ORIGINAL ARTICLE

Assessment of Vitamin D Deficiency, Consequences, and Treatment among Pregnant Women in Saudi Arabia: A Retrospective Cohort Study

Tahani Al-Rahbeni, Sarah Al-Qahtani, Omar Al-Sharji, Nasser Aldekhail, Ahmed H. Abdelazeem

Department of Pharmacy, College of Pharmacy, Nursing and Medical Sciences, Riyadh Elm University, Riyadh, Saudi Arabia

Abstract

Aims: Vitamin D deficiency (VDD) during pregnancy is associated with adverse maternal and fetal outcomes. This study aimed to investigate the prevalence of VDD, its complications, and supplementation practices among pregnant women in Riyadh, Saudi Arabia. **Materials and Methods:** A retrospective review of medical records from child-bearing women who attended prenatal clinics at King Khalid University Hospital in 2021 was conducted. Data from 478 pregnant women were analyzed using the Statistical Package for the Social Sciences version 21. Descriptive and inferential statistics were applied, with $P < 0.05$ considered statistically significant. **Results:** The mean age of participants was 31.09 ± 5.71 years, and mean plasma Vitamin D (VD) level was 34.26 ± 25.74 ng/mL. The prevalence of VD inadequacy was 55.4% (deficiency 27.5% and insufficiency 27.9%). Approximately 30% of women with VDD did not receive supplementation. Among supplemented women, most (n = 119, 67.2%) received cholecalciferol 50,000 IU weekly for 4 weeks. Predictors of VD plasma concentration included maternal age (β = 1.049, $P < 0.001$), body weight (β = 0.275, $P = 0.012$), post-discharge hemoglobin (β = 2.193, $P = 0.049$), and neonatal pulse rate (β = −0.366, $P = 0.021$). The number of babies (odds ratio [OR] = 0.092, $P = 0.003$) and number of live births (OR = 0.416, $P < 0.001$) significantly predicted VDD prevalence. Common maternal complications included previous cesarean section (21.3%), gestational diabetes mellitus (14.6%), and hypothyroidism (7.3%). **Conclusion:** VDD is highly prevalent among pregnant women in Riyadh, and supplementation practices often do not follow recommended guidelines. Educational campaigns targeting both pregnant women and healthcare providers are needed to improve awareness, prevent VDD-related complications, and promote safe, guideline-based VD supplementation during pregnancy.

Key words: Deficiency, maternal outcomes, pregnancy, supplementation, Vitamin D

INTRODUCTION

Vitamin D (VD) is considered a fat-soluble molecule that is crucial for optimum health. It has a couple of active metabolites, named calcidiol 25-hydroxyvitamin D (25[OH]D) and calcitriol (1,25$[OH]_2$D).[1] The advantageous effects of the vitamin come from its efficiency in maintaining bone density, dental health, and muscle function as well as the other characteristics such as anti-inflammatory, antibacterial, and anticancer properties. Studies confirmed the low levels of the vitamin expose individuals, both adults and pediatrics, to many disorders such as osteoporosis, rickets, osteomalacia, cancer, respiratory infections, cardiovascular pathogenesis, asthma, as well as autoimmune disorders:[2-4] Based on the generally accepted standard classification, the women were grouped as being VD deficient if they had plasma VD concentrations of <20 ng/mL. Conversely, the women were considered VD insufficient if

Address for correspondence:
Tahani Al-Rahbeni,
Department of Pharmacy, College of Pharmacy,
Nursing and Medical Sciences, Riyadh Elm University,
Riyadh - 11681, Saudi Arabia.
E-mail: ph.tahani@gmail.com

Received: 21-08-2025
Revised: 24-09-2025
Accepted: 30-09-2025

their plasma VD level was between 20 ng/mL and 30 ng/mL. However, pregnant women with plasma levels of the vitamin above 30 ng/mL were considered VD sufficient.[5] There are serious problems caused by VD deficiency (VDD) during pregnancy for both expecting women and their newborns. The findings of various studies stated that there is a significant positive correlation between VDD during pregnancy and the occurrence of preeclampsia, preterm birth (PTB), gestational diabetes, and low birth weight.[6-8]

VD supplementation during the pregnancy period has been advocated by experts, which involves using the vitamin for both prophylactic and treatment purposes. Evidence shows that this pharmacotherapy helps pregnant women and developing fetuses avoid the determinantal consequences resulting from the low levels of the compound.[9]

However, the safety of the vitamin during pregnancy is not well established, making the recommended doses of the vitamin during the pregnancy period a controversial issue. A randomized controlled trial supports the use of higher doses of cholecalciferol, as much as 60,000 IU monthly.[10] According to the study, 60,000 IU of monthly administration of cholecalciferol is as effective and safe as 2000 IU/day. In addition, lower doses up to 800 IU/day are often reserved for VD supplementation in asymptomatic people with little or moderately reduced VD levels.[11]

