

Association Between Vitamin D Supplementation and Blood Pressure of Healthy Pregnant Women in a Single-center Cohort in Basrah City

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Vitamin-D deficiency during pregnancy is connected to many health problems, including cardiovascular health problems. The study aims to reveal the association between vitamin -D supplement and the blood pressure of healthy pregnant women. It is a prospective observational cohort study carried out in Barash City at a private hospital for obstetrics and gynecology hospital. A total of 115 young pregnant women (22-33 years of age) were recruited. They were divided into two groups: one consisted of 65 pregnant women who took vitamin-D supplements, while other consisted of 50 pregnant women who didn't take Vitamin-D. Each participant had two readings of blood pressure measurements. The first reading was at the booking visit (week eight) and the second reading was at the third trimester (week 30) of pregnancy. We found that systolic blood pressure at the third trimester was significantly reduced in the group on vitamin D, and not significantly changed in the pregnant women who did take vitamin D. Although the systolic blood pressure was not changed in Vitamin-D supplement group (before supplementation) compared to non-supplement group. Vitamin- D supplementation for 22 weeks during pregnancy may have a role in systolic blood pressure decline.

Keywords: Blood pressure, Pregnancy, Supplement, Vitamin D, Young.

One of the widespread global problems is vitamin-D deficiency. ¹ Vitamine-D is a steroid hormone that plays a vital function in the immune system and various cellular activities ². It has been shown to have a significant impact on bone and calcium metabolism, as well as on diabetes mellitus, metabolic syndrome, cardiovascular diseases, hypertension, and respiratory function. ^{3,4} There has been substantial attention regarding the prospective

relationship between vitamin-D concentrations and human unexpected hypertension. Recently stated that vitamin-D is effective as a strong negative endocrine modulator of renin gene regulation providing an explanation about the onset of hypertension, according to different studies, a systematic review and meta-analysis of existing prospective findings on the relation of vitamin-D and hypertension. ⁵⁻⁷ It has been supposed that

vitamin-D deficiency may be caused by inadequate exposure to sunlight as well as little diet intake in pregnant women in a way that may affect both women's health status and fetus.^{2,8}

Throughout the gestational period, vitamin-D deficiency is connected to various maternal and fetal short- and long-term disorders. Fetuses may experience growth retardation, skeletal abnormalities, diabetes, asthma, and mental defects.^{2,9} Whereas vitamin-D deficiency in mothers has been related to a high risk of cardiovascular disease, cancer, Alzheimer's disease, and even hypertension.^{1,4} A previous study revealed that vitamin-D deficiency during pregnancy may cause different health issues like preeclampsia, gestational diabetes, gingivitis, and periodontal conditions.¹⁰ It has been found that Vitamin-D may improve placental function by inducing the innate and adaptive immune response.¹¹ Preeclampsia, which is a serious disorder, occurs after 20 weeks of gestation. Vitamin-D insufficiency is related to the risk of preeclampsia.^{2,12} Moreover, a significant relation has been found between preeclampsia and serum vitamin-D levels.² Several hypotheses in studies have tried to explain the etiology of preeclampsia in pregnancy. In this context, vitamin-D insufficiency has been highlighted as a stimulating factor of vascular and systemic inflammation that promotes deficient placental development.^{2,13} Clinical trials in a systematic review discovered the consequences of vitamin-D supplementation during pregnancy, revealing the reduction in the incidence of preeclampsia.¹⁴ The current study is a trial to reveal the potential association between vitamin-D supplement and blood pressure of healthy pregnant women in a single-center cohort in Basrah City, Iraq.

MATERIALS AND METHODS

Study design

This study is a prospective observational cohort. carried out from January to July 2024 in Basrah City at a private hospital for obstetrics and gynecology hospital. The research was carried out with each participant's agreement and in accordance with the STROBE statement for observational studies. The present study was conducted after obtaining informed consent and approved by the College Research Ethics Committee of Medicine,

The University of Basrah (No.3 on November 26, 2025)

Patients

In the present study, 115 young pregnant women within the age range between (22-33) years were recruited using consecutive sampling. The participants were divided into two groups: The first group composed of 65 pregnant women who had taken vitamin-D supplements besides iron and folic acid from the eighth week of pregnancy (at the booking visit). The other group included 50 pregnant women who had taken iron and folic acid supplements only. The participants in both groups were healthy and not suffering from medical problems such as hypertension or endocrine diseases. All participants were assessed clinically by a physician.

