JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/737dgz27

Original Article

Association of Vitamin D Deficiency with Uterine Atony in Females Delivering at a Tertiary Care Hospital

Muhammad Naeem[1], Asma Ahmed[2], Sabba Zahid[1], Muhammad Faheem[3]

[1] Primary and Secondary Healthcare and Population Department, Town Hospital Mumtazabad, Multan, Pakistan
[2] Recep Tayyep Erdogan Hospital, Muzaffargarh, Pakistan
[3] Allama Iqbal Medical College and Jinnah Hospital, Lahore, Pakistan

***Corresponding author: Muhammad Naeem, drnaeemszmc@gmail.com**

"Cite this Article" Received: 05 February 2026; **Accepted**: 25 March 2026; **Published**: 30 April 2026

Author Contributions: Concept: MN; Design: AA; Data Collection: SZ; Analysis: MF; Drafting: MN. **Ethical Approval**: Town Hospital Mumtazabad, Multan, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

ABSTRACT

Background: Uterine atony is a leading cause of postpartum hemorrhage and remains difficult to predict using routine obstetric risk factors alone. Vitamin D deficiency may impair calcium-mediated myometrial contractility, but clinical evidence linking vitamin D status with uterine atony is limited. Objective: To determine the association between vitamin D deficiency and uterine atony among females delivering at a tertiary care hospital. Methods: This hospital-based case-control study included 200 postpartum females aged 20-35 years at Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, from 1 January 2020 to 30 June 2020. Cases were 100 females who developed uterine atony within 24 hours of delivery, and controls were 100 females with normal uterine tone. Serum 25-hydroxyvitamin D was measured after delivery, and deficiency was defined as <30 ng/mL. Results: Mean serum vitamin D level was lower in cases than controls (22.35 ± 9.02 vs 28.48 ± 10.53 ng/mL). Vitamin D deficiency was present in 84.0% of cases and 57.0% of controls, corresponding to a crude odds ratio of 3.96 (95% CI 2.04 to 7.70; p<0.001). Conclusion: Vitamin D deficiency was significantly associated with uterine atony, although prospective studies are needed to confirm temporality and causality. Keywords: Uterine atony; Vitamin D deficiency; Postpartum hemorrhage; Case-control study; Serum 25-hydroxyvitamin D.

INTRODUCTION

Maternal hemorrhage remains one of the most important preventable causes of severe maternal morbidity and mortality, and postpartum hemorrhage is a major obstetric emergency after both vaginal and caesarean delivery. Uterine atony, defined by inadequate postpartum contraction of the myometrium, is the leading cause of postpartum hemorrhage and requires rapid recognition because delayed uterine contraction can result in substantial blood loss within a short interval (1–3). Although several clinical risk factors for uterine atony have been described, including hypertensive disease, chorioamnionitis, prolonged labor, uterine overdistension, and obstetric interventions, many cases still occur without reliable prediction from history or routine intrapartum risk assessment alone (4). This uncertainty supports the need to identify biologically plausible, measurable, and potentially modifiable factors that may improve risk stratification.

Vitamin D is traditionally recognized for its role in calcium homeostasis, but its relevance during pregnancy extends to placental physiology, immune regulation, and smooth muscle function. Serum 25-hydroxyvitamin D [25(OH)D] reflects vitamin D status, and concentrations below sufficiency thresholds are common in pregnant populations, particularly where nutritional intake, sunlight exposure, and supplementation practices are variable (5). The biological rationale linking vitamin D status with uterine tone is clinically plausible because myometrial contraction depends on calcium-mediated intracellular signaling, while vitamin D contributes to systemic and local regulation of calcium availability. Placental

ISSN 3007-0570 | © 2026 The Authors | CC BY 4.0

vitamin D metabolism and extrarenal activation of vitamin D further support the possibility that peripartum vitamin D status may influence reproductive tissue function at the maternal–fetal interface (6,7). Low maternal vitamin D status has also been associated with adverse pregnancy outcomes, including spontaneous preterm birth, suggesting that vitamin D may have broader relevance to uterine physiology beyond skeletal metabolism (8).

Direct clinical evidence on vitamin D deficiency and uterine atony remains limited. The principal local study reported vitamin D deficiency in 87% of females with uterine atony compared with 68% of those without uterine atony, indicating a statistically significant association; however, that study had unequal group sizes and limited adjustment for potential confounding (9). Important covariates such as body mass index, parity, gestational age, and mode of delivery may influence both vitamin D status and the likelihood of uterine atony, making careful analytic control necessary before the association can be interpreted clinically. A case-control design with equal numbers of cases and controls from the same delivery setting therefore provides an opportunity to estimate the magnitude of association more precisely while improving comparability between groups.

