The correlation between vitamin D level and primary cesarean section

Henan Dh Skheel ALjebory (1)
Abeer N. Hamdy (2)

(1) Assistant Professor gyn & obs, College of Medicine, Almustansiryia University
Consultant Gyn & obs, ALyarmouk teaching hospital
(2) Abeer N. Hamdy (MB.,Ch.,B)

Correspondence:
Dr Henan Dh Skheel ALjebory
Assistant Professor, Department of Obstetrics & Gynaecology,
AL - Yarmouk Teaching Hospital, Iraq
Email: hanandhali@yahoo.com

Abstract

Background: Delivery by cesarean is a common operative procedure experienced by reproductive age women. Factors which increase risk include older maternal age, obesity, parity and poor vitamin D use along with a more recently defined factor - maternal nutrition.

Recent research has found low circulating 25-hydroxyvitamin D (25(OH)D), the primary indicator of vitamin D status, among women who were either pregnant or in their reproductive years. One way by which poor maternal vitamin D status might increase risk of cesarean delivery is by reducing strength of the pelvic musculature and the mother's ability to push and deliver vaginally.

The extent to which maternal vitamin D influences the course and outcome of human pregnancy needs to be more completely studied.

Objective: To assess the possible correlation between vitamin D level and primary cesarean section.

Study design: A prospective case-control study.

Subjects and method: This study was carried out at AL - Yarmouk Teaching Hospital, Department of Obstetrics and Gynecology for a period of 1 year from the first of October 2012 to the first of October 2013 and included 100 singleton pregnant women; fifty women with cesarean section for the first time (study group) and another fifty women with spontaneous vaginal delivery (control group). Serum level of 25(OH) vitamin D was measured in both groups and the correlation of vitamin D level with cesarean section was studied.

Vitamin D level was measured; women in both groups were classified according to their vitamin D status into vitamin D deficient group (level<30nmol/L), vitamin D insufficient group (level 30-49.9 nmol/L) and those with normal (adequate) vitamin D (level>50).

Results: We found that 31 women from the total number of women with cesarean section and control groups had serum 25(OH)D less than 30 nmol/L (considered as a group of vitamin D deficiency according to the Institute of Medicine (IOM)), 46% (n=23) of them delivered by cesarean section and 8% delivered vaginally; 42% women with vitamin D level between 30-49.9 nmol/L (group of vitamin D insufficiency), 32%(n=16) of them delivered by cesarean section and 26% delivered vaginally; 27% women with vitamin D =>50nmol/L (vitamin D adequacy), 22% (n=11) of them delivered by cesarean section and 16 delivered vaginally, P value 0.0001. In multivariable logistic regression analysis controlling for age, education level, BMI and vitamin D use, women with 25(OH)D less than 30 nmol/liter (group with vitamin D deficiency) were almost four and a half times as likely to have a cesarean (OR ratio=4.47, 95%CI=1.75-11.43). There was an inverse association with having a cesarean section and serum 25(OH)D levels.

Conclusion: Vitamin D deficiency was associated with increased odds of primary cesarean section.

Key words: Hydroxy vitamin D; vitamin insufficiency; vitamin D deficiency; vitamin D intake; parathyroid hormone; caesarian delivery; prolonged labor.