Characteristics like age, height, weight, body mass index (BMI), co-morbidities, drug history, or smoking history were recorded using a questionnaire form. The BMI was considered according to the formula $(\text{BMI} = \text{weight (kg)} / [\text{height (m)}]^2)$. Individuals with respiratory, cardiovascular, endocrine (thyroid diseases and diabetes mellitus), neuromuscular, and physical abnormalities were excluded from the study. The baseline values have been recorded from the booking visits (week eight). Following that, patients in group A were given vitamin D tablet (4000 IU), NOW, USA. daily for 22 weeks starting from 10 week of pregnancy. Supplement adherence was assessed by self-report. All women were committed to take the supplement (compliance rate was 100%); non-compliant women were excluded from the study.

Ethical approval of the study was obtained from the Professional Conduct Committee in the College of Medicine, University of Basrah.

Measurements of blood pressure

Blood pressure was measured in a semi-sitting position after 5 minutes rest using an aneroid sphygmomanometer with an appropriate cuff size for the arm at each visit. The aneroid sphygmomanometers used are validated and calibrated. Each participant has two readings. The first reading was at the booking visit (week eight) and the second reading was at the third trimester (week 30). Each reading was repeated three times to get the average, within two minutes span to run a precise measurement. The baseline blood pressure

thresholds for normotension are 90-119 for systolic and 60-79 for diastolic.

Serum 25-Hydroxyvitamin D

The electrochemiluminescence technique was adopted to estimate serum levels of vitamin-D [25(OH)D3] using a Cobas E411 analyzer (India), which is an essential marker used to evaluate vitamin-D3 status. This method has 90-95% sensitivity and 85-95% specificity. Vitamin-D deficiency was considered when serum vitamin-D3 was < 20 ng/ml, insufficient level was considered if the level >20ng/ml and < 30 ng/ml.

Statistical analysis

Data were summarized as mean $\pm$ standard deviation; SPSS version was used for analysis of the data, the difference in the groups was assessed by Student's t-test, a significant difference was considered if the P value was equal to or less than 0.05. Analysis of Covariance (ANCOVA) was used to test for follow-up pressure between treated and non-treated groups after adjusting for baseline blood pressure, initial vitamin D levels, BMI, and age.

RESULTS

Table 1 shows that age, body weight, height and BMI were not significantly changed in vitamin-D supplement compared to non-supplement pregnant women [28.25 $\pm$ 8.1 versus 27.25 $\pm$ 8.0 year (p value=0.66), 59.38 $\pm$ 11.23 versus 58.67 $\pm$ 11.34 kg (p value =0.74), 161.78 $\pm$ 10.7 versus 160 $\pm$ 9.94 cm (p value = 0.46), 22.67 $\pm$ 3.58 versus 22.74 $\pm$ 3.19 (p value=0.915), respectively].

Table 2 shows that vitamin-D supplement (4000 IU/day) in pregnant women results in a significant increase in serum vitamin-D level from 16.62 $\pm$ 6.08 to 21.04 6.14ng/ml (p <0.001) and a significant reduction in systolic blood pressure from 128.65 $\pm$ 5.99 to 125.07 $\pm$ 5.39 mmHg (p<0.001). However, the reduction in diastolic pressure from 85.62 $\pm$ 3.74 to 84.57 $\pm$ 4.66 mmHg) was not significant (p value=0.161).