In this hospital-based case-control study, the population comprised postpartum females aged 20–35 years delivering at Sheikh Zayed Medical College/Hospital, Rahim Yar Khan; the exposure was peripartum vitamin D deficiency; the comparison group consisted of females with adequate serum vitamin D levels; and the outcome was uterine atony occurring within 24 hours of delivery. The study aimed to determine whether vitamin D deficiency was independently associated with uterine atony among females delivering at a tertiary care hospital. The primary hypothesis was that vitamin D deficiency would be more frequent among females with uterine atony than among controls with normal uterine tone.

MATERIALS AND METHODS

This hospital-based case-control study was conducted in the Gynaecology Unit of Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, from 1 January 2020 to 30 June 2020, and was designed and reported in accordance with STROBE guidance for observational studies (10). A total of 200 postpartum females who delivered in the labor room of the study institution were enrolled through non-probability consecutive sampling after written informed consent. Cases were defined as 100 females who developed uterine atony within 24 hours of delivery, while controls were 100 females from the same source population who had normal uterine tone during the corresponding postpartum observation period. Using the same setting, recruitment period, eligibility criteria, clinical definitions, and laboratory method for both groups was intended to reduce selection and measurement bias.

Females aged 20–35 years who delivered at the study institution and fulfilled the operational definitions were eligible. Uterine atony was defined as absent or inadequate uterine tone on abdominal palpation accompanied by blood loss exceeding 500 mL after vaginal delivery or exceeding 1000 mL after caesarean section within 24 hours of delivery. Controls were postpartum females with normal uterine tone within 24 hours of delivery. Patients were excluded if they had chronic renal disease indicated by serum creatinine >2 mg/dL, parity greater than five, multiple gestation, polyhydramnios, deranged coagulation parameters with prothrombin time >13 seconds or activated partial thromboplastin time >33 seconds, vaginal or cervical tear on per-speculum examination, or refusal to participate.

Blood loss was measured by the gravimetric method using pre-weighed pads and gauze pieces. The dry weight of each item was subtracted from the soaked weight, and the standard conversion of 1 g weight difference to 1 mL blood loss was applied. A 5 mL venous blood sample was collected after delivery under aseptic conditions, transferred to a serum vial, and dispatched to the laboratory on the same day for serum 25(OH)D estimation by radioimmunoassay. Vitamin D deficiency was defined as serum 25(OH)D <30 ng/mL, consistent with the threshold used in the comparator uterine-atony study and with commonly used clinical sufficiency cutoffs, while interpretation was restricted to peripartum vitamin D status because sampling occurred after delivery (5,9).

Data were recorded on a structured proforma and included age, gestational age, parity, mode of delivery, weight, height, body mass index, measured blood loss, serum vitamin D level, vitamin D deficiency status, and uterine tone status. Body mass index was calculated as weight in kilograms divided by height in meters squared. To address confounding, clinically relevant covariates were identified before analysis, including age, gestational age, parity, body mass index, and mode of delivery. Subgroup analyses were planned by age group, gestational age, parity, mode of delivery, and BMI category; blood loss strata were interpreted descriptively as markers of hemorrhage severity rather than baseline confounders.

The sample size was calculated using 80% statistical power and a 5% level of significance, based on previously reported vitamin D deficiency proportions of 87% among females with uterine atony and 68% among those without uterine atony (9). Data were analyzed using SPSS version 23. Continuous variables were summarized as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Baseline differences were assessed using independent-sample t tests or Mann–Whitney U tests for continuous variables, according to distribution, and chi-square or Fisher's exact tests for categorical variables, according to cell size. The primary association between vitamin D deficiency and uterine atony was estimated using crude odds ratios with 95% confidence intervals. Multivariable logistic regression was planned with uterine atony as the dependent variable and vitamin D deficiency as the primary exposure, adjusting for age, gestational age, parity, BMI, and mode of delivery. Two-sided p-values <0.05 were considered statistically significant, while subgroup analyses were interpreted as exploratory because of multiple comparisons and smaller stratum-specific sample sizes.

Data integrity was maintained through same-day laboratory dispatch of samples, use of uniform operational definitions, range checks during data entry, and cross-verification of clinical records with the completed proforma. Records with complete exposure and outcome information were included in the final analysis. Participant confidentiality was maintained by anonymizing study data before analysis. Ethical approval was obtained from the institutional review board of Sheikh Zayed Medical College/Hospital, Rahim Yar Khan, under approval number 126/2020, and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki (11).