Introduction

We already know Vitamin D is important for bone health of the mother and infant, but we are just starting to scratch the surface about the many potential health benefits of Vitamin D during pregnancy. Vitamin D deficiency is the major cause of rickets around the world, but rickets may be just the tip of the iceberg. Increasingly, research is revealing the importance of vitamin D in protecting against a host of health problems -- not just those involving calcium and bone.(1,2) Cesarean is a common operative procedure experienced by reproductive age women(3). Optimal cesarean delivery rates will vary over time and across different populations according to individual and societal circumstances(4,5). Factors which increase risk include older maternal age, obesity, parity and ethnicity along with a more recently defined factor-maternal nutrition.(6) Recent research in the United States found low circulating 25-hydroxyvitamin D (25(OH)D), the primary indicator of vitamin D status, among women who were either pregnant or in their reproductive years(7). One way by which poor maternal vitamin D status might increase risk of cesarean delivery is by reducing strength of the pelvic musculature and the mother's ability to push and deliver vaginally(8). Some have speculated that cesarean section rates have increased due to a relationship between birth weight and maternal pelvis size, positing on the basis of Darwinian-inspired logic that since the advent of successful Caesarean birth over the last 150 years, more mothers with small pelvises and babies with large birth weights have survived and contributed to these traits. However, this idea fails to take into account that historically disproportion in childbirth was caused by maternal malnutrition in childhood, in particular malformed pelvic bones due to childhood rickets. Improved maternal nutrition should have led to increased ease in vaginal birth, not an increase in cesarean sections.(5)Vitamin D deficiency is common in Arab women, and its deficiency in pregnancy is detrimental to the health of both mother and child and is largely due to how Arab women dress outdoors - preventing exposure of the skin to sunlight and subsequent vitamin D intake as the majority of vitamin D is synthesized photochemically by the skin from ultraviolet B radiation.(9) There is a growing body of evidence that Vitamin D levels have fallen below what is considered healthy in the overall population and vitamin D has reemerged as an important nutritional factor in maternal and infant health.

Patients and Method

This prospective case-control study was conducted in the Department of Obstetrics and Gynecology in Al-Yarmouk teaching hospital for a period of 1 year starting from the first of October 2012 to the first of October 2013. The study protocol was approved by Obstetrics and Gynecology committee of Iraqi Board for medical specialization and the hospital administration and verbal consent was taken from each patient included in the study.

Patient Collection:

This study included 100 singleton pregnant women; fifty women with cesarean section for the first time (study group) another fifty women with spontaneous vaginal delivery (control group) who were enrolled in this study. All attended the labor ward in Al-Yrmouk Teaching Hospital, Department of Obstetrics and Gynecology during the study period. Serum level of 25(OH) vitamin D was measured in both groups and the correlation of vitamin D level with cesarean section was studied. Vitamin D level was measured; women in both groups were classified according to their vitamin D status into vitamin D deficient group (level<30nmol/L), vitamin D insufficient group (level 30-49.9 nmol/L) and those with normal (adequate) vitamin D (level=>50). During the conduct of this study we have encountered an obstacle; the number of tests allowed per day was very limited and restricted to two patients only and the test was not available at the weekend. This explains the small sample collection, so we selected daily the first 2 patients who were:

- Primigravida.
- Singleton pregnancy with cephalic presentation,
- term pregnancy (37-42 weeks),
- with spontaneous onset of labor, (women planned for induction were excluded),
- no history of thyroidectomy or parathyroidectomy,
- women with known pre-pregnancy BMI .
- no history of travel within two months.
- no history of medical illness (liver, renal, thyroid or parathyroid disease),
- no history of drug interference or alcohol intake.

Enrollment was evenly distributed over the time to ensure data was representative of season as sunlight exposure affects vitamin D status (10). All women were of the same ethnic group. Full history and obstetrical examination was taken for all of them; their progress of labor was observed on partogram.

Blood sample was collected by veni-puncture within 24 hours of delivery. None of the patients were receiving an IV infusion at time of the veni-puncture. Serum 25(OH)D, was accepted as the indicator of vitamin D status in children and adults, and was measured by competitive electrochemiluminescence protein binding assay by Roche Cobace e411(11). The half life of 25(OH)D is about 21 days; it was minimally influenced by fasting or changes in dietary intake during a short fasting.

At the conclusion of the study period we ended with 100 patients.

Data analysis

The dependent variable was maternal vitamin D deficiencies, defined as serum 25(OH)D level less than 30 nmol/l, 30-49.9 nmol/l as insufficiency and=>50nml/l as adequate. Prenatal vitamin use was analyzed as well as frequency of use in each trimester. BMI measured by dividing the weight in kg by the height in m^2 according to

WHO ranges. Reason of cesarean section was obtained from the surgeon who performed the cesarean section. Continuous variables are presented as medians with binomially obtained 95% confidence intervals.

