The Egyptian Journal of Hospital Medicine (January 2023) Vol. 90, Page 894-900

Serum Vitamin D Deficiency in Idiopathic Preterm Labor: Case Control Study

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ABSTRACT

Background: Preterm labor (PTL) is the most common cause of neonatal death worldwide. In Egypt, the average rate of preterm labor is estimated to be 14.7%. **Objective:** This study aimed to evaluate the relation between maternal vitamin D deficiency and idiopathic preterm birth.

Patients and Methods: This case-control study was conducted on 160 pregnant women; 80 women with PTL as cases and another 80 women with term birth as controls, who were admitted to the Obstetrics and Gynecology Department in Ain Shams University Maternity Hospital.

Results: Using ROC curve, serum 25(OH) D level ≤ 32 ng/ml was significantly associated with PTL (p = 0.001), with moderate sensitivity of 80% and low specificity of 47.5%.

Conclusion: Preterm delivery was significantly associated with vitamin D ≤ 32.0 ng/ml. Although serum 25(OH) D deficiency is a significant risk factor, but it cannot be considered a diagnostic tool in predicting PTL.

Keywords: Preterm labor, Vitamin D deficiency, Pregnant women.

INTRODUCTION

Every year, 15 millions of infants are born preterm, worldwide [(1)]. Unknown factors that increase the chance of spontaneous preterm labour include low socioeconomic status, little education, genitourinary infections, numerous pregnancies, cervical incompetence, intense manual labour, prior abortion, and prior preterm labour [(2)].

Some studies stated that intra-amniotic microbial infections or inflammation and premature cervical changes are the most important causes of preterm labor. The mechanism of preterm labor may be due to complement activation caused by micro-organisms invasion [(3)].

Due to changes in the vagina's microbial habitat during pregnancy, ascending vaginal or cervical infections are believed to be the primary cause of the majority of intra-amniotic infections [(4)].

Maintaining appropriate blood levels of calcium and phosphate, which are necessary for bone mineralization, muscle contraction, nervous system activity, and cellular function, is facilitated by vitamin D [(5)]. Additionally, vitamin D has potent immuno-modulating characteristics that may support the development of a healthy maternal immune response to the placenta. Studies examined its function in ensuring normal placenta implantation by controlling particular target genes [(6, 7)]. Vitamin D is also found to have a role in production of sex steroids during pregnancy [(8)].

Vitamin D is well recognized for its antioxidant activity, immune-modulatory, anti-fibrotic and anti-inflammatory effects, as it regulates the production and function of cytokines, neutrophil degranulation products and antimicrobial peptides such as cathelicidin, preventing microbial invasion, reducing the risk of infection [(9)]. It works by lowering the production of inflammatory cytokines that contribute to spontaneous preterm delivery, such as tumour necrosis factor-alpha (TNF- α) and Interleukin-1, 6 (IL-1, 6) [(10)]. Additionally, several research revealed that pregnant women with vitamin D deficiency produced more inflammatory cytokines like TNF- α [(11)]. In order to preserve myometrial quiescence, vitamin D may also lower the chance of premature delivery [(10)].

Preeclampsia, gestational diabetes, preterm delivery, intrauterine growth restriction, spontaneous abortion, caesarean section, maternal depressive symptoms, and low birth weight babies are just a few of the harmful outcomes for mothers and their unborn children that have been linked to vitamin D deficiency in numerous studies [(12)]. However, other research has not discovered a connection between low vitamin D level and preterm labour or premature membrane rupture [(13)].

PATIENTS AND METHODS

This case-control study was conducted on 160 pregnant women who were admitted to the Obstetrics and Gynecology Department in Ain Shams University Maternity Hospital during the period from December 2019 to January 2021, allocated into 2 groups:

- **Cases:** 80 pregnant women who delivered their babies between 28 weeks and 37 weeks of gestation (preterm labor).
- **Control:** 80 pregnant women who delivered their babies at term, with no obstetric complications.

Inclusion criteria: Primigravida women aged between 20 and 35 years old with BMI between 5th percentile and 95th percentile for age.

