)	––	0.008
	Placebo Group	5 (33.3)	10 (66.7)		
Multiparous	Vitamin D Group	10 (19.2)	42 (80.8)	0.66 (0.33 – 1.30)	0.220
	Placebo Group	17 (29.3)	41 (70.7)		

*chi-square test (Fisher's exact test where cell count < 5).

DISCUSSION

The results of our research suggest that the overall incidence of preeclampsia recurrence was 21.9%. Incidence of preeclampsia was less in the vitamin D group in comparison to the placebo group (13.7% vs. 30.1%, p-value=0.016). A meta-analysis of RCTs on vitamin D and preeclampsia was carried out in 2024 by Kokkinari *et al.* They found that taking vitamin D supplements significantly decreased the risk of preeclampsia (pooled RR = 0.61) [12]. This is in line with our findings and demonstrates that vitamin D protects against preeclampsia, especially in areas where baseline deficiency is prevalent. Patients in the intervention group had a considerably decreased (p-value=0.036) likelihood of PE compared to women in the control group, according to a randomized trial by Behjat Sasan *et al.* which administered 50,000 IU of vitamin D every two weeks. Preeclampsia was 1.94 times more likely to occur in the control group than in the vitamin D group [8]. This closely resembles the decrease in recurrence risk that this study has observed. According to reports, vitamin D lowers endothelial dysfunction and systemic inflammation linked to the pathophysiology of preeclampsia [13]. Some factors, like dose regimens, timing of supplementation, and study populations, also make a difference. Some trials administered high-dose intermittent vitamin D (e.g., 50,000 IU every two weeks until late pregnancy), while others used lower daily doses (400–600 IU), which may lead to different biological effects on placental function and endothelial regulation. In 2023, Dahma carried out a systematic review on vitamin D supplementation before 20 weeks. In several trials, early pregnancy vitamin D supplementation was linked to a lower incidence of preeclampsia (ORs=0.26–0.31) [14]. This further validates the use of early supplementation as a preventative measure, as demonstrated in our RCT. Early in pregnancy, enough vitamin D may have a positive impact on placental vascular remodeling and trophoblast invasion [15]. In a Moghib *et al.* 4956 people were examined in a meta-analysis. Vitamin D supplementation dramatically decreased the risk of preeclampsia by 45% (RR=0.55) in 33 RCTs. This greater synthesis confirmed that maternal vascular and inflammatory pathways were impacted by vitamin D in a quantifiable way [16]. A systematic review was carried out by AlSubai *et al.* The supplementation of vitamin D reduced the chance of preeclampsia by half (OR ~0.50), while deficiency was linked to an increased risk, according to pooled data from randomized and observational trials [17]. Their conclusion that supplementing vitamin D reduces recurrence is consistent with our findings. Increased levels of 25-hydroxyvitamin D decrease the anti-angiogenic imbalance linked to preeclampsia and raise angiogenic factors. The authors of a smaller RCT from Faisalabad, Pakistan, demonstrated that the vitamin D versus placebo difference in preeclampsia incidence (4% vs. 8%) did not reach statistical significance [18]. This is not consistent with what we found. A lower dosage and a different baseline vitamin D level could be the most likely cause. In the present study, it was seen that in women < 30-years of age, the incidence of pre-eclampsia was markedly less in vitamin D group in contrast to the group without vitamin D. Subgroup analysis in a study by Moghib *et al.* showed greater risk reductions in younger or earlier-treated women, indicating that early gestational intervention or age may increase the protective effect [16]. Younger women frequently have greater placental adaptability and fewer comorbidities; early or adequate vitamin D dose can enhance immune modulation and placental vascularization more successfully, resulting in higher preventative effects in these subgroups. This study also observed that in women at 24-30 weeks of gestational age, the incidence of pre-eclampsia was considerably less in women who received vitamin D in contrast to those who did not (11.1% vs. 38.5%). Vitamin D supplementation beginning early in pregnancy (median GA of 15 weeks) significantly decreased the incidence of preeclampsia (RR = 0.36; p=0.001) when compared to no supplementation, according to a randomized clinical trial from the Democratic Republic of Congo [19]. The substantial protective impact confirms our results that vitamin D supplementation started before or during mid-gestation reduces the incidence of