This is in in agreement with the recommendations of the American College of Gynecologists and Obstetricians (ACGO).[12] Pregnant women are susceptible to VD insufficiency globally. Low VD levels in pregnant women have been linked to complications including low birth weight, high blood pressure (BP), gestational diabetes, and early delivery. This shortage represents a significant concern to public health as it may have long-term effects on both the mother and the developing child. The research databases show that KSA has paid less attention to this issue. Hence, it is vital to collect data particular to this area to avoid poor pregnancy and delivery outcomes. The issue is of more concern since pregnant women in Saudi are subject to distinguished with nutritional, cultural, and environmental impacts compared with other parts of the world. Hence, this study is filling this gap in the literature with the aim of creating evidence that ensures the protection of the pregnant community in the kingdom and new generations. The status of the VD level as well as its consequences on pregnant women and developing fetuses in this area is crucial due to its unique demographic and environmental features. The environment, cultural norms, and dietary choices of Saudi Arabians may have a substantial impact on their VD levels.[13]

The purpose of the research was to provide information on the problem of VD inadequacy during pregnancy and its associated harmful outcomes on both pregnant women and fetuses in Riyadh, KSA. It also aimed to investigate the supplementation of the vitamins during this critical period. The specific objectives of the study were as follows: (1) to assess the prevalence of VDD among pregnant women and (2) to determine the consequences associated with low levels of VD among pregnant women on the expectant women and their fetuses, and to compare existing practices for the prevention and treatment of VD abnormality in pregnant women with evidence-based standard.

MATERIALS AND METHODS

Study design

This is a retrospective observational cohort study.

Source of data

Data were collected retrospectively from patients' electronic medical records.

Study setting

The study was conducted at King Khaled University Hospital, a tertiary care teaching hospital in Riyadh, Saudi Arabia, with a bed-capacity of 800–1,200 beds.

Inclusion and exclusion criteria

The study included pregnant women whose age ≥18 years and excluded those who have a medical condition and/or a drug that affects their VD metabolism and/or concentration.

Sample size

As a prevalence study, the sample size was calculated using the following formula

$$\text{Sample size (n)} = Z^2\, P\, (1\text{-}P)/d^2$$

So

$$\text{Sample size (n)} = 1.96^2 * 0.60\ (1–0.6)/0.05^2$$

(n) = 368

(n) = 526 (An additional 158 files (43% of the sample) were added to increase the study power and to compensate for any expected loss).

Data collection tool

The data collection sheet was prepared by referring to similar published studies and considering the study aim and objectives.

Ethical considerations

Two ethical approvals were granted to the study the ethical committees at REU (FPGRP/2023/782/1042/944) and King Saud University (23/0571/IRB).

Statistical analysis

The Statistical Package for the Social Sciences version 21 was used for data analysis. Descriptive statistics (frequency, percent, mean, and standard deviation) were used to summarize the study participants' demographic and clinical characteristics. Chi-square test was used to examine the association between categorical variables. In addition, Pearson correlation was used to determine the relationship involving linear and continuous variables. Furthermore, the variables that showed significant association after running Chi-square and Pearson correlation tests were subjected to multivariate logistic and linear regression tests, respectively, to determine the actual predictors or determinants of VD levels and prevalence of VDD among the study group. The probability values <0.05 were considered statistically significant.

A total of 478 medical records out of the 526 collected were included in the analysis. The study participants were women of childbearing age, with an average age of 31.09 ± 5.71. The mean plasma level of VD ([25(OH) D]) is 34.26 ± 25.74, with minimum and maximum values of 1.84 and 143.00 mg/mL [Table 1]. On average, about 459.16 ± 318.38 mL of blood was lost during childbirth among the women. The mean diastolic BP (68.49 ± 7.18) and systolic BP (114.88 ± 9.94) of the study participants were largely within acceptable standards for pregnant women. The mean hemoglobin level among the women was 10.46 ± 1.28 g/dL. The majority of the women (n = 299, 62.6%) have given birth multiple times, while approximately six of the participants have not given birth to a live baby.

Table 2 contains the general characteristics of the newborn babies during the study period. The results reveal that the APGAR score ranged from 3 to 10, with an average score of 7.81 ± 0.91. According to the categorized birth weight, most of the babies had normal birth weight (n = 413, 88.2%), while about 8.3% (n = 39) had low birth weight on delivery.

Figure 1 shows the details of the maternal blood group distribution in this study while the prevalence of VD abnormality is presented in Figure 2. The prevalence of VDD among the women is 27.5%, while about 27.9% of the women have insufficient levels of VD.The findings demonstrate that about 177 (37.0%) of the women benefitted from VD supplementation by receiving cholecalciferol. However, the majority of the women (n = 301, 63.0%) were not given supplements [Table 3]. The findings also reveal that most of the women (n = 119, 67.2%) who received VD supplements

Table 1: Demographic and clinical characteristics of the study participants (n=478)

Variables	Minimum	Maximum	Mean	SD
Age (years)	19	42	31.09	5.71
Weight (kg)	46.60	116.0	76.10	14.92
Calcium level (mmol/L)	2.00	2.70	2.37	0.22
Vitamin D level (ng/mL)	1.84	143.00	34.26	25.74
Blood loss (mL)	200	2400	459.16	318.38
Diastolic blood pressure (mmHg)	53	91	68.49	7.18
Systolic blood pressure (mmHg)	100	138	114.88	9.94
Hemoglobin level on discharge (g/dL)	8.1	12.9	10.46	1.28
Parity/number of live births	**Frequency**		**Percent**	
Nulliparous	6		1.3	
Primiparous	173		36.2	
Multiparous	299		62.6	