Statistical analysis

Analysis of data was carried out using the available statistical package of SPSS-20 (Statistical Packages for Social Sciences- version 20). Data were presented in simple measures of frequency, percentage, mean, standard deviation, range (minimum-maximum values). The significance of difference of different means (quantitative data) was tested using analysis of variance (ANOVA) for more than two groups and using independent student-t-test for difference between two means. Statistical significance was considered whenever the P value was equal to or less than 0.05.

Results

There is no significant difference in the age, level of education between the study group and the control group since the p-value was= 0.525 for the age and 0.909 for the level of education. There is no significant difference in BMI between the two groups. (Table 1 - below).

74% of cesarean sections were performed for cephalopelvic disproportion,13% for fetal distress; there were no significant associations between vitamin D use during pregnancy or season of birth, but there was significant association with history of vitamin D use before pregnancy(p=0.0001) as shown in Table 2 - opposite page.

The mean vitamin D level in the cesarean group was (28.12 ±20.38) which is significantly lower than that in the vaginal delivery group (43.82±16.45) p=0.0001. Plasma PTH levels were inversely associated with vitamin D levels and there was direct relation between vitamin D and plasma Ca levels p=0.0001 (Table 3 - opposite page).

The relative risk of cesarean section is 4.47 in women with vitamin D deficiency and insufficiency (95%CI=1.75-11.43) compared to women with normal vitamin D level (Table 4, Figure 1 - page 8).

Discussion

The main focus of the current work is to study the possible correlation between vitamin D level and primary cesarean section in term pregnancy. Vitamin D plays a major role in bone metabolism and vitamin D deficiency can initiate rickets and pelvic deformity in the future which may prevent vaginal delivery; also vitamin D acts on the growth of skeletal muscle receptors (Vitamin D receptors) (12,13); vitamin D deficiency and insufficiency are related to muscle mass and strength in younger women(14-16), thus its deficiency or insufficiency reduces the power of pushing during labor and increases the risk of cesarean section.

Vitamin D insufficiency is a common problem worldwide. Among a sample of Iraqi pregnant women, vitamin D deficiency and insufficiency was found in 40% and 38% pregnant women respectively(17). Moreover the rate of cesarean section was 38% according to the Iraqi Ministry of Health report for 2012.

In the current study, it was found that 23 women (46%) of those who underwent primary cesarean section had vitamin D level of less than 30 nmol/l placing them in the vitamin D deficient group. After excluding other confounding factors, there was a 4.5 fold increase in cesarean section rate for those in the deficient group in comparison with the vitamin D sufficient group. Their main indication for cesarean section (74%) was due to cephalopelvic disproportion (CDP) and 26% due to fetal distress. These results neither differ markedly from prevalence data reported by the center for disease control using institute of medicine guidelines, Micheal 2008, Theresa. O Scoll 2012 or Merewood 2009 studies(18-20). They demonstrated that 22.9% of patients who

Table 1: Demographic characteristics for the age, level of education, BMI (Kg/m2) in study group compared to controls

	Cesarean delivery	Vaginal delivery	P value
Age (years)	25.02±5.08 (16-34)	25.06±4.41 (17-34)	0.697
BMI (Kg/m2)	24.57±6.82 (16.0-39.5)	23.35±4.52 (17.0-34.0)	0.296
Gestational age (weeks)	39.9±1.3 (38-42)	38.8±1.1 (36-41)	0.0001*
*Significant using Students-t-test for difference between two independent means at 0.05 level			
Data were presented as Mean ± SD (Range)			
-23 were males and 27 were females, equal for both groups			

Table 2: Indications for cesarean section and association with season of birth, vitamin D use in each trimester and before pregnancy