RESULTS

A total of 200 postpartum females were analyzed, including 100 cases with uterine atony and 100 controls with normal uterine tone. The mean age was comparable between cases and controls (29.55 ± 2.25 vs 29.26 ± 2.46 years; mean difference 0.29 years, 95% CI −0.37 to 0.95; p=0.385), as was gestational age (38.81 ± 1.33 vs 38.99 ± 1.21 weeks; p=0.318). Cases had significantly lower mean weight than controls (63.54 ± 11.41 vs 70.30 ± 12.91 kg; mean difference −6.76 kg, 95% CI −10.16 to −3.36; p<0.001) and lower BMI (26.13 ± 4.94 vs 29.53 ± 5.48 kg/m²; mean difference −3.40 kg/m², 95% CI −4.86 to −1.94; p<0.001). Mean blood loss was substantially higher among cases than controls (788.50 ± 241.21 vs 403.10 ± 227.23 mL; mean difference 385.40 mL, 95% CI 320.05 to 450.75; p<0.001). Mean serum vitamin D level was significantly lower in cases than controls (22.35 ± 9.02 vs 28.48 ± 10.53 ng/mL; mean difference −6.13 ng/mL, 95% CI −8.86 to −3.40; p<0.001). Baseline and clinical characteristics are shown in Table 1.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Case Group (n=100)	Control Group (n=100)	Effect Estimate (95% CI)	p-value
Age, years	29.55 ± 2.25	29.26 ± 2.46	MD 0.29 (−0.37 to 0.95)	0.385
Gestational age, weeks	38.81 ± 1.33	38.99 ± 1.21	MD −0.18 (−0.53 to 0.17)	0.318
Weight, kg	63.54 ± 11.41	70.30 ± 12.91	MD −6.76 (−10.16 to −3.36)	<0.001
Height, m	1.565 ± 0.10	1.546 ± 0.08	MD 0.019 (−0.006 to 0.044)	0.140
BMI, kg/m²	26.13 ± 4.94	29.53 ± 5.48	MD −3.40 (−4.86 to −1.94)	<0.001
Blood loss, mL	788.50 ± 241.21	403.10 ± 227.23	MD 385.40 (320.05 to 450.75)	<0.001
Serum vitamin D, ng/mL	22.35 ± 9.02	28.48 ± 10.53	MD −6.13 (−8.86 to −3.40)	<0.001
Parity >3, n (%)	3 (3.0%)	4 (4.0%)	OR 0.74 (0.16 to 3.41)	1.000
Caesarean section, n (%)	36 (36.0%)	20 (20.0%)	OR 2.25 (1.19 to 4.26)	0.012

MD: mean difference, calculated as case minus control; OR: odds ratio; BMI: body mass index. Continuous variables are presented as mean ± SD. Fisher's exact test was used for parity because of small cell counts.

Vitamin D deficiency was significantly more frequent among females with uterine atony. Deficiency was present in 84 of 100 cases compared with 57 of 100 controls, corresponding to an absolute difference of 27.0 percentage points. The crude odds of uterine atony were approximately four times higher among females with vitamin D deficiency than among those without deficiency (OR 3.96, 95% CI 2.04 to 7.70; p<0.001), as shown in Table 2.

Table 2. Association Between Vitamin D Deficiency and Uterine Atony

Vitamin D Status	Case Group (n=100)	Control Group (n=100)	Absolute Difference	Odds Ratio (95% CI)	p-value
Deficient, <30 ng/mL	84 (84.0%)	57 (57.0%)	27.0%	3.96 (2.04 to 7.70)	<0.001
Not deficient, ≥30 ng/mL	16 (16.0%)	43 (43.0%)			

Stratified analysis showed that the association between vitamin D deficiency and uterine atony remained directionally consistent across most age, gestational age, and parity strata. Among females aged 20–30 years, vitamin D deficiency was present in 54 of 63 cases (85.7%) and 35 of 62 controls (56.5%), with an OR of 4.63 (95% CI 1.95 to 11.00; p<0.001). Among females older than 30 years, deficiency was present in 30 of 37 cases (81.1%) and 22 of 38 controls (57.9%), with an OR of 3.12 (95% CI 1.10 to 8.86; p=0.029). The association was also significant among females delivering at 36–39 weeks and among those with parity 0–3. In contrast, estimates for gestational age >39 weeks and parity >3 were imprecise, with wide confidence intervals and non-significant p-values, reflecting limited subgroup size.