SD: Standard deviation

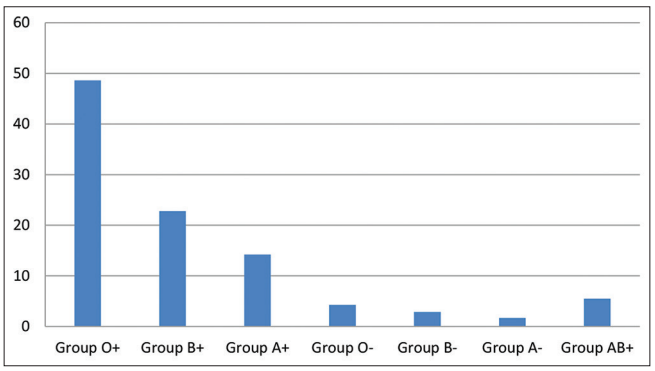

Figure 1: Percentage distribution of maternal blood group

(cholecalciferol) were given a dosage regimen of 50,000 IU once weekly for 4 weeks.

The study revealed that 161 (35.5%) were through cesarean section. First-degree and 2^{ndo} lacerations (perineal tears) were seen in 15.6% (n = 63) and 20.6% (n = 83), respectively [Table 4]. About 0.9% of babies experienced postpartum hemorrhage. The findings also showed that 6.1% of the babies assumed in breech position.

The results showed that a higher plasma VD level was seen among pregnant women with higher age and body weight. Furthermore, plasma calcium level had a moderate positive relationship with the VD level (r = 0.357, P = 0.001). This suggests that as the Cal level increases, the plasma VD level

Table 2: General characteristics of the newborn babies

Variables	Minimum	Maximum	Mean	SD
APGAR score	3	10	7.81	0.91
Head circumference (cm)	34	69	34.22	4.53
Length of infant (cm)	42	56	50.31	4.89
Maturity (weeks)	32	42	38.85	1.51
Pulse rate (beats/min)	60	110	80.40	9.38
Temperature (°C)	36.0	37.2	36.72	0.17
Weight (infant, kg)	1.690	4.415	3.13	0.46
Number of babies	**Frequency**		**Percent**	
Single	450		96.2	
Twins	18		3.8	
Gender				
Male	227		47.4	
Female	252		52.6	
APGAR score				
Low	31		7.0	
High	412		93.0	
Category of weight (infant, kg)				
Low birth weight	39		8.3	
Normal birth weight	413		88.2	
High birth weight	16		3.4	
Method of feeding				
Breastfeeding	281		92.7	
Infant formula	16		5.3	
Neonatal intensive care units	6		2.0	

SD: Standard deviation

Table 3: Vitamin D supplementation, anesthesia, and anti-D immunoglobulin utilization during child delivery

Variables	Frequency	Percent
Vitamin D supplementation (cholecalciferol)		
Yes	177	37.0
No	301	63.0
Strength of cholecalciferol		
800 units once daily for 21 days	58	32.8
50,000 units once weekly for 4 weeks	119	67.2
The pattern of anesthesia use during delivery		
General anesthesia	28	6.1
Local anesthesia	30	6.5
Spinal/intrathecal anesthesia	247	53.7
Epidural anesthesia	101	22.0
Entonox anesthesia (Gaseous)	6	1.3
None	48	10.4
Anti-D immunoglobulin		
Yes	34	9.3
No	333	90.7

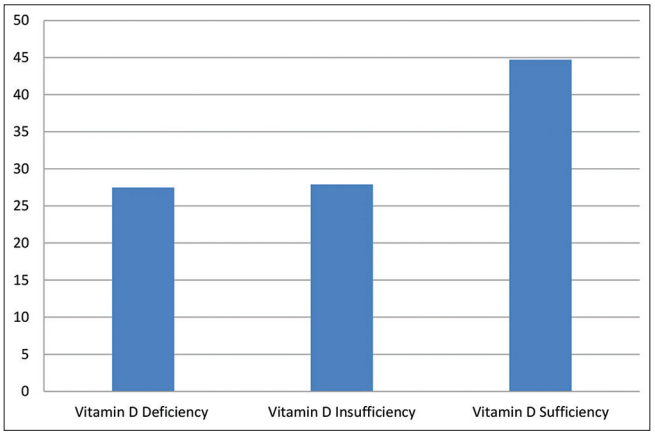

Figure 2: Prevalence of Vitamin D deficiency

increases correspondingly and vice versa. Similarly, the maternal hemoglobin level has a weak positive correlation with the plasma VD level (r = 0.183, $P = 0.001$). Correlation of plasma level of VD with demographic and clinical characteristics of the mother and the newborn baby is shown in [Table 5].