DOI: https://doi.org/10.54393/pjhs.v7i7.3953

preeclampsia, even when the supplementation started earlier than 24–30 weeks. Adequate vitamin D may support healthy immunological and endothelial function during the crucial mid-gestational phase for placental remodeling and maternal vascular adaptation, hence reducing hypertensive problems [20]. In the present study, the incidence of pre-eclampsia was considerably less in the vitamin D group in contrast to placebo (3.2% vs. 15.3%) only in the non-obese group. While higher dosing improved serum 25OHD levels, there were no significant improvements in maternal or birth outcomes, according to a randomized trial comparing 800 IU vs. 400 IU vitamin D supplementation in pregnant women with overweight/obesity [21]. This suggests that standard supplementation may not adequately modify outcomes like hypertension or preeclampsia in obese pregnancies. This corroborates our findings that there is no discernible advantage of vitamin D in the obese group. Obesity may affect vitamin D metabolism and response; therefore, conventional pregnancy supplementation may be less successful in lowering the risk of preeclampsia in obese women unless significantly greater doses are employed. The strengths of our study include its experimental study design. By reducing observer bias and selection, double-blind randomized controlled trials improved causal inference. Clinical relevance and applicability to preventive obstetric care were improved by including women who had already experienced preeclampsia. Internal validity was guaranteed by using a fixed, evidence-based vitamin D dose (4000 IU/day) with a placebo control.

One of the study's limitations was a single-center study; its conclusions might not be as applicable to different populations or healthcare environments. Baseline imbalance was observed in maternal age and gestational age between the groups despite randomization. Since these variables are clinically relevant, an adjusted analysis was carried out to assess for potential confounding. Only outcomes up to 36 weeks were studied; perinatal outcomes and late-onset preeclampsia were not studied. Underpowered subgroup analyses raise the possibility of type II error. Baseline vitamin D levels in serum were not measured, and vitamin D toxicity monitoring during supplementation was not performed, limiting assessment of dose-response relationships and safety profiling. Larger sample sizes and multi-center trials should be carried out in the future to verify efficacy across a range of demographics. To establish a correlation between biochemical correction and clinical results, baseline and repeated vitamin D values should be included. Future research studies should be conducted on long-term maternal and neonatal outcomes, such as preterm birth, fetal growth, and newborn morbidity.

CONCLUSIONS

In conclusion, vitamin D supplementation at 4000 IU daily significantly reduces the recurrence of preeclampsia in females with a prior history of the disorder, with the greatest benefit observed among younger, non-obese women and those treated earlier in gestation. These results underscore the need for customized strategies in obese groups and additional large-scale validation.

Authors' Contribution

Conceptualization: TA, MK
Methodology: SAJ, FA, AR
Formal analysis: FA, AR
Writing and Drafting: TA, SAJ, MK
Review and Editing: TA, SAJ, MK, FA, AR

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Srialluri N, Surapaneni A, Chang A, Mackeen AD, Paglia MJ, Grams ME. Preeclampsia and Long-Term Kidney Outcomes: An Observational Cohort Study. American Journal of Kidney Diseases. 2023 Dec; 82(6): 698-705. doi: 10.1053/j.ajkd.2023.04.010.

[2] Amin MM, Ibrahim MS, Ali AE. Values of Application of the Three Delays Model to Maternal Mortality Scenarios at Sohag University Hospital Bidirectional Cohort Study. The Egyptian Journal of Hospital Medicine. 2021 Apr; 83(1): 812-6. doi: 10.21608/ejhm.2021.156449.

[3] Pasternak Y, Lifshitz D, Shulman Y, Hiersch L, Rimon E, Kuperminc M *et al.* Diagnostic Accuracy of Random Urinary Protein-to-Creatinine Ratio for Proteinuria in Patients with Suspected Pre-Eclampsia. Archives of Gynecology and Obstetrics. 2021 Jul; 304(1): 109-15. doi: 10.1007/s00404-020-05937-0.

[4] Simmi K, Chetna B, Smiti N, Gurpreet G. Sex-Specific Variations in Vitamin D and Vitamin D Binding Protein (Vdbp) and Flipped Pattern of their Association in Preeclamptic Women with Dyslipidemia. Current Hypertension Reviews. 2023 Dec; 19(3): 180-6. doi: 10.2174/1573402119666230816090148.

[5] Wainstock T and Sheiner E. Clinical Factors Associated with Preeclampsia Recurrence. Pregnancy Hypertension. 2022 Dec; 30: 31-5. doi: 10.1016/j.preghy.2022.08.004.

DOI: https://doi.org/10.54393/pjhs.v7i7.3953

[6] Lee SB, Jung SH, Lee H, Lee SM, Jung JE, Kim N *et al.* Maternal Vitamin D Deficiency in Early Pregnancy and Perinatal and Long-Term Outcomes. Heliyon. 2023 Sep; 9(9). doi: 10.1016/j.heliyon.2023.e19367.

[7] Ribeiro VR, Romao-Veiga M, Nunes PR, de Oliveira LR, Romagnoli GG, Peracoli JC *et al.* Immunomodulatory Effect of Vitamin D on the Stats and Transcription Factors of CD4+ T Cell Subsets in Pregnant Women with Preeclampsia. Clinical Immunology. 2022 Jan; 234: 108917. doi: 10.1016/j.clim.2021.108917.