		Cesarean delivery		Vaginal delivery		P value
		No	%	No	%	
Cause for CS	CPD	37	74.0	-	-	-
	Fetal distress	13	26.0	-	-	
First Trim Vit D use	Yes	34	68.0	37	74.0	0.509
	No	16	32.0	13	26.0	
Second Trim Vit D use	Yes	42	84.0	40	80.0	0.603
	No	8	16.0	10	20.0	
Third Trim Vit D use	Yes	40	80.0	39	78.0	0.806
	No	10	20.0	11	22.0	
History of taking Vit D	Never	33	66.0	18	36.0	0.0001*
	Occasionally	8	16.0	27	54.0	
	Daily	9	18.0	5	10.0	
Season of birth	Spring	16	32.0	13	26.0	0.795
	Summer	10	20.0	8	16.0	
	Autumn	7	14.0	9	18.0	
	Winter	17	34.0	20	40.0	
*Significant using Pearson Chi-square test at 0.05 level						

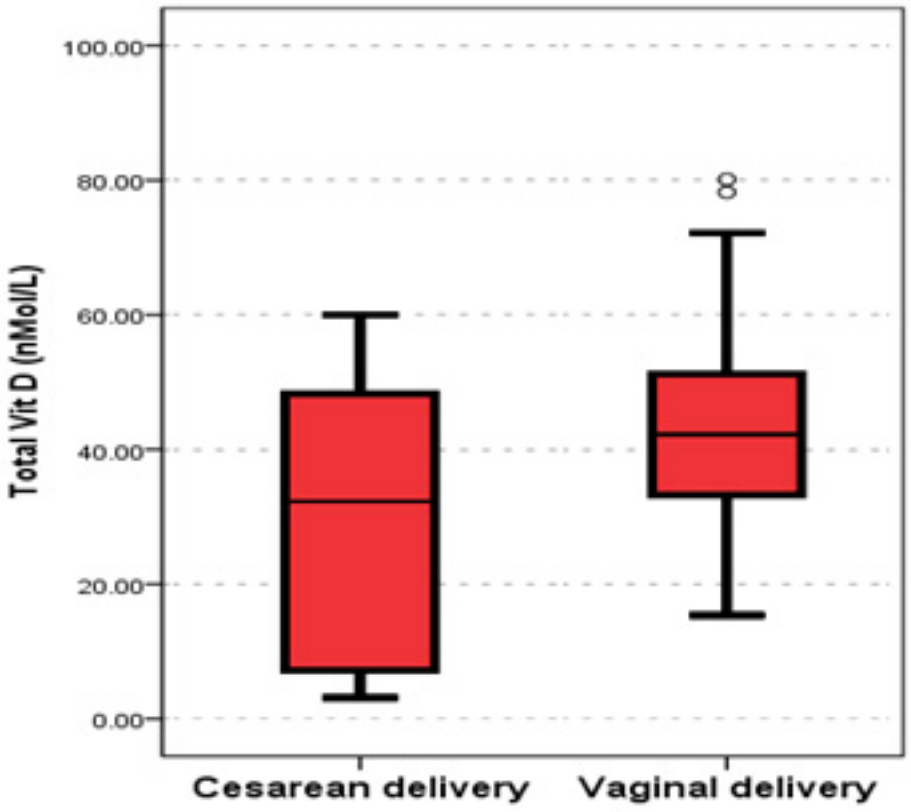
Table 3: The relation between vitamin D, plasma PTH and plasma Ca levels

		Cesarean delivery		Vaginal delivery		P value
		No	%	No	%	
Total Vit D (nMol/ll)	<30	23	46.0	8	16.0	0.0001*
	30-49.9	16	32.0	26	52.0	
	=>50	11	22.0	16	32.0	
	Mean ± SD (Range)	28.12±20.38 (3.15-60.00)		43.82±16.45 (15.38-80.12)		
Plasma PTH (pg/ml)	Low (<15)	-	-	4	8.0	0.0001*
	Normal (15-65)	28	56.0	42	84.0	
	High (>65)	22	44.0	4	8.0	
	Mean ± SD (Range)	50.23±23.52 (16.10-82.00)		31.85±19.05 (10.50-86.40)		
Plasma Ca (mEq/dL)	Low (<8.5)	23	46.0	3	6.0	0.0001*
	Normal (8.5-10.5)	26	52.0	33	66.0	
	High (>10.5)	1	2.0	14	28.0	
	Mean ± SD (Range)	8.53±1.00 (6.8-10.7)		9.88±1.15 (8.0-12.5)		
*Significant using Pearson Chi-square test at 0.05 level						