The results in Table 3 shows that vitamin D level, diastolic and systolic blood pressure were not significantly altered from first to third trimester of pregnancy in non-vitamin D supplement group [14.63 $\pm$ 5.32 versus

Table 1. Demographic characteristics of the participants of the groups

Parameter	Vitamin-D Supplement Group (n=65)	Non vitamin- D supplement group (n=50)	P value
Age (year)	28.25 $\pm$ 8.1	27.25 $\pm$ 8.0	0.660
Body weight (kg)	59.38 $\pm$ 11.23	58.67 $\pm$ 11.34	0.740
Height (cm)	161.78 $\pm$ 10.7	160 $\pm$ 9.94	0.460
BMI (kg/m ²)	22.67 $\pm$ 3.58	22.74 $\pm$ 3.19	0.915

Independent sample T test

Table 2. Effect of oral vitamin-D supplement (4000 IU/day) on serum vitamin D level and blood pressure (n=65)

Parameter	First trimester (before vitamin-D supplement) Mean $\pm$ SD	Third trimester (after Vitamin-D supplement) Mean $\pm$ SD	P value
Serum Vitamin D (ng/ml)	16.62 $\pm$ 6.08	21.04 $\pm$ 6.14	<0.001*
Diastolic blood pressure (mmHg)	85.62 $\pm$ 3.74	84.57 $\pm$ 4.66	0.161
Systolic blood pressure (mmHg)	128.65 $\pm$ 5.99	125.07 $\pm$ 5.39	<0.001*

*P value is a significant

15.19±5.7 (p=0.163), 84.49±0.09 versus 84.22 ±5.51 (0.786), 127.04±7.67 versus 128.31±7.07 (0.398)], respectively.

Table 4 shows that there is no significant change in vitamin-D level in vitamin supplement compared to non-supplement groups before supplementation (16.62±6.08 versus 14.63±5.32ng/ml, p value=0.071). It was significantly more in vitamin-D supplement group after supplementation (21.04±6.14 versus 15.19±5.7ng/ml, p >0.001). Although the systolic blood pressure was not significantly different between Vitamin-D supplement and non-supplement

groups before supplementation (128.65±5.99 versus 127.04±7.67mmHg, p value=0.212), it is significantly lower in vitamin-D supplement group after supplementation (125.07±5.39 from 128.31±7.07mmHg, p value 0.006). The diastolic blood pressure was not significantly changed in vitamin-D supplement compared to non-supplement groups before and after the supplementation [85.62±3.74 versus 84.49±0.09mmHg (p value 0.177), 84.57±4.66 versus 84.22 ±5.51mmHg (p value=0.212), respectively].

Table 5 shows improvement in vitamin D status after vitamin D supplementation. Vitamin

Table 3. Vitamin-D level and blood pressure during pregnancy in non vitamin-D supplement group (n=50)

Parameter	First trimester Mean ± SD	Third trimester Mean ± SD	P value
Serum Vitamin-D (ng/ml)	14.63±5.32	15.19±5.7	0.163
Diastolic blood pressure (mmHg)	84.49±0.09	84.22 ±5.51	0.786
Systolic blood pressure (mmHg)	127.04±7.67	128.31±7.07	0.398

Paired sample T test

Table 4. Comparison of vitamin D level, systolic and diastolic blood pressure between vitamin D supplement and non-supplement pregnant women

Parameter	Vitamin-D Supplement Group (n=65) Mean ± SD	Non vitamin-D supplement group (n=50) Mean ± SD	P value
Baseline Vitamin-D level (ng/ml)	16.62±6.08	14.63±5.32	0.071
Follow up Vitamin-D level (ng/ml)	21.04±6.14	15.19±5.7	<0.001*
Baseline Diastolic blood pressure (mmHg)	85.62±3.74	84.49±0.09	0.177
Follow up diastolic blood pressure (mmHg)	84.57±4.66	84.22 ±5.51	0.692
Baseline Systolic blood pressure (mmHg)	128.65±5.99	127.04±7.67	0.212
Follow up systolic blood pressure (mmHg)	125.07±5.39	128.31±7.07	0.006*

Independent sample T test

*P value is a significant

Table 5. Baseline and followup level of vitamin D in pregnant women recieved vitamin D supplement (4000 IU/day), n=65

Vitamin D level	Baseline vitamin D level	Followup vitamin D level	P value
Defeicient (<20ng/ml)	42 (64.6%)	26 (40%)	p<0.001
Insuffeicient (>20ng/ml and < 30ng/ml)	22 (33.8%)	35 (53.8%)	p<0.001
Sufficient (>30ng/ml)	1 (1.5%)	4 (6.2%)	p<0.001

Exact Fisher test

D deficient women decreased from 42 (64.6%) to 26 (40%). Whereas, the insufficient and sufficient vitamin D women increased from 22 (33.8%) to 35 (53.8%) and from 1 (1.5%) To 4 (6.2%), respectively.