Findings indicated a statistically significant association between the prevalence of VDD and maternal blood group ($P < 0.001$), parity ($P < 0.001$), and use of anti-D immunoglobulin ($P = 0.011$). However, fetal position before delivery did not reveal any significant association with VDD ($P = 0.159$), as shown in [Table 6].

The multivariate linear regression demonstrated that every unit increase in maternal age leads to a 1.049 unit increase in plasma VD concentration. Likewise, every unit increase in body weight was associated with a corresponding 0.275 units increase in the plasma VD concentration. Furthermore, a unit increase in hemoglobin level leads to approximately 2.193 units increase in the plasma VD concentration. Furthermore, a unit increase in the pulse rate of the fetus leads to approximately 0.366 units reduction in the plasma VD concentration. Regarding calcium level as a predictor of VD level, the findings showed that every unit increase in plasma calcium concentration leads to about 13.628 units increase in VD level [Table 7].

Previous cesarean section (21.3%), gestational diabetes mellitus (14.0%), and hypothyroidism (7.3%) were commonly observed complications followed by others during the study period. The complications observed among pregnant women in this study are contained in [Table 8].

Table 4: Maternal perinatal characteristics

Variables	Frequency	Percent
Method of delivery		
Spontaneous vaginal delivery	260	57.3
Cesarean section	161	35.5
Ventouse	18	4.0
Forceps	10	2.2
Vaginal birth after cesarean section	5	1.1
Episiotomy		
Right mediolateral episiotomy	107	23.7
Intact perineum	49	10.8
None	296	65.2
Laceration		
1^{sto}	63	15.6
2^{ndo}	83	20.6
3^{rdo}	6	1.3
Intact	37	9.2
None	214	53.1
Placenta removal		
Controlled cord traction	350	73.8
Manual	92	19.4
Normal	12	2.5
Complete	16	3.4
Spontaneous	4	0.8
Post-delivery condition		
Stable	432	97.7
Post emergency LSCS	6	1.4
Postpartum hemorrhage	4	0.9
Presentation/position of fetus		
Cephalic	286	61.9
Vertex	148	32.0
Breech	28	6.1

Majority of the women (n = 93, 71.0%) who had VDD received cholecalciferol, while about one-third of the women were not given VD supplements. Similarly, more than half of the pregnant women (n = 76, 57.1%) with VD insufficiency were given cholecalciferol. On the other hand, a vast majority of the women (n = 205, 96.2%) who had sufficient VD levels did not receive cholecalciferol [Table 9].

The outcomes of multivariate logistic regression analysis revealed that the number of babies and number of live births (parity) significantly predicted the prevalence of VDD among pregnant women. Specifically, women who gave birth to a single baby have about 10 times lower odds of developing VDD compared to women who delivered twins. Furthermore, primiparous women have about 2 times lower odds of developing VDD than multiparous women, with more than one live birth [Table 10].

Table 5: Correlation of plasma level of Vitamin D with demographic and clinical characteristics of the mother and the newborn baby

Variables	Correlation coefficient (r)	*P*-value
Age (years)	0.232	<0.001*
Weight (kg)	0.151	0.002*
APGAR score	−0.031	0.524
Calcium level	0.357	0.001*
Volume of blood loss (mL)	0.044	0.359
Diastolic blood pressure (mmHg)	−0.047	0.340
Systolic blood pressure (mmHg)	−0.077	0.149
Head circumference (infant, cm)	−0.043	0.373
Length (infant, cm)	0.040	0.412
Maturity (weeks)	−0.133	0.005*
Pulse rate (beats/min)	−0.126	0.010*
Weight (infant, kg)	−0.163	0.001*
Post-discharge hemoglobin level (mg/dL)	0.183	0.001*

*Pearson correlation is significant at P<0.05

There was a significant association between the prevalence of VDD and Group B streptococcus infection (χ^2 = 5.000, P = 0.025), placenta abruption (χ^2 = 5.780, P = 0.045), intrauterine growth restrictions (χ^2 = 5.760, P = 0.036), decreased fetal movement (χ^2 = 10.782, P = 0.001), 3^{rdo} tear (χ^2 = 4.903, P = 0.027), chronic uveitis (χ^2 = 7.531, P = 0.006), and induction of labor with Foley's catheter (χ^2 = 6.263, P = 0.012). In addition, meconium stain (χ^2 = 4.903, P = 0.027) and anemia (χ^2 = 4.587, P = 0.032) were significantly associated with the prevalence of VDD [Table 11].