Exclusion criteria: Multigravida. Rupture of membranes. Maternal vaginal bleeding in 1st or 2nd

Received: 25/07/2022
Accepted: 27/09/2022

trimester. Threatened preterm labor. History of cervical cerculage, cauterization, conization, or cervical incompetence as patients having history of 2nd trimester miscarriages. History of previous miscarriage. Moderate anemia of pregnancy (Hb levels 7 to 8.9 g/dL) to severe anemia of pregnancy (Hb levels less than 7g/dL). BMI below 5th percentile or above 95th percentile for age. Twin pregnancy. The use of tocolytic drugs during pregnancy, as calcium channel blockers, oxytocin receptor antagonists, non-steroidal anti-inflammatory drugs (NSAIDs), magnesium sulphate and beta adrenergic receptor agonists. Maternal chronic diseases as cardiovascular diseases, D.M. and hypertension (HTN). Fetal anomalies or distress. Pregnant mothers who were taking vitamin D supplements. Suspected maternal urinary infections, indicated by fever, cloudy urine, dysuria, frequent urination, urgency, stomach, or suprapubic discomfort. Suspected genital infections in mothers, fever without a known cause, and any of the following:

a) Gram stain or vaginal swab culture revealing microbial infection.
b) Clear or yellowish thick discharge verified clearly on speculum exam to be originating from the cervical os. Definite purulent fluid from the cervical canal.
c) Maternal WBC > 15,000/mm^3 without the use of corticosteroids.
d) Baseline foetal tachycardia (more than 160 beats per minute for at least 10 minutes, excluding accelerations, decelerations, and times of notable variability) [(14)].

Study procedure: Each pregnant woman was subjected to:

1. Complete history taking:

a) Personal history: to obtain maternal data; age, pre-pregnancy weight and height.

b) Present history: including medications, urinary tract infections and current obstetric problems.

c) Menstrual history: as gestational age and expected date of delivery.

d) Past medical history: chronic medications, and previous pelvic operations as in cervical cerculage.

e) Family history: as diabetes, hypertension and family history of preterm labor.

2. Examination:

a. General examination: to assess vital signs and maternal BMI:

- Temperature was measured using a digital infrared forehead thermometer (Model: Fl06, Ningbo Shangcun Electronic Co., Ltd. Zhejiang, China).
- Blood pressure was measured by digital Sphygmomanometer.
- By counting the cardiac and breathing rates throughout a minute, the heart and respiratory rates were manually measured.
- Following the history taking and examination, vital sign measures were taken while the patient was resting in a sitting posture.
- Self-recorded pre-pregnancy weights were obtained from patients confirmed by their medical records.
- Maternal height in cm was measured in the study during routine prenatal care.
- BMI was calculated and women with BMI from 5th percentile to 95th percentiles were recruited in the study.

b. Abdominal examination: to assess gestational age and tender abdomen.

c. Imaging by ultrasound: to assess gestational age, expected date of delivery (EDD), fetal viability, heart rate (HR) and congenital anomalies.

d. Examination to diagnose active labor: as regular painful uterine contractions, cervical effacement of at least 80%, cervical dilatation > 2 cm and short cervix by ultrasound (< 30 mm) **(Hanley *et al.*, 2016** and **Suman and Luther, 2019)**.

e. Exclusion of maternal genital infections.

3. Investigations:

Quantitative measurement of 25(OH) vitamin D in serum by using enzyme-linked immunosorbent assay (ELISA); Shanghai Shanghong (SRB) Biotechnology Co., Ltd, China, Product No. 201-12-1982, for the quantitative determination of 25(OH) vitamin D (vitamin D2 and vitamin D3) in all patients' sera. This assay utilized a monoclonal antibody (double antibody sandwich principle) that binds to both 25- OH Vitamin D2 and 25-OH Vitamin D3 equally.

Ethical consent: This study was approved by Ain Shams University Ethical Committee. Informed written consents were obtained from all included women after explanation. This study was conducted in accordance with the local ethical committee regulation and according to the Declaration of Helsinki.

Statistical analysis:

The collected data were coded, tabulated, and statistically analysed using the Statistical Package for Social Sciences (IBM Corp., Chicago, USA, 2013). Quantitative normally distributed data were expressed as mean ± SD (standard deviation) after being tested for normality using the Shapiro-Wilk test, and if normal, is then compared using an independent t-test. When comparing qualitative data with small expected numbers (at least one cell with expected zero frequency or more than 20% of cells with expected less than five frequency), Chi square test and Fisher's Exact test were used. To identify the variables influencing preterm delivery, logistic regression was utilised. The effectiveness of 25(OH) D in discriminating preterm birth was assessed using a ROC curve. P values ≤ 0.050 were considered to be significant.