As illustrated by table 6 ,ANCOVA was performed to compare follow-up systolic blood pressure between the vitamin D supplementation and control groups after adjusting for baseline systolic blood pressure, age, BMI, and baseline vitamin D level. The treatment group had a significant effect in follow-up systolic blood pressure ($F = 18.663$, $P < 0.001$). Baseline systolic blood pressure was also a significant predictor of follow-up systolic blood pressure ($F = 70.286$, $P < 0.001$). Age, BMI, and baseline vitamin D level were not significantly associated with follow-up systolic blood pressure (all $P > 0.05$). Table 7 shows that ANCOVA was performed to compare follow-up diastolic blood pressure between the vitamin D supplementation and control groups after adjusting for baseline diastolic blood pressure, age, BMI, and baseline vitamin D level. Baseline systolic blood pressure was a significant predictor of follow-up diastolic blood pressure ($F = 41.086$, $P < 0.001$). However, there was no significant effect of vitamin D supplementation on follow-up diastolic blood pressure after adjustment ($F=0.435$, $P= 0.511$). Age, BMI, and baseline vitamin D level were also not significantly associated with follow-up systolic blood pressure (all $P > 0.05$).

DISCUSSION

We found that serum vitamin-D level is significantly lower in pregnant women at booking time compared to its level 22 weeks after vitamin supplementation. It has been found that vitamin D deficiency is common in some conditions of pregnancy, such as preeclampsia¹⁵, and vitamin D demands are greater in pregnancy. There are several reasons behind vitamin-D deficiency, for example, the limitation in exposure to UVB, a decrease in dietary intake of vitamin D, such as in vegetarians and low intake of fish and eggs, or other conditions related to vitamin D metabolism, such as obesity or malabsorption.¹⁶

We found that supplementation of vitamin-D for 22 weeks of pregnancy could improve serum levels of vitamin D. An increase

in vitamin-D activates metabolites, enhancing the absorption of fetal requirements of calcium, and this may directly improve vitamin D metabolism in progeny.¹⁷Moreover, vitamin D deficiency is highly linked to fetal growth restriction. On the other hand, vitamin-D level in the non-supplemented group was not significantly different between the two periods of pregnancy.

Regarding the change in blood pressure in pregnant women (on vitamin-D supplementation), we found that the systolic blood pressure was significantly reduced. However, the reduction in diastolic blood pressure was not significant. On the other hand, we didn't find a significant change in blood pressure between the two readings in pregnant women who did not take vitamin-D (Table 3).

Although systolic blood pressure was not significantly changed in vitamin-D supplement (before supplementation) and non-supplement groups, it was significantly lower in vitamin-D supplement group after supplementation. The association between vitamin-D and blood pressure in general has been considered in several previous research studies and meta-analyses. To reveal the impact of vitamin-D deficiency on blood pressure, many studies were included in a meta-analysis study by Beveridge.¹⁸ The results revealed that vitamin-D did not affect both diastolic and systolic blood pressure in individuals with vitamin-D deficiency. Furthermore, this finding was supported by another meta-analysis study by Golzarand,¹⁹ which stated that there was no significant effect of vitamin-D supplements on systolic and diastolic blood pressure. However, our findings were different from the results of these two meta-analysis studies. Vitamin-D supplementation could create a significant decline in systolic blood pressure in pregnant women after 22 weeks of supplementation. The other group that did not take vitamin-D didn't show such a difference.

On the other hand, the findings of the current study were consistent with prior studies that reported the blood pressure levels remained normal after supplementation of vitamin-D. The differences between the groups of the study in systolic and diastolic blood pressure were statistically significant.²⁰Moreover, Wei Zhen's et al²¹ mentioned in their meta-analysis the effect of vitamin-D supplementation in reducing

both systolic and diastolic blood pressure in hypertensive patients but not in normotensive subjects. Therefore, it was stated that vitamin-D has a hypotensive consequence on hypertensive individuals, but it is useless on normotensive individuals. This result is a point of contention with the result of the current study because all the participants were normotensive; however, they showed a significant decline in systolic pressure in the group who received vitamin-D. Despite that, increased weight is positively associated with blood pressure, as reported by a cohort study in China.⁸ Moreover, a positive correlation was found in individuals with BMI > 24 and blood pressure.²² Obesity related vitamin-D deficiency may be attributed to reduced physical activities and exercise with less exposure to ultraviolet radiation. Changing the lifestyle in those patients may reduce the risk of hypertension by improving UV induced vitamin-D synthesis in the skin.