[8] Behjat Sasan S, Zandvakili F, Soufizadeh N, Baybordi E. The Effects of Vitamin D Supplement on Prevention of Recurrence of Preeclampsia in Pregnant Women with A History of Preeclampsia. Obstetrics and Gynecology International. 2017; 2017(1): 8249264. doi: 10.1155/2017/8249264.

[9] Dahma G, Neamtu R, Nitu R, Gluhovschi A, Bratosin F, Grigoras ML *et al.* The Influence of Maternal Vitamin D Supplementation in Pregnancies Associated with Preeclampsia: A Case-Control Study. Nutrients. 2022 Jul; 14(15): 3008. doi: 10.3390/nu14153008.

[10] Nasir JA, Imran M, Zaidi SA. Pattern of Vitamin D among Pakistani Pregnant Women. Journal of College of Physicians and Surgeons Pakistan. 2018 Mar; 28(3): 233-7. doi: 10.29271/jcpsp.2018.03.233.

[11] Hopewell S, Chan AW, Collins GS, Hróbjartsson A, Moher D, Schulz KF *et al.* CONSORT 2025 Statement: Updated Guideline for Reporting Randomized Trials. The Lancet. 2025 May; 405(10489): 1633-40. doi: 10.1016/S0140-6736(25)00672-5.

[12] Kokkinari A, Antoniou E, Orovou E, Andronikidi PE, Tzitiridou-Chatzopoulou M, Sarantaki A *et al.* The role of vitamin D supplementation in preventing pre-eclampsia: a review of randomized controlled trials with meta-analysis. In Healthcare. 2025 May; 13(11): 1221. doi: 10.3390/healthcare13111221.

[13] Zheng S, Dong S, Shen H, Xu P, Shu C. Role of Vitamin D in the Pathogenesis of Early-Onset Preeclampsia: A Narrative Review. Frontiers in Nutrition. 2025 Jun; 12: 1598691. doi: 10.3389/fnut.2025.1598691.

[14] Dahma G, Reddy G, Craina M, Dumitru C, Popescu A, Stelea L *et al.* The Effects of Vitamin D Supplementation Before 20 Weeks of Gestation on Preeclampsia: A Systematic Review. Journal of Personalized Medicine. 2023 Jun; 13(6): 996. doi: 10.3390/jpm13060996.

[15] Gerovasili E, Sarantaki A, Bothou A, Deltsidou A, Dimitrakopoulou A, Diamanti A. The Role of Vitamin D Deficiency in Placental Dysfunction: A Systematic Review. Metabolism Open. 2025 Mar; 25: 100350. doi: 10.1016/j.metop.2025.100350.

[16] Moghib K, Ghanm TI, Abunamoos A, Rajabi M, Moawad SM, Mohsen A *et al.* Efficacy of Vitamin D Supplementation on the Incidence of Preeclampsia: A Systematic Review and Meta-Analysis. BioMed Central Pregnancy and Childbirth. 2024 Dec; 24(1): 852. doi: 10.1186/s12884-024-07081-y.

[17] AlSubai A, Baqai MH, Agha H, Shankarlal N, Javaid SS, Jesrani EK *et al.* Vitamin D and Preeclampsia: A Systematic Review and Meta-Analysis. SAGE Open Medicine. 2023 Nov; 11: 20503121231212093. doi: 10.1177/20503121231212093.

[18] Safdar M, Zafar H, Irfan S, Naz M, Fatima A, Fatima U *et al.* Vitamin D Supplementation Reduces the Risk of Preeclampsia in High-Risk Pregnant Females. International Journal of Research in Medical Sciences. 2023 Jan; 11(1): 43. doi: 10.18203/2320-6012.ijrms20223621.

[19] Kabuyanga RK, Tugirimana PL, Sifa B, Balezi M, Dikete ME, Mitangala PN *et al.* Effect of Early Vitamin D Supplementation on the Incidence of Preeclampsia in Primigravid Women: A Randomized Clinical Trial in Eastern Democratic Republic of the Congo. BioMed Central Pregnancy and Childbirth. 2024 Feb; 24(1): 107. doi: 10.1186/s12884-024-06277-6.

[20] Hu KL, Zhang CX, Chen P, Zhang D, Hunt S. Vitamin D Levels in Early and Middle Pregnancy and Preeclampsia, A Systematic Review and Meta-Analysis. Nutrients. 2022 Feb; 14(5): 999. doi: 10.3390/nu14050999.

[21] Ku CW, Lee AJ, Oh B, Lim CH, Chang TY, Yap F *et al.* The Effect of Vitamin D Supplementation in Pregnant Women with Overweight and Obesity: A Randomized Controlled Trial. Nutrients. 2023 Dec; 16(1): 146. doi: 10.3390/nu16010146.