RESULTS

There was no statistically significant difference between preterm group and full-term group regarding age of mothers, BMI or BMI grades **(Table 1)**.

Table (1): Comparison between preterm and full-term groups regarding maternal demographic data (age, BMI and BMI grades)

Variables		**Preterm (N=80)**	**Full term (N=80)**	**p-value**
Age (years)	**Mean ± SD**	25± 4.15	25.14±3.52	^0.821
	Range (Min-Max)	20.0–35.0	20.0–32.0	
BMI (kg/m^2)	**Mean± SD**	28.2±2.99	27.3±3.8	^0.066
	Range (Min-Max)	22.3–34.3	18.6–37.5	
BMI grades	**Lean**	14 (17.5%)	22 (27.5%)	#0.243
	Overweight	39 (48.8%)	38 (47.5%)	
	Obese	27 (33.8%)	20 (25%)	

Independent t-test. #Chi square test.

Table (2) showed that there was no statistically significant difference between preterm and full-term groups regarding maternal vital signs on admission.

Table (2): Comparison between preterm and full-term groups regarding maternal vital signs on admission

Variables		**Preterm (N=80)**	**Full term (N=80)**	**^p-value**
Heart rate (beat/minute)	**Mean± SD**	71.5±5.0	71.2±5.3	0.704
	Range	62.0–85.0	63.0–90.0	
Respiratory rate (cycle/minute)	**Mean± SD**	15.9±2.1	16.3±2.1	0.274
	Range	11.0–19.0	11.0–20.0	
Temperature (°C)	**Mean± SD**	36.9±0.2	36.9±0.1	0.548
	Range	36.5–37.2	36.5–37.2	
systolic blood pressure; SBP (mmHg)	**Mean± SD**	120.9±9.4	121.6±9.2	0.640
	Range	100.0–140.0	95.0–140.0	
diastolic blood pressure; DBP (mmHg)	**Mean± SD**	73.7±8.6	73.1±7.4	0.657
	Range	60.0–90.0	60.0–85.0	

^Independent t-test

Table (3) showed that delivery by cesarean section was significantly more frequent in preterm group (53.8%).

Table (3): Comparison between preterm and full-term groups regarding mode of delivery

Mode of delivery	**Preterm (N=80)**	**Full term (N=80)**	**p-value**
Vaginal	37 (46.3%)	55 (68.8%)	**#0.004***
Cesarean section	43 (53.8%)	25 (31.3%)	

#Chi square test. *Significant

Table (4) showed that serum 25 (OH) vitamin D was significantly lower in preterm group with mean of 28.7 ± 8.4 ng/ml compared to 33.3 ± 9.6 ng/ml in full-term group. Also, it showed that serum 25 (OH) vitamin D insufficiency and deficiency were significantly more frequent in preterm group (50% and 6.3% respectively).

Table (4): Comparison between preterm and full-term groups regarding serum 25 (OH) vitamin D

Variables		**Preterm (N=80)**	**Full term (N=80)**	**p-value**
25(OH) D (ng/mL)	**Mean ± SD**	28.7±7.1	33.3±8.2	**^0.001***
25(OH) D grades	**Sufficiency**	35 (43.8%)	53 (66.3%)	**§0.008***
	Insufficiency	40 (50.0%)	26 (32.5%)	
	Deficiency	5 (6.3%)	1 (1.3%)	

^Independent t-test. **§**Fisher's Exact test. *****Significant.

Table (5) showed that the best cut off point between cases and controls regarding vitamin D level was found ≤ 32 ng/ml.

Table (5): Serum vitamin D cut off point in predicting preterm delivery

Factors	**AUC**	**SE**	**p-value**	**95% CI**	**Cut off (ng/ml)**
25(OH)D	0.649	0.044	**0.001***	0.563−0.734	≤ 32.0

AUC: Area under curve, SE: Standard error, CI: Confidence interval, *significant.

Table (6) showed that serum 25(OH) D ≤ 32.0 ng/mL had moderate sensitivity and low other diagnostic performance in predicting preterm delivery.