Table 3. Stratified Association of Vitamin D Deficiency With Uterine Atony by Age, Gestational Age, and Parity

Subgroup	Cases Deficient/ Total (%)	Controls Deficient/ Total (%)	Absolute Difference	Odds Ratio (95% CI)	p-value
Age 20–30 years	54/63 (85.7%)	35/62 (56.5%)	29.2%	4.63 (1.95 to 11.00)	<0.001
Age >30 years	30/37 (81.1%)	22/38 (57.9%)	23.2%	3.12 (1.10 to 8.86)	0.029
Gestational age 36–39 weeks	69/81 (85.2%)	43/75 (57.3%)	27.9%	4.28 (1.99 to 9.20)	<0.001
Gestational age >39 weeks	15/19 (78.9%)	14/25 (56.0%)	22.9%	2.95 (0.76 to 11.44)	0.112
Parity 0–3	82/97 (84.5%)	54/96 (56.2%)	28.3%	4.25 (2.15 to 8.41)	<0.001
Parity >3	2/3 (66.7%)	3/4 (75.0%)	−8.3%	0.67 (0.03 to 18.06)	1.000

OR: odds ratio. Fisher's exact test was used for parity >3 because of very small cell counts.

When stratified by mode of delivery, vitamin D deficiency remained significantly associated with uterine atony after vaginal delivery, occurring in 50 of 64 cases (78.1%) and 42 of 80 controls (52.5%; OR 3.23, 95% CI 1.55 to 6.76; p=0.001). Among caesarean deliveries, the point estimate was higher (OR 5.67), but the confidence interval was wide (95% CI 0.99 to 32.57) and Fisher's exact test did not reach statistical significance (p=0.084), indicating instability due to small non-deficient cell counts. Across BMI strata, the association was significant both in females with BMI ≤25 kg/m² (OR 5.36, 95% CI 1.90 to 15.10; p<0.001) and BMI >25 kg/m² (OR 3.10, 95% CI 1.25 to 7.64; p=0.012). In the blood loss ≤1000 mL stratum, vitamin D deficiency remained significantly more frequent among cases than controls (78.8% vs 55.3%; OR 3.00, 95% CI 1.47 to 6.14; p=0.002). The blood loss >1000 mL stratum was not statistically significant and should be interpreted descriptively because blood loss is part of the outcome definition and the control subgroup was small.

Table 4. Stratified Association of Vitamin D Deficiency With Uterine Atony by Mode of Delivery, BMI, and Blood Loss

Subgroup	Cases Deficient/ Total (%)	Controls Deficient/ Total (%)	Absolute Difference	Odds Ratio (95% CI)	p-value
Vaginal delivery	50/64 (78.1%)	42/80 (52.5%)	25.6%	3.23 (1.55 to 6.76)	0.001
Caesarean section	34/36 (94.4%)	15/20 (75.0%)	19.4%	5.67 (0.99 to 32.57)	0.084
BMI ≤25 kg/m²	49/57 (86.0%)	16/30 (53.3%)	32.7%	5.36 (1.90 to 15.10)	<0.001
BMI >25 kg/m²	35/43 (81.4%)	41/70 (58.6%)	22.8%	3.10 (1.25 to 7.64)	0.012
Blood loss ≤1000 mL	52/66 (78.8%)	52/94 (55.3%)	23.5%	3.00 (1.47 to 6.14)	0.002
Blood loss >1000 mL	32/34 (94.1%)	5/6 (83.3%)	10.8%	3.20 (0.24 to 42.19)	0.394

BMI: body mass index; OR: odds ratio. Fisher's exact test was used for caesarean section and blood loss >1000 mL because of small cell counts. Blood loss strata are descriptive and should not be interpreted as baseline risk strata because blood loss contributed to the clinical definition of uterine atony.