Table 4: Vitamin D levels in cesarean and vaginal delivery groups

	Total Vit D (nMol/L)				P value
	<30		30-49.9		
	No	%	No	%	
Cesarean delivery	23	46.0	27	54.0	0.001*
Vaginal delivery	8	16.0	42	84.0	
OR=4.47 95%CI=1.75-11.43					
*Significant using Pearson Chi-square test at 0.05 level					

Figure 1: Vitamin D in cesarean and vaginal delivery groups



undergo primary cesarean section had vitamin D concentration of <30 nmol/l considered as a deficient group, another 19.1% had vitamin D concentration of 30-49.9nmol/l and 17% more than 50nmol/l so there was a 2 fold increase in primary cesarean section in those with vitamin D deficiency. One explanation for our findings is the fact that skeletal muscle contains the Vitamin D receptors (21). Vitamin D deficiency has been associated with proximal muscle weakness as well as suboptimal muscle performance and strength(22-27). Moreover, vitamin D deficiency is a possible risk factor for preeclampsia(28,29), which is a common indication for cesarean section in primigravida.

Papandreouet et al (30). reported significantly higher serum calcium levels in pregnant women at the time of vaginal delivery compared with term women not in labor or women who were not in labor but delivered by scheduled cesarean. It was speculated that the higher serum calcium levels played a role in the mechanism of initiation of labor because vitamin D is critically important for maintenance of calcium homeostasis. It is possible that vitamin D deficiency, which causes a slight lowering of the serum calcium, is related to both skeletal muscle and smooth muscle strength and may play a role in initiation of early labor. It is also possible that vitamin D deficiency might be related to specific types of cesareans (such as cephalopelvic disproportion or failure to progress) than to others (such as breech), although we did not have a large enough sample to be able to analyze this. This finding can be confirmed on a large scale study which would be a critical area for future research. Serum

ca and 25(OH)D are positively related, when vitamin D concentration increase is associated with increased serum calcium level, p- value 0.0001,(Table 5). Vitamin D status is linked to immune status(31, 32). Certain infections have been associated with preeclampsia which in turn increases the odds of cesarean (33). Vitamin D deficiency may thus be a marker for a compromised immune system and an associated, higher risk for cesarean.

A study performed in 1994-1995 by Brunvand et al. (34) found no association between vitamin D deficiency at the time of delivery and obstructed labor in a case control study of Indian women giving birth in Karachi. Their findings bear little relevance for the present study however; outcomes were measured only for cesareans due to cephalopelvic disproportion; the sample consisted of largely undernourished women, and 71% of study participants were severely vitamin D deficient [25(OH)D <30 nmol/liter]. In addition, the paper did not satisfactorily clarify the use of the term cephalopelvic disproportion (as opposed, for example, to alternative, yet closely related reasons such as fetal distress). The specific validity of the term disproportion has been questioned for more than a year.(35,36).

Other variables, which are factors associated with primary cesarean section, BMI, vitamin D use (during 1st, 2nd and 3rd trimester), history of vitamin D intake before pregnancy, season, education, all are factors associated either with elevated or no significant difference in the rate of cesarean section, according to the BMI, season, vitamin D use in 1st, 2nd and 3rd trimester, level of education we found no significance difference between both group in the study. According to the history of vitamin D intake before pregnancy we found significant decrease in the rate of cesarean section in patients with a positive history of vitamin D intake.

The Parathyroid hormone (PTH) is inversely related with 25(OH)D; an increased concentration of PTH is a functional indicator of vitamin D deficiency and insufficiency, consistent with others we found, that as circulating concentrations of 25(OH)D decreased, PTH rose(37,38). In our study PTH was increased at concentrations suggestive of deficiency and insufficiency, declined as 25(0H)D increased and was no different when concentrations consistent with vitamin D sufficiency and those exceeding 50 nmol/L were compared. There is no significant difference with prevalence data reported by, Merewood study(2009), Michael study (2008) and Theresa O. Scholl study(2012). A randomized clinical trial is now needed to determine whether adequate vitamin D supplementation during pregnancy to raise blood levels of 25(OH)D above at least 37.5 nmol/liter can reduce the cesarean section rate.