DISCUSSION

Prevalence of vitamin D hypovitaminosis among pregnant women

The present study showed that the prevalence of VD hypovitaminosis among pregnant women in Riyadh, Saudi Arabia was found to be 55.4% (27.5% deficiency and 27.9% insufficiency). This high trend could be the reason for the hypocalcemia that was seen in some pregnant women with a minimum calcium level of 2 mmol/L. Furthermore, a positive correlation was found between VD level and calcium level which suggests that, as the plasma VD level increases, the calcium level increases accordingly. The issue is also striking if we compare the prevalence trend

Table 6: Association of the prevalence of VDD with maternal ABO blood group, parity, use of anti-D immunoglobulin, and the baby's position before delivery

Variables	Level of Vitamin D concentration, *n* (%)			Chi-square value (χ^2)	*P*-value
	Vitamin D deficiency	Vitamin D insufficiency	Vitamin D sufficiency		
Blood group					
Group O+	53 (42.7)	67 (56.8)	82 (47.1)	45.816	<0.001
Group B+	37 (29.8)	28 (29.5)	30 (31.6)		
Group A+	18 (14.5)	12 (10.2)	29 (16.7)		
Group O−	1 (0.8)	4 (3.4)	13 (7.5)		
Group B−	5 (4.0)	7 (5.9)	0 (0.0)		
Group A−	0 (0.0)	0 (0.0)	7 (1.7)		
Group AB+	10 (8.1)	0 (0.0)	13 (7.5)		
Total	124 (100.0)	118 (100.0)	174 (100.0)		
Parity					
Nulliparous	48 (36.6)	71 (53.4)	53 (24.9)	45.358	<0.001*
Primiparous	6 (4.6)	0 (0.0)	0 (0.0)		
Multiparous	77 (58.8)	62 (46.6)	160 (75.1)		
Total	131 (100.0)	133 (100.0)	213 (100.0)		
Anti-D immunoglobulin					
Yes	4 (4.0)	7 (6.7)	138 (85.7)	8.981	0.011*
No	97 (96.0)	97 (93.3)	23 (14.3)		
Total	101 (100.0)	104 (100.0)	161 (100.0)		
Position of baby during delivery					
Cephalic	89 (70.6)	76 (58.9)	121 (58.7)	6.598	0.159
Vertex	33 (26.2)	45 (34.9)	69 (33.5)		
Breech	4 (3.2)	8 (6.2)	16 (7.8)		
Total	126 (100.0)	129 (100.0)	206 (100.0)		

*Chi-square test is significant at *P*<0.05

Table 7: Predictors of plasma concentration of Vitamin D among pregnant women

Model	Unstandardized coefficients		Standardized coefficients	*t*	*P*-value	95% confidence interval	
	B	Standard error	Beta			Lower	Upper
Constant	−18.332	55.903		−0.328	0.743	−128.463	91.799
Age (years)	1.049	0.255	0.274	4.118	<0.001*	0.547	1.551
Weight (Kg)	0.275	0.109	0.170	2.521	0.012*	0.060	0.489
Maturity (weeks)	−0.114	1.379	−0.007	−0.083	0.934	−2.831	2.603
Pulse rate (b/m)	−0.366	0.158	−0.148	−2.326	0.021*	−0.677	−0.056
Weight (infant, Kg)	2.148	4.551	0.037	0.472	0.637	−6.816	11.113
Post-discharge hemoglobin level (mg/mL)	2.193	1.108	0.126	1.979	0.049*	0.010	4.376
Calcium level (mmol/L)	13.628	4.263	0.357	3.197	0.002*	5.126	22.130

*Multivariate linear regression is significant at *P*<0.05; R=0.301; R-square=0.145; Adjusted R square=0.123

of our study with other local and international studies. A study conducted in Al Jouf, KSA, which was published in 2020, revealed that 70% of the expectant women had VDD.[14] On the country level, 60% of the public including pregnant women had VDD.[15] Another sturdy was done in 2016 in Riyadh revealed that the VD subnormal level was

Table 8: Complications encountered among pregnant women within the study period

Complications	Frequency	Percent
Previous cesarean section	102	21.3
Gestational diabetes mellitus	70	14.6
Hypothyroidism	35	7.3
Group B streptococcus	4	0.8
Placenta abruption	4	0.8
Intrauterine growth restrictions	4	0.8
COVID-19	24	5.0
Breech presentation	22	4.6
Decreased fetal movement	13	2.7
Rubella	10	2.1
VBAC	11	2.3
Polyhydramnios	11	2.3
3rdº tear	6	1.3
Chronic uveitis	6	1.3
Candida infection	4	0.8
Acute liver problem	4	0.8
Induction of labor Foley	5	1.0
Meconium stain	6	1.3
Preterm	4	0.8
Anemia	12	2.5
High blood pressure	3	0.6

Table 9: Proportion of pregnant women with Vitamin D deficiency who received cholecalciferol and the dose administered

Variables	Received Vitamin D supplements (cholecalciferol)	
	Yes (*n*, %)	No (*n*, %)
Vitamin D status		
Vitamin D deficiency	93 (71.0)	38 (29.0)
Vitamin D insufficiency	76 (57.1)	57 (42.9)
Vitamin D sufficiency	8 (3.8)	205 (96.2)

reported in 93.8% of the study sample. These proportions indicated that the issue of VD subnormality is decreasing with time, being 93.8% in 2016 and 55.4% in the present study with data of 2021.[16] In reality, there are factors behind the increased risk of VDD among pregnant women in KSA, such as the environmental nature of the country represented by the hot season that occupies most of the year leading to not spending time outdoors. Add to this, the cultural practices promote covering the skin, such as wearing sunscreens and dressing modestly, which may further reduce the body's natural ability to generate VD from sunlight. To shed light on the matter globally, VDD among child-bearing women was found to be 98.64 in China,[17] 44.6% in Nepal,[18] and1.3% in Western Europe.[19] These statistics confirm that the issue of VDD during pregnancy has been observed worldwide.