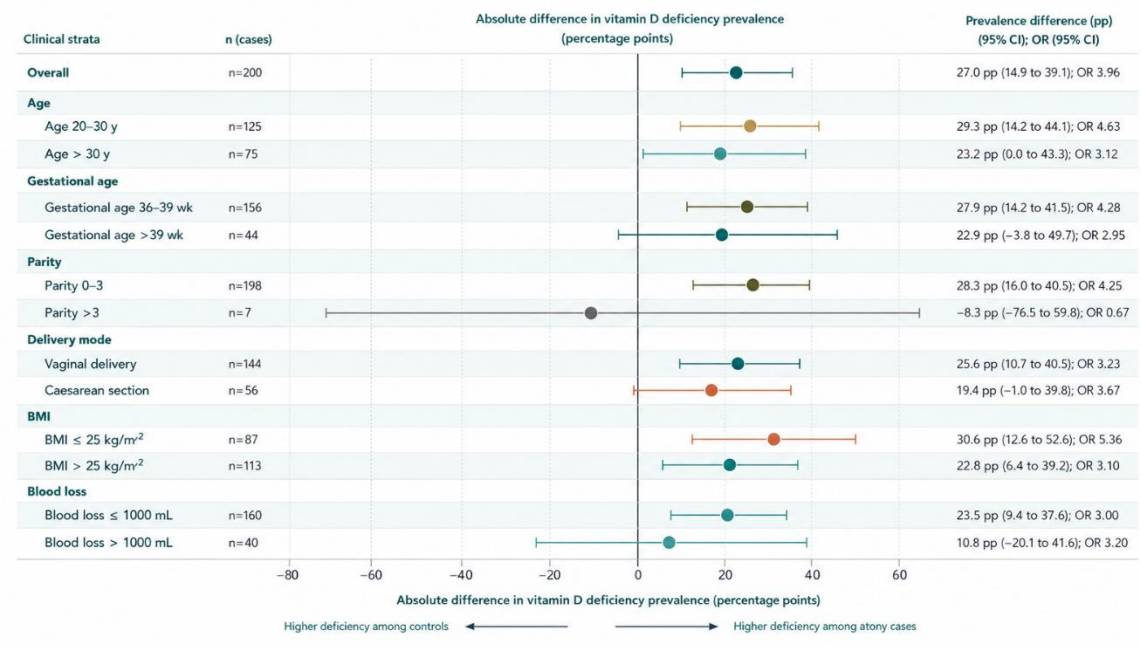

Figure 1 Vitamin D Atony Effect Gradient

The subgroup effect profile demonstrated a consistent excess burden of vitamin D deficiency among females with uterine atony, with the overall absolute difference reaching 27.0 percentage points compared with controls (84.0% vs 57.0%; 95% CI 14.9 to 39.1; OR 3.96). The largest deficiency gradient was observed among females with BMI ≤25 kg/m², where cases exceeded controls by 32.6 percentage points (86.0% vs 53.3%; 95% CI 12.6 to 52.6; OR 5.36), followed by age 20–30 years at 29.3 percentage points and parity 0–3 at 28.3 percentage points. Clinically meaningful positive gradients were also maintained after vaginal delivery, gestational age 36–39 weeks, and BMI >25 kg/m², while estimates for parity >3, caesarean delivery, gestational age >39 weeks, and blood loss >1000 mL were imprecise because their confidence intervals crossed zero, supporting cautious interpretation of these sparse strata.

DISCUSSION

The present case-control study found a clinically meaningful association between peripartum vitamin D deficiency and uterine atony. Vitamin D deficiency was identified in 84.0% of females with uterine atony compared with 57.0% of controls, producing a crude odds ratio of 3.96 with a 95% confidence interval of 2.04 to 7.70. Mean serum vitamin D concentration was also significantly lower among cases than controls by 6.13 ng/mL. These findings are relevant because uterine atony remains a major cause of postpartum hemorrhage and is often difficult to predict reliably using obstetric history alone (1-4).

The observed association is consistent with the previous local case-control study by Khan et al., which reported vitamin D deficiency or insufficiency in 87% of females with uterine atony compared with 68% of those without uterine atony (9). The present study extends that evidence by using equal-sized case and control groups and by reporting effect estimates across clinically relevant strata. However, the findings should still be interpreted as an association rather than proof of causality, because vitamin D was measured after delivery and may only approximate antenatal vitamin D status.

The biological plausibility of this association is supported by the role of vitamin D in calcium homeostasis and the calcium-dependent physiology of smooth muscle contraction. Adequate myometrial contraction after delivery depends on intracellular calcium signaling, and uterotonic therapies used for uterine atony act partly through enhancement of myometrial contractile pathways

(3,12). Vitamin D also has recognized systemic and local actions, including extrarenal metabolism and placental regulation, which may be relevant to peripartum uterine function (5-7). Prior evidence linking low maternal vitamin D status with adverse pregnancy outcomes further supports a possible role for vitamin D in reproductive physiology, although the exact mechanism in uterine atony remains unconfirmed (8).