Conclusions

- Serum vitamin D level was significantly lower in patients with primary cesarean section in comparison to the control group.
- There is a significant increase in the rate of cesarean section in patients with vitamin D level <30 nmol/L.
- Vitamin D deficiency and insufficiency are common in Iraqi women. Health professionals have been slow to respond to this problem even though the issue has been highlighted in the literature for a number of years.

References

1. Melamed ML, Michos ED, Willett W, Jorde R, Post W, Pande JN et al. 25-Hydroxyvitamin D levels and the risk of mortality in the general population. Archives of Internal Medicine. 2008; 168(15): 1629-37.
2. Ginde AA, Scragg R, Schwartz RS, Figenschau Y, Cook JA, Stonehouse W et al. Prospective study of serum 25-hydroxyvitamin D level, cardiovascular disease mortality, and all-cause mortality in older U.S. adults. J of Am Geriatric Society.2009; 57(9): 1595-603.
3.Villar J, Valladares E, Wojdyla D, Zavaleta N, Shah A, Campodónico L, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. Lancet 2006; 367(9525): 1819-29.
4. Belizán JM, Althabe F, Cafferata ML. Health Consequences of the Increasing Caesarean Section Rates. Epidemiology. 2007; 18 (4): 485-6.
5. Walsh, Joseph A. “Evolution and the Cesarean Section Rate”. The Am Biol Teacher 2008; 70 (7): 401-4.
6. Yu C, Sykes, Sethi M, Teoh T, Robinson S. Vitamin D deficiency and supplementation during pregnancy. Clin Endocrinol 2009, 70(5):685-90.
7. Hudson Street Press., Penguin Group, USA. Holick, M, The vitamin D solution: A 3-step strategy to cure our most Common health problem. November. Institute of Medicine. Washington, DC: Nat Academy Press2010; 19(8):218-19.
8. Ceglia L. Vitamin D and its role in skeletal muscle. Current Opinion in Clin Nutr and Metab Care2009; 12(6):628-33.
9. Feldman, D., Pike, J.W., & Glorieux, F.H., eds. Holick, M. F. Photobiology of vitamin D. J Clin Endocrinol Metab 2005;45,422-30.
10. Holick MF Resurrection of vitamin D deficiency and rickets. J Clin Invest 2006; 116:2062-72
11. Chen TC, Turner AK, Holick MF. A method for the determination of the circulating concentration of 25-hydroxyvitamin D. J Nutr Biochem 1990;1:315-19.
12. Ceglia, L. Vitamin D and skeletal muscle tissue and function. Mol. Aspects Med 2008, 29, 407-14.
13. Ward, K.A.; Das, G.; Berry, J.L.; Roberts, S.A.; Rawer, R.; Adams, J.E.; Mughal, Z. Vitamin D status and muscle function in post-menarchal adolescent girls. J. Clin Endocrinol Metab 2009,94, 559-63
14. Foo, L.H.; Zhang, Q.; Zhu, K.; Ma, G.; Hu, X.; Greenfield, H.; Fraser, D.R. Low vitamin D status has an adverse influence on bone mass, bone turnover, and muscle strength in Chinese adolescent girls. J. Nutr 2009, 139, 1002-7.