Table (6): Diagnostic characteristics of serum 25(OH) D ≤ 32.0 ng/mL in predicting preterm delivery

Characters	Value	95% CI
Sensitivity	80.0%	69.6%–88.1%
Specificity	47.5%	36.2%–59.0%
Diagnostic accuracy (DA)	63.8%	55.8%–71.2%
Youden's index	27.5%	13.5%–41.5%
Positive Predictive value (PPV)	60.4%	50.4%–69.7%
Negative Predictive value (NPV)	70.4%	56.4%–82.0%
Positive likelihood ratio (LR+)	1.52	1.20–1.93
Negative likelihood ratio (LR-)	0.42	0.26–0.69
Diagostic odd ratio (OR)	3.62	1.79–7.30
Kappa	0.275	0.134–0.416

CI: Confidence interval

Table (7) showed that there was no statistically significant relationship between vitamin D status in preterm and full-term groups and maternal age.

Table (7): Comparison between 25(OH) D statuses regarding maternal age and BMI mean ± SD

Variables	Sufficiency	Insufficiency/ Deficiency	p-value
Preterm	**N=35**	**N=45**	
Age (years)	26.5±1.9	26.9±1.8	^0.442
Full term	**N=53**	**N=27**	
Age (years)	26.7±2.4	26.4±1.7	^0.502

^Independent t-test. #Chi square test. *Significant

Table (8) showed that no significant differences were found between 25(OH) D statuses regarding mode of delivery.

Table 8): Comparison between 25(OH) D statuses regarding mode of delivery

Variables		Sufficiency	Insufficiency/ Deficiency	p-value
Preterm		**N=35**	**N=45**	
Mode of delivery	**Vaginal**	20 (57.1%)	17 (37.8%)	#0.085
	Cesarean	15 (42.9%)	28 (62.2%)	
Full term		**N=53**	**N=27**	
Mode of delivery	**Vaginal**	35 (66.0%)	20 (74.1%)	#0.463
	Cesarean	18 (34.0%)	7 (25.9%)	

#Chi square test. *Significant.

Table (9) showed that no significant differences were found between 25(OH)D statuses regarding maternal vital data on admission

Table (9): Comparison between 25(OH) D statuses regarding maternal vital data on admission

Variables	Sufficiency	Insufficiency/ Deficiency	p-value
Preterm	**N=35**	**N=45**	
Heart rate (beat/minute)	70.9±5.7	71.9±4.5	^0.387
Respiratory rate (cycle/minute)	15.7±2.1	16.1±2.1	^0.460
Temperature (C°)	36.9±0.2	36.9±0.2	^0.318
SBP (mmHg)	120.4±10.6	121.2±8.4	^0.710
DBP (mmHg)	74.6±9.1	73.0±8.2	^0.421
Full term	**N=53**	**N=27**	
Heart rate (beat/minute)	70.8±4.7	72.0±6.4	^0.356
Respiratory rate (cycle/minute)	16.1±2.1	16.6±2.1	^0.393
Temperature (C°)	36.9±0.1	36.9±0.1	^0.568
SBP (mmHg)	120.3±9.2	124.1±8.9	^0.081
DBP (mmHg)	72.6±7.6	74.1±6.8	^0.413

^Independent t-test

DISCUSSION

Regarding age of mothers, the mean age in preterm and term groups among subjects of this study was 25 ± 4.149 years old and 25.14 ± 3.521 years old, respectively, with no statistically significant difference (p = 0.821). This is in accordance with the Egyptian prospective observational case-control study of **Ibrahim *et al.*** [15] that was conducted on 80 women with singleton pregnancy, 40 women with PTL and 40 women with full term labor. They found no significant difference between women with term birth and women with preterm birth as regards age of the mother, with mean age of the mother in preterm group 28.32 ± 5.48 years old, versus mean age of 28.47 ± 5.56 years old in term group (p = 0.904). This is in agreement with the polish case control study of **Baczyńska-Strzecha and Kalinka** [16] that was carried out from 2013 to 2015 at the Department of Perinatology. They recruited 100 women with spontaneous PTL and 101 women with full term labor and reported that the mean age of the mother in preterm group was 31.0 ± 5.0, versus 29.9 ± 4.5 years in term group, with no significant difference (p = 0.114). As well, **Tahoun *et al.*** [17] in an Egyptian case-control study, included 90 subjects of pregnant females at labor (45 preterm cases and 45 controls at term), with ages ranged from 14 to 40 years old, admitted to Al-Hussein and Bab-Elshareyia University Hospitals, found that the mean maternal age was 26.88 ± 5.78 among women with preterm labor compared to 27.56 ± 5.11 years among women at term, with no statistically significant difference (p = 0.568).