In the present study, the pregnant women in the supplement group were given a daily dose of 4000 IU throughout pregnancy. The blood pressure measurement relied on for comparison was 22 weeks after administration of vitamin-D, and this dose made a significant decline in the systolic blood pressure. It was reported in the meta analysis by Golzarand ¹⁹ that vitamin-D supplementation for a period less than six months with a daily dose greater than 800 IU/d appeared to play an effective role in decreasing blood pressure. Several research attempts have endeavored to elucidate the plausible processes by which a vitamin-D deficiency could produce hypertension. These are three hypotheses that may summarize the processes. The renin-angiotensin-aldosterone system is triggered, as concluded in an animal experiment.²³ The other is that hyperparathyroidism is caused by a vitamin-D deficiency. There is a negative correlation between the levels of parathyroid hormone (PTH) and serum 25-OHD, and hypertension is caused by excessive PTH levels. The last hypothesis states that vitamin-D deficiency may result in endothelial dysfunction and reduced secretion of NO, a vasodilator, from vascular endothelium, explaining the correlation between vitamin-D deficiency and development of hypertension.²² ²³Vitamin-D deficiency in pregnancy may be a cause of several maternal complications and growth restriction of the fetus. It is still uncertain whether

the deficiency in vitamin-D during pregnancy is linked to hypertension and preeclampsia. On the other hand, it has been reported 1 α hydroxylase, an enzyme that activates vitamin-D, has aberrant expression in preeclamptic patients, suggesting a latent function as a regulator of 1,25(OH)₂D₃ placental function. 1,25(OH)₂D₃ suppresses cell proliferation, reduces cytokine expression, and production of α -interferon and interleukin-2 that may lead to preeclampsia.²⁴ Vitamin-D may be functioning in the regulation of blood pressure besides its role in calcium homeostasis and regulating pregnancy-induced hypertension.²⁵ It was concluded by a case-control study that 25(OH) D level was decreased in the preeclampsia group when compared to the control group suggesting that the increase in preeclampsia among pregnant women may be attributed to vitamin-D deficiency.

^{26,27}

A meta-analysis study has revealed an association between vitamin-D deficiency and several pregnancy consequences, including preeclampsia, diabetes mellitus, and small-for-gestational age. Additionally, a randomized controlled trials have pointed to that supplementation of vitamin-D throughout pregnancy improves both maternal and neonatal status of vitamin-D.²⁸ Parity, prior hypertensive disorders, calcium supplementation, and seasonality, which were not reported, may be considered as limitations in the study, but presence of another group to compare may reduce the potential.

Regarding table 6,7 the findings suggest that vitamin D supplementation was associated with a significant reduction in systolic blood pressure but not diastolic blood pressure after controlling for baseline blood pressure, age, BMI, and baseline vitamin D level. Baseline blood pressure remained a significant predictor of follow-up blood pressure, indicating that individuals with higher baseline values tended to have higher follow-up values irrespective of treatment. These results suggest that the beneficial effect of vitamin D supplementation may be more pronounced for systolic than for diastolic blood pressure.

CONCLUSION

There is an association between vitamin-D supplementation and blood pressure during

pregnancy. This association is represented by a reduction in the systolic blood pressure of healthy pregnant women in a single-center cohort. However, for more confirmation of the present findings, we recommend conducting a research series to establish the function of vitamin-D in maintaining blood pressure throughout pregnancy.

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This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials.

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Not Applicable.

Author Contributions

Azza Sajid Jabbar: Supervision, Conceptualization, Methodology, Writing - Review & Editing; Haithem Jawad Khadhim: Writing - Original Draft, Software, Formal analysis; Rasha Naseer Mohammed: Investigation; Hind Sajid Alkinani: Data Curation and Visualization.

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