15. Marantes, I.; Achenbach, S.J.; Atkinson, E.J.; Khosla, S.; Melton, L.J., III; Amin, S. Is Vitamin D a determinant of muscle mass and strength? J. Bone Miner. Res. 2011, 26, 2860-71.
16. Badalian, S.S.; Rosenbaum, P.F. Vitamin D and pelvic floor disorders in women. Obstet Gynecol 2010, 115, 795-803.
17. Henan. D. SK., The correlation between maternal & newborn serum 25-hydroxy-vitamin D in sample of Iraqi women. ME-JIM, 2013, 6(5):3-12.
18. Michael Holik, MD, ph D. Vitamin D Deficiency associated with greater rates of cesarean sections. J Nutr 2008,133, 140-48.
19. Theresa O. Scholl, Xinhua Chen and Peter Stein. Nutrients Maternal vitamin D status and delivery by cesarean section. nutrients 2012, 4, 319-30.
20. Merewood, A.; Mehta, S.D.; Chen, T.C.; Bauchner, H.; Holick, M.F. Association between vitamin D deficiency and primary cesarean section. J. Clin Endocrinol Metab 2009, 94, 940-45.
21. Hanley DA, Davison KS. Vitamin D insufficiency in North America. J Nutr2005, 135:332-89. Holick MF. Vitamin D deficiency. N Engl J Med 2007, 357:266-81.
22. Bischoff-Ferrari H, Giovannucci E, Willett WC, Dietrich T, Dawson-Hughes B. Estimation of optimal serum concentrations of 25-hydroxyvitamin D for multiple health outcomes. Am J Clin Nutr2006, 84:18-28.
23. Holick MF. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. Am J Clin Nutr 2004 80(6):1678-88.
24. Torres CF, Forbes GB, Decancq GH. Muscle weakness in infants with rickets: distribution, course, and recovery. Pediatr Neurol1986, 2:95-98.
25. Staud R. Vitamin D: more than just affecting calcium and bone. Curr Rheumatol Rep 2005, 7:356-64.
26. Molgaard C, Michaelsen KF. Vitamin D and bone health in early life. Proc Nutr Soc 2003,62:823-28.
27. Siddiqui TS, Rai MI. Presentation and predisposing factors of nutritional rickets in children of Hazard Division. J Ayub Med Coll A bbottabad. 2005, 17:29-32.
28. Bodnar LM, Catov JM, Simhan HN, Holick MF, Powers RW, Roberts JM. Maternal vitamin D deficiency increases the risk of preeclampsia. J Clin Endocrinol Metab.2007, 92:3517-22.
29. Hypponen E. Vitamin D for the prevention of preeclampsia? A hypothesis. Nutr Rev. 2005, 63:225-32.
30. Papandreou L, Chasiotis G, Seferiadis K, Thanasoulias NC, Dousias V, Tsanadis G, Stefos T. Calcium levels during the initiation of labor. Eur J Obstet Gynecol Reprod Biol.2004, 115:17-22. 99. Adams JS, Hewison M. Unexpected actions of vitamin D: new perspectives on the regulation of innate and adaptive immunity. Nat Clin Pract Endocrinol Metab.2008, 4:80-90.
31. Adams JS, Hewison M. Unexpected actions of vitamin D: new perspectives on the regulation of innate and adaptive immunity. Nat Clin Pract Endocrinol Metab.2008, 4:80-90.
32. Adams JS, Liu PT, Chun R, Modlin RL, Hewison M. Vitamin D in defense of the human immune response. Ann NY Acad Sci 2007, 1117:94-105.
33. Vanek M, Sheiner E, Levy A, Mazor M. Chronic hypertension and the risk For adverse pregnancy outcome after superimposed pre-eclampsia. Int J Gynae-Col Obstet2004, 86: 7-11.
34. Brunvand L, Shah SS, Bergstrom S, Haug E. 1998 Vitamin D deficiency in pregnancy is not associated with obstructed labor. A study among Pakistani women in Karachi. Acta Obstet Gynecol Scand 77:303-6.
35. Lydon-Rochelle MT, Holt VL, Cardenas V, Nelson, JC, Easterling TR Gardella C, Callaghan WM. The reporting of pre-existing maternal medical conditions and complications of pregnancy on birth certificates and in hospital discharge data. Am J Obstet Gynecol 2005, 193:125-34.
36. Gibberd GF. Can we correctly assess cephalopelvic disproportion? Am J Obstet Gynecol1953, 65:1284-92.
37. Institute of Medicine, Food and Nutrition Board. Dietary reference intakes for calcium and vitamin D. Washington, DC: Nat Academy Press 2010; 41(5):301-9.
38. Institute of Medicine. Dietary Reference intakes for calcium and vitamin D. Report Brief. 2010; 81(7):331-402.