In the current study, self-reported pre-pregnancy weights were obtained from subjects in the preterm and term groups, to estimate pre-pregnancy BMI of mothers. According to **Holland *et al.*** [18] who reported that pre-pregnancy weight is typically not accessible in the prenatal care environment due to lack of preparation. However, self-reported pre-pregnancy weight and measured weight at the first prenatal visit led to similar classification of pre-pregnancy BMI.

In this study, pre-pregnancy BMI was not significantly correlated to preterm group (28.2 ± 2.99) or full-term group (27.3±3.8), (p = 0.066). In accordance, **Ibrahim *et al.*** [15] study revealed that there was no significant difference between the two groups' mean BMIs (p = 0.588), with the preterm group's mean BMI being 28.94 ± 4.00 and the full-term group's mean BMI being 28.48 ± 3.55. In contrast, **Jacob *et al.*** [19] found a strong correlation between preterm labour and maternal BMI where overweight and obese pregnant women had a greater incidence of PTL (p = 0.029) in a retrospective observational Indian research that included 399 singleton births. Additionally, **Bhavadharini *et al.*** [20] demonstrated a significant correlation between preterm labour and obesity (p = 0.01) in another retrospective observational Indian study that included 2728 pregnant women visiting private maternity homes and antenatal clinics in Chennai, South India, between January 2011 and January 2014. These discrepancies of the results of the current study may be explained by the fact that our subjects did not include any women whose BMI fell under the 5th or above 95th percentiles [19].

In the current study, Cesarean delivery was significantly more frequent in preterm group, with a percentage of 53.8% versus 31.3% in the term group (p = 0.004). This is in agreement with **Baczyńska-Strzecha and Kalinka** [16] who revealed that Cesarean section deliveries were more (50%) among women in preterm group versus 22.8% among women in term group in statistically significant manner (p < 0.001). This can be explained by the higher risk of abnormal fetal presentation and reduced pelvic muscle strength in preterm group, compared to the term group [20].

Serum 25 (OH) vitamin D levels were found to be considerably lower in the preterm group than the full-term group, with a mean of 28.7 ± 8.4 ng/ml compared to 33.3 ± 9.6 ng/ml (p = 0.001). Additionally, the prevalence of serum vitamin D deficiency and insufficiency in the preterm group was considerably higher, at 50% and 6.3%, respectively (p = 0.008). This is in line with a meta-analysis by **Zhou *et al.*** [21] that included 18 observational studies and 6 RCTs and discovered that low vitamin D levels (20 ng/ml) and high levels (20–30 ng/ml) were statistically significant predictors of preterm labour. They also highlighted that pregnant women who take vitamin D supplements orally may have fewer preterm births (pooled RR, 0.57; 95%CI: 0.36-0.91). Also, this is in agreement with **Bodnar *et al.*** [22], in a case-cohort American study that involved 2327 women in sub-cohort group versus 1126 women with PTL in cases group. They found that the risk of preterm birth less than 37 weeks of gestation was 1.8-folds (95% CI, OR = 1.3 - 2.6) and 1.4 folds (OR = 1.1, 1.8) higher among mothers with serum vitamin D < 50 nmol/L (< 20 ng/ml), and 50–74.9 nmol/L (20 – 30 ng/ml) compared to ≥ 75 nmol/L (≥ 30 ng/ml), after adjustment of confounders like pre-pregnancy body mass index, race and educational level. Additionally, moms with blood vitamin D levels below 50 nmol/L (less than 20 ng/ml) had an adjusted risk of spontaneous preterm delivery less than 37 weeks and preterm birth less than 34 weeks that was 1.8 to 2.1 times higher than mothers with levels above 75 nmol/L (more than 30 ng/ml). In contrast to the results of the current investigation, **Rodriguez *et al.*** [23] prospective cohort analysis on 2358 pregnant women in Spain found no link between vitamin D level during pregnancy and preterm birth after controlling for covariates (P > 0.4). Also, a retrospective cohort study, that was conducted in USA, in 2014, by **Flood-Nichols *et al.*** [24] where they recruited 2279 deliveries from Madigan Army Medical Center, they found no association between low maternal serum vitamin D and preterm delivery and spontaneous abortion, (p = 0.738), odds ratio: 1.01, 95% CI (0.947–1.164). A possible explanation is that the previous two studies used plasma collected from

pregnant mothers in the first trimester to estimate vitamin D level.