Table 10: Multiple logistic regression identifying predictors of Vitamin D deficiency

Variable	Adjusted odds ratio	95% confidence interval	*P*-value
Number of babies			
Single	0.092	0.019–0.453	0.003
Twins	Reference		
Parity			
Nulliparous	0.323	0.209–0.499	<0.001
Primiparous	0.416	0.365–0.689	<0.001
Multiparous	Reference		
Post-delivery condition			
Stable	0.223	0.089–0.345	0.999
Post-emergency LSCS	0.022	0.009–0.312	0.999
Postpartum hemorrhage	Reference		

LSCS: Lower uterine segment section

Table 11: Association of prevalence of Vitamin D subnormality with complications encountered during pregnancy

Complications	Chi-square value χ^2	*P*-value
Previous cesarean section	0.041	0.839
Gestational diabetes mellitus	3.569	0.059
Hypothyroidism	0.331	0.565
Group B streptococcus	5.000	0.025*
Placenta abruption	6.780	0.045*
Intrauterine growth restrictions	5.760	0.036*
COVID-19	0.925	0.336
Breech presentation	0.006	0.938
Decreased fetal movement	10.782	0.001*
Rubella	0.090	0.765
Vaginal birth after cesarean	0.446	0.504
Polyhydramnios	0.476	0.324
3rdº tear	4.903	0.027*
Chronic uveitis	7.531	0.006*
Candida infection	3.255	0.071
Acute liver problem	2.788	0.092
Induction of labor with Foley's catheter	6.263	0.012*
Meconium stain	4.903	0.027*
Preterm	4.255	0.072
Anemia	4.587	0.032*
High blood pressure	0.892	0.256

*Indicates p<0.05.

VDD and consequences on pregnant women

The present study did not show a positive correlation between maternal VD levels and PTB. However, a study in the United States of America showed a significant association between maternal VD levels and PTB.[20] In terms of preeclampsia, a pregnancy-related disorder characterized by high BP and proteinuria after 20 weeks of gestation, the association did not exist. The average BP among pregnant women was within the standard level (114.88/68.49 mmHg). This is also a conflating trend if we compare it with international studies. VD hypovitaminosis was found to be a contributing factor for preeclampsia by many studies.[21] A controlled trial suggested that the normal level of 1,25 dihydroxy VD has an immunomodulatory and vascular function that precludes the occurrence of preeclampsia.[22] The expected reason of why our study did not show these consequences might be the fact that all our sample are in their third trimester while the occurrence of these issues (PTB and Preeclampsia) are mainly related to the level of VD from the early beginning of pregnancy. Furthermore, in our study sample, GDM was one of the most common disorders faced during the pregnancy period, affecting 14.6% of the expectant women. This is supposed to be the function of VD subnormal level among the investigated pregnant women. This finding is consistent with another study conducted in Riyadh, KSA, which confirmed that GDM is significantly higher among pregnant women who have VD hypovitaminosis. Apart from these disorders, our study showed significant association between the level of VD and the incidence of many complications in pregnant women and fetus, named; Group B streptococcus infection, placenta abruption, intrauterine growth restrictions, decreased fetal movement, 3$^{rd^{o}}$ tear, chronic uveitis, and induction of labor with Foley's catheter, meconium stain, and anemia.

Maternal VDD and its impact on neonates

The health of the fetus and the infant depends on adequate levels of VD since inadequate bone mineralization in gestation caused by VDD can cause congenital rickets, osteopenia, or craniotabes in the newborn.[23] In our study, we evaluated the APGAR score of the newborns to determine the extent of their health. The Apgar score is a test taken after delivery to assess the condition of the newborns. This scoring system provides a standardized assessment for infants after delivery. The low score is a sign of reduced vitality and is a risk factor for future health-related complications.[24] The system is comprised five components: (1) Color, (2) heart rate, (3) reflexes, (4) muscle tone, and (5) respiration, each of which is given a score of 0, 1, or 2. Thus, the Apgar score quantitates clinical signs of neonatal depression such as cyanosis or pallor, bradycardia, depressed reflex response to stimulation, hypotonia, and apnea or gasping respirations.[25] The score is reported at 1 min and 5 min after birth for all infants, and at 5-min intervals thereafter until 20 min for infants with a score <7. Our study revealed that the APGAR score ranged from 3 to 10, with an average score of 7.81 ± 0.91. A vast majority of the babies have a high APGAR score (n = 412, 93.0%), which is a score between 7 and 10. Based on the average APGAR score, many of the newborn babies were healthy and active on delivery. By contrast, Swedish prospective population-based cohort study reported that pregnant women whose VD levels are low deliver newborns with significantly lower APGAR score.[24] In fact, no association was found in this study between maternal VD level and the weight of new infants. However, a systematic review depicted otherwise. It concluded that the risk of low birth weights has been significantly associated with poor maternal VD levels and the pharmacological supplementation of the vitamin is paramount public health policy to assist in decreasing the risk of low birth weight.[26]

In addition, the present study revealed that the length and circumference of newborns ranged from 42–56 cm to 34–69 cm, respectively. This shows some abnormality since the normal birth length of the neonate is between 49 and 50 cm with a head circumference which is 33–35 cm. These results are in agreement with a study from Iraq, which found that the babies of pregnant women with VDD have a length of about 49.5 cm and a circumference of 33.7 cm.[27] In addition, a study found that children born to mothers who took VD supplements during pregnancy had a greater head circumference at birth than children born to mothers who did not take VD supplements.