Stratified analysis showed that the deficiency gradient was generally consistent across age, gestational age, parity, mode of delivery, and BMI groups. The largest absolute difference was observed among females with BMI <=25 kg/m², followed by younger maternal age and parity 0-3. These subgroup findings may suggest differential vulnerability, but they should be treated as exploratory because several strata had small cell counts and wide confidence intervals. The blood-loss strata are particularly cautious in interpretation because blood loss contributed to the clinical definition of uterine atony and therefore should not be considered an independent baseline predictor.

This study has several limitations. It was conducted at a single tertiary care hospital, used non-probability consecutive sampling, and measured vitamin D after delivery rather than during antenatal care. Important confounders such as antenatal vitamin D supplementation, sunlight exposure, diet, season, anemia, labor duration, induction or augmentation of labor, birthweight, magnesium sulfate exposure, chorioamnionitis, and socioeconomic status were not fully available for adjustment. Baseline differences in BMI and mode of delivery also indicate the need for multivariable logistic regression using individual-level data. Therefore, the findings support vitamin D deficiency as a potentially modifiable associated factor, but they do not justify routine vitamin D prophylaxis specifically for uterine atony prevention without prospective confirmation.

CONCLUSION

Vitamin D deficiency was significantly more frequent among females with uterine atony than among controls with normal uterine tone, and the crude odds of uterine atony were approximately four times higher among vitamin D-deficient participants. These findings suggest that low peripartum serum 25(OH)D may be an important associated factor for uterine atony, but causality cannot be established from this case-control design. Prospective antenatal studies with adjustment for obstetric, nutritional, seasonal, and labor-related confounders are needed to determine whether correction of vitamin D deficiency can reduce the risk of uterine atony and related postpartum hemorrhage.

REFERENCES

1. Townsley DM. Hematologic complications of pregnancy. Semin Hematol. 2013;50(3):222-31. https://doi.org/10.1053/j.seminhematol.2013.06.004

2. Su CW. Postpartum hemorrhage. Prim Care. 2012;39(1):167-87. https://doi.org/10.1016/j.pop.2011.11.009

3. Breathnach F, Geary M. Uterine atony: definition, prevention, nonsurgical management, and uterine tamponade. Semin Perinatol. 2009;33(2):82-7. https://doi.org/10.1053/j.semperi.2008.12.001

4. Wetta LA, Szychowski JM, Seals S, Mancuso MS, Biggio JR, Tita ATN. Risk factors for uterine atony/postpartum hemorrhage requiring treatment after vaginal delivery. Am J Obstet Gynecol. 2013;209(1):51.e1-6. https://doi.org/10.1016/j.ajog.2013.03.011

5. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011;96(7):1911-30. https://doi.org/10.1210/jc.2011-0385

6. Adams JS, Chen H, Chun R, Ren S, Wu S, Gacad MA, et al. Substrate and enzyme trafficking as a means of regulating 1,25-dihydroxyvitamin D synthesis and action: the human innate immune response. J Bone Miner Res. 2007;22 Suppl 2:V20-4. https://doi.org/10.1359/JBMR-07S214

7. Novakovic B, Sibson M, Ng HK, Manuelpillai U, Rakyan V, Down T, et al. Placenta-specific methylation of the vitamin D 24-hydroxylase gene: implications for feedback autoregulation of active vitamin D levels at the fetomaternal interface. J Biol Chem. 2009;284(22):14838-48. https://doi.org/10.1074/jbc.M809542200

8. Bodnar LM, Klebanoff MA, Gernand AD, Platt RW, Parks WT, Catov JM, et al. Maternal vitamin D status and spontaneous preterm birth by placental histology in the US Collaborative Perinatal Project. Am J Epidemiol. 2014;179(2):168-76. https://doi.org/10.1093/aje/kwt237

9. Khan SM, Saeed M, Mustafa G, Durrani HD. Uterine atony: association of low serum vitamin D. Professional Med J. 2014;21(6):1117-21.

10. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP; STROBE Initiative. Strengthening the reporting of observational studies in epidemiology: guidelines for reporting observational studies. BMJ. 2007;335(7624):806-8. https://doi.org/10.1136/bmj.39335.541782.AD

11. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191-4. https://doi.org/10.1001/jama.2013.281053

12. Committee on Practice Bulletins-Obstetrics. Practice Bulletin No. 183: Postpartum hemorrhage. Obstet Gynecol. 2017;130(4):e168-86.