Using ROC curve, it was revealed that the cut-off point between cases and controls among the recruited subjects concerning serum vitamin D level was ≤ 32 ng/ml (p = 0.001), with moderate sensitivity (80%) and low other diagnostic characteristics in predicting preterm delivery where specificity was 47.5%, positive predictive value (PPV) was 60.4% and negative predictive value (NPV) was 70.4%. This is in line with a meta-analysis carried out by **Qin *et al.* [25],** which comprised 11 observational studies, 11 of which were done in the United States of America, 6 of which were in Spain, 2 of which were in Australia, 1 in China, and 1 of which was in Canada. With an OR of 1.29 and a 95% confidence interval. They came to the conclusion that there was a link between vitamin D insufficiency (20 ng/ml) and the likelihood of premature delivery (1.16, 1.45). Additionally, **Andersen *et al.* [26]** found that among 2874 study participants, there was a strong correlation between low maternal serum vitamin D levels and risk of first-trimester abortion (as the primary outcome), with the risk of first-trimester abortion being approximately >2-fold, odds ratio = 2.50; 95% confidence interval (1.10-5.69). In addition, **Wagner *et al.* [27],** in a post-hoc analysis, reported that the cut-off point for serum vitamin D level was 20 ng/ml using the datasets of 333 women from the National Institute of Child Health and Human Development (NICHD) and the dataset of 145 women from Thrasher Research Fund (TRF) randomised-controlled studies. They also pointed out that, after adjusting for race and ethnicity, pregnant women with low serum vitamin D concentrations in the third trimester (20 ng/mL) had 3.81 times the odds of giving birth prematurely compared to those with serum concentrations over 40 ng/ml, as opposed to 2 times the odds in the second trimester. Additionally, they found that a blood vitamin D level of 40 ng/mL was linked to a 47% reduction in premature deliveries [27].

There was no statistically significant correlation between vitamin D status (sufficiency, insufficiency, and deficiency) and maternal age at birth when vitamin D levels were compared to other measures. Similar findings were made by **Baczyska-Strzecha and Kalinka [20],** who discovered no connection between maternal age and a vitamin D level below 10 ng/ml (p = 0.414). In contrast to this study, **Rodriguez *et al.* [23]** discovered that there was a significant connection between vitamin D levels and maternal age (p = 0.001) in a prospective cohort study that was carried out in Spain. On the other hand, a cross-sectional Saudi Arabian study by **Al-Shaikh *et al.* [28]** on 1000 women admitted to the labour ward at King Khaled University Hospital (KKUH) in Riyadh discovered that approximately half of the women with vitamin D deficiency or insufficiency belonged to the age range of 25 to 35, with a significant difference (p = 0.01). However, in contrast to this study, the two earlier investigations included moms of all ages without age constraints.

Also, it was reported in the current study that there was no statistical difference between women who suffered from vitamin D deficiency or insufficiency and women who were vitamin D sufficient as regards mode of delivery. This is in agreement with **Rodriguez *et al.* [23]** who found no association between maternal serum level of vitamin D and mode of delivery (P = 0.695). **Al-Shaikh *et al.* [28]** reported similar findings, stating that there was no significant correlation between vitamin D status and the manner of delivery, including spontaneous delivery, assisted delivery, or Caesarian section (p = 0.71).

Finally, there was no statistically significant difference between vitamin D serum levels and maternal vital signs (temperature, blood pressure, heart rate and respiratory rate) at time of delivery between cases and control groups in the present study. This is in agreement with **Al-Shaikh *et al.* [28]** who found no significant relation between vitamin D status and hypertension either pre-existing or gestational hypertension (p = 0.44 and 0.79, respectively)**.** Similar findings were found in Turkish literature by **Ates *et al.* [29]** who conducted a cross-sectional study with 229 pregnant women who visited the Obstetrics and Gynecology Outpatient Clinic at Bezmialem Vakif University in Istanbul, Turkey. They found no statistically significant relationship between mean systolic or mean diastolic blood pressure and severe vitamin D deficiency; 10 ng/ml (p = 0.84 and 0.59).

CONCLUSION

Preterm delivery was significantly associated with vitamin D deficiency, with cut-point of ≤ 32.0 ng/ml. Serum 25(OH) D deficiency had moderate sensitivity and low other diagnostic characteristics in predicting preterm delivery.

Financial support and sponsorship: Nil.
Conflict of interest: Nil.

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