Treatment of VDD during pregnancy

Prophylactic and therapeutic supplementation with VD during pregnancy was supported by many studies. Randomized controlled trials are available to support the need and benefits of prophylactic and therapeutic VD supplementation during pregnancy. However, the safe doses of VD during this critical period are controversial. It is an undeniable fact that high doses of VD result in negative consequences on both expectant women and their fetuses such as hypercalcemia, hypercalciuria, hypocalcemia, and hypervitaminosis D. Considering the current guidelines, our study found that high doses of VD were prescribed to pregnant women which might carry some risks. Around 67.2% of pregnant women received VD with a dose of 50,000 IU a week for 4 weeks, which accounts for 7142 IU a day. In reality, this is considered a high and unsafe dose for pregnant women and developing fetuses. A randomized controlled trial supports the use of cholecalciferol with a dose of 60,000 IU monthly.[10] According to the study, 60,000 IU of monthly administration of cholecalciferol is as effective and safe as 2000 IU/day. In addition, lower doses such as 800 IU/day are often reserved for VD supplementation in asymptomatic people with little or moderately reduced VD levels.[11] This is in parallel with the recommendations of the ACGO, which advises consuming at least 600 IU of VD daily for those with no symptoms while 1,000–2,000 IU daily is the advised dose

when a deficit is detected.[12] Hence, our study recommends educational activities targeting pregnant women and heath care providers to ensure rational drug prescribing and use.

CONCLUSION AND RECOMMENDATIONS

The outcomes of this study confirmed the high prevalence of VD hypovitaminosis among pregnant women in Riyadh, Saudi Arabia. This is in line with other studies overseas which depicted the popularity of the VD subnormal levels among pregnant women world-wide. For the consequences associated with VD low level, PTB and preeclampsia were not found to be dependent on VD level. The GDM was found to be common among the pregnant women. In addition, a positive association was discovered between the prevalence of VDD and experiencing Group B streptococcus infection, placenta abruption, intrauterine growth restrictions, decreased fetal movement, 3^{rdo} tear, chronic uveitis, induction of labor with Foley's catheter, meconium stain, and anemia.

The study contributed to the possibility of predicting the occurrence of VD inadequacy among pregnant women based on many factors. With regard to the supplementation with VD during the pregnancy course, the findings reported that the adherence to VD supplementation guidelines is not satisfactory. In fact, around 30% of pregnant women who showed VD did not receive the needed treatment of the vitamin. Furthermore, most of those who received VD supplementation were prescribed inappropriately high doses.

The study recommends screening the level of VD level in each pregnant woman at the beginning of pregnancy with proper follow-up during the pregnancy course. Furthermore, launching a VD support program by Saudi health authorities is highly advised since VDD is common among pregnant women and could contribute to negative health outcomes for both childbearing women and their neonates. Educational activities are recommended to health care providers, focused on the consequences of VDD on mothers and their new babies and the need to be compliant with the local and international guidelines of VD measurements, prevention, and treatment during the pregnancy period. Of the other research areas of interest that are recommended by this study is to evaluate the level of VD among newborns and to find out its correlation with the maternal levels. Pregnant women should also be encouraged to have daily sunlight exposure and intake of VD-fortified foods. These measures have been linked to maintaining sufficient levels of vitamins and consequently better health outcomes for the mothers and their babies.

REFERENCES

1. Jeyakumar A, Shinde V. A systematic review and meta-analysis of prevalence of vitamin D deficiency among adolescent girls in selected Indian States. Nutr Health 2019;25:61-70.
2. Bouillon R, Marcocci C, Carmeliet G, Bikle D, White JH, Dawson-Hughes B, *et al*. Skeletal and extraskeletal actions of vitamin D: Current evidence and outstanding questions. Endocr Rev 2019;40:1109-51.
3. Roth DE, Abrams SA, Aloia J, Bergeron G, Bourassa MW, Brown KH, *et al*. Global prevalence and disease burden of vitamin D deficiency: A roadmap for action in low-and middle-income countries. Ann N Y Acad Sci 2018;1430:44-79.
4. Dhamayanti M, Noviandhari A, Supriadi S, Judistiani RT, Setiabudiawan B. Association of maternal vitamin D deficiency and infants' neurodevelopmental status: A cohort study on vitamin D and its impact during pregnancy and childhood in Indonesia. J Paediatr Child Health 2020;56:16-21.
5. Zainel AJ, Qotba H, Al Nuaimi A, Syed M. Vitamin D status among adults (18-65 years old) attending primary healthcare centres in qatar: A cross-sectional analysis of the electronic medical records for the year 2017. BMJ Open 2019;9:e029334.
6. Cheng Y, Chen J, Li T, Pei J, Fan Y, He M, *et al*. Maternal vitamin D status in early pregnancy and its association with gestational diabetes mellitus in Shanghai: A retrospective cohort study. BMC Pregnancy Childbirth 2022;22:819.
7. Tous M, Villalobos M, Iglesias L, Fernandez-Barres S, Arija V. Vitamin D status during pregnancy and offspring outcomes: A systematic review and meta-analysis of observational studies. Eur J Clin Nutr 2020;74:36-53.
8. Yoshikata H, Tsugawa N, Watanabe Y, Tsuburai T, Chaki O, Hirahara F, *et al*. 25-Hydroxyvitamin D profiles and maternal bone mass during pregnancy and lactation in Japanese women. J Bone Miner Metab 2020;38:99-108.
9. Curtis EM, Moon RJ, Harvey NC, Cooper C. Maternal vitamin D supplementation during pregnancy. Br Med Bull 2018;126:57-77.
10. Mir SA, Masoodi SR, Shafi S, Hameed I, Dar MA, Bashir MI, *et al*. Efficacy and safety of Vitamin D supplementation during pregnancy: A randomized trial of two different levels of dosing on maternal and neonatal Vitamin D outcome. Indian J Endocrinol Metab 2016;20:337-42.
11. Mithal A, Kalra S. Vitamin D supplementation in pregnancy. Indian J Endocrinol Metab 2014;18:593-6.
12. ACOG committee opinion no. 495. Vitamin D: Screening and supplementation during pregnancy. Obstet Gynecol 2011;118:197-8.
13. Sunuwar N, Gautam S, Twayana AR, Yadav SA, Anjum F, Kandel K. Hereditary vitamin-D dependent rickets type II: A case report. JNMA J Nepal Med Assoc 2021;59:597-600.
14. Alsrhani A. Prevalence of vitamin D deficiency in pregnant women of Al jouf region, kingdom of Saudi Arabia. Pak J Med Health Sci 2020;14:734-7.
15. Al-Alyani H, Al-Turki HA, Al-Essa ON, Alani FM,

Sadat-Ali M. Vitamin D deficiency in Saudi Arabians: A reality or simply hype: A meta-analysis (2008-2015). J Family Community Med 2018;25:1-4.
16. Al-Faris NA. High prevalence of vitamin D deficiency among pregnant Saudi women. Nutrients 2016;8:77.
17. Chen B, Chen Y, Xu Y. Vitamin D deficiency in pregnant women: Influenced by multiple risk factors and increase the risks of spontaneous abortion and small-for-gestational age. Medicine (Baltimore) 2021;100:e27505.
18. Shrestha D, Saha R, Karki C, Mahato S. Study of vitamin-D deficiency among pregnant women in their first trimester visiting a tertiary care hospital: A descriptive cross-sectional study. JNMA J Nepal Med Assoc 2021;59:626-9.
19. Eggemoen ÅR, Falk RS, Knutsen KV, Lagerløv P, Sletner L, Birkeland KI, *et al*. Vitamin D deficiency and supplementation in pregnancy in a multiethnic population-based cohort. BMC Pregnancy Childbirth 2016;16:7.
20. Tahsin T, Khanam R, Chowdhury NH, Hasan AT, Hosen MB, Rahman S, *et al*. Vitamin D deficiency in pregnancy and the risk of preterm birth: A nested case-control study. BMC Pregnancy Childbirth 2023;23:322.
21. Burris HH, Rifas-Shiman SL, Huh SY, Kleinman K, Litonjua AA, Oken E, *et al*. Vitamin D status and hypertensive disorders in pregnancy. Ann Epidemiol 2014;24:399-403.e1.
22. 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. Obstet Gynecol Int 2017;2017:8249264.
23. Urrutia-Pereira M, Solé D. Vitamin D deficiency in pregnancy and its impact on the fetus, the newborn and in childhood. Rev Paul Pediatr 2015;33:104-13.
24. Augustin H, Mulcahy S, Schoenmakers I, Bullarbo M, Glantz A, Winkvist A, *et al*. Late pregnancy vitamin D deficiency is associated with doubled odds of birth asphyxia and emergency caesarean section: A prospective cohort study. Matern Child Health J 2020;24:1412-8.
25. Watterberg KL, Aucott S, Benitz WE, Cummings JJ, Eichenwald EC, Goldsmith J, *et al*. The apgar score. Pediatrics 2015;136:819-22.
26. Fang K, He Y, Mu M, Liu K. Maternal vitamin D deficiency during pregnancy and low birth weight: A systematic review and meta-analysis. J Matern Fetal Neonatal Med 2021;34:1167-73.
27. Ibrahim BY, Hachim AM, Saeed LH. Prevalence and impact of vitamin d deficiency on maternal and fetal outcomes. J Popul Ther Clin Pharmacol 2023;30: 35-43.

Source of Support: Nil. **Conflicts of Interest:** None declared.