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Original Research Article

Vitamin D status in pregnant female and its effect on the maternal and fetal outcome

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ABSTRACT

Background: Vitamin D deficiency is a global public health problem and is very common in pregnancy. Vitamin D status during pregnancy is of very much importance as it's deficiency leads to increase risk of maternal and fetal complications like hypertensive disorders of pregnancy (HDOP), gestational diabetes mellitus (GDM), preterm, prelabor rupture of membranes (PROM), caesarean section, low birth weight (LBW) babies, intrauterine growth restriction (IUGR), still birth and neonatal intensive care unit (NICU) admission.
Methods: 300 pregnant women were studied to assess serum vitamin D level over period of 9 months followed by analytical study done regarding maternal and fetal outcome.
Results: Study shows 250 pregnant women out of 300 were deficient in vitamin D. Most of vitamin D deficient patients were under age of 30 years, housewives from rural sector. In both groups, most of patients underwent vaginal delivery. Pregnancies with complication were more seen in vitamin D deficient patients which include higher rate of GDM and HDOP. But other pregnancy complications like preterm, abruption, and prolonged labor were not prominently associated with vitamin D deficiency. Fetal complications and higher NICU admission rate were more seen in babies of vitamin D deficient mothers but no or little effect found on birth weight.
Conclusions: Our study has observed higher rate of vitamin D deficiency in pregnant women and its level had significant effect on maternal and fetal complications. Though routine screening is not beneficial attributed to its high prevalence rate and cost effectiveness but since supplementation of vitamin D is simple with low likelihood of toxicity, we recommend adequate exposure to sunlight and supplementation of vitamin D in all pregnant women to keep serum level of 25(OH)D in the normal range for adult >30 ng/ml.

Keywords: Fetal and maternal outcome, Pregnancy, Vitamin D

INTRODUCTION

Vitamin D has emerged as a micronutrient of concern due to widespread prevalence of deficiency and being the most untreated nutritional deficiency currently in the world.[1,2] Vitamin D deficiency during pregnancy and childbirth poses more threat to health than in other periods of life.

It has been estimated that around 1 billion people worldwide have been vitamin D deficient or insufficient. The global prevalence of vitamin D deficiency ranges between 54–100% and insufficiency ranges between 39–76%, respectively.[6] Among Asian countries, unexpectedly, vitamin D deficiency is widespread in tropical countries such as India where majority of its population lives in areas receiving ample sunlight throughout the year. Individual studies in India report 93% prevalence in Delhi, 97% in Bangalore, Karnataka, and 94% in Mumbai, and Maharashtra.[7,8] Vitamin D deficiency is identified by the circulating concentration of 25 (OH)D, the indicator of nutritional vitamin D status. There is no consensus in defining vitamin D deficiency in pregnancy, and cut-off serum value range from 10 to 32 ng/ml. According American College of Obstetricians and Gynecologists (ACOG), serum vitamin D concentration of at least 20 ng/ml is needed to avoid bone problems and

vitamin D deficiency should be defined as circulating vitamin D levels less than 32 ng/ml. Endocrine society defines deficiency of vitamin D as serum levels below 20 ng/ml and insufficiency between 20 and 30 ng/ml.[9] Given the lack of solid, consistent outcome data with higher levels of vitamin D, we feel that a minimum level of 30 ng/ml would be desirable in pregnancy. This still leaves scope for better outcomes with higher levels, further data is still awaited.

The physiological role of vitamin D implicated beyond bone health evoked extensive research. Data suggests vit D – through its effect on immune function and surveillance – plays a role beyond calcium and bone metabolism on the health status of both the mother and her fetus. Deficiency in pregnancy is known to increase risk of hypertensive disorders of pregnancy (HDOP), gestational diabetes mellitus (GDM), preterm birth, prelabor rupture of membranes (PROM), caesarean section and other tissue-specific conditions.[11-13] Moreover, vitamin D status of new born is affected by vitamin D levels of mothers and its deficiency leads to fetal complications, low birth weight babies, intrauterine growth restriction (IUGR), still birth and admissions in neonatal intensive care unit (NICU).

The paucity of national data and high prevalence of vitamin D deficiency as per regional evidence identifies the need to know whether vitamin D status affect the maternal and fetal outcome or not, and if it does, then to what extent. Therefore, the present study has been undertaken with the objective to compare maternal and fetal outcome of pregnant women with normal vitamin D level as against pregnant women having vitamin D deficiency.

Aim

The aim of the study was to compare feto-maternal outcome between vitamin D deficient and vitamin D sufficient pregnancies.

METHODS

Our study was a hospital-based prospective case control analytical observational study which was conducted in the obstetrics and gynecology department of Umaid Hospital, Dr. SNMC, Jodhpur, Rajasthan. Study was conducted in patients admitted in Umaid Hospital during 9 months of study period from September 2021.

Inclusion criteria

Pregnant women in 3rd trimester in active labor admitted were included.

Exclusion criteria

Pregnant women with - active thyroid disease like thyroiditis or Grave's disease, Cushing disease; pre-existing calcium or parathyroid condition; chronic ill conditions like kidney and liver diseases; osteoblastic and osteoclastic malignancies; and drugs inhibiting vitamin D3 absorption and metabolism including diuretic, and calcium channel blocker were excluded.

Data collection

After counselling and informed consent, 300 eligible women who fulfilled our inclusion criteria were enrolled. Information on age, education, parity, occupation, iron and calcium intake and obstetric history was obtained from the mother using a questionnaire. Blood investigations like haemoglobin, and serum vitamin D was done. These women were followed up and the delivery details including gestation age at delivery, mode of delivery, intrapartum and postpartum complications were recorded. The birth outcome, baby details, birthweight and neonatal events were also written on predesigned proforma. According to serum vitamin D value, these women were categorized as vitamin D sufficient and vitamin D deficient and analysis study regarding maternal and fetal outcome was carried out. In our study, the sufficient value of vitamin D was taken as more than 30 ng/ml and deficient as less than 30 ng/ml

Statistical analysis

Data was expressed as frequency and percentage (%). Association between vitamin D category, demographic variable, mode of delivery and maternal and fetal outcome was assessed by Chi square test/fisher exact test. A p value of 0.05 or less was considered statistically significant.

RESULTS

The present study was done on 300 patients admitted in labor ward in the obstetrics and gynaecology department, Umaid Hospital, Jodhpur, Rajasthan.

These were subjected to assess serum vitamin D levels. Table 1 shows only 16.67% pregnant women were vitamin D sufficient, rest 83.33 % were vitamin D deficient. Table 2 shows the socio demographic characteristics of patients according to vitamin D status. In vitamin D deficient group, majority of patients were in age group less than 30 years old (87.20 %), multigravida (54.40%), belonging from rural areas (60%), housewife (92%), and were not supplemented with vitamin D (87.2%).

Table 1: Vitamin D status.

Vitamin D status	No. of patients	%	P value
Vitamin D deficient (<30 ng/ml)	250	83.33	<0.0001 (S)
Vitamin D sufficient (>30 ng/ml)	50	16.67	
Total	300	100.00	

S: significant.

Table 3 shows 12% of vitamin D deficient group had non-reactive NST while all of vitamin D sufficient group had reactive NST.

Table 4 shows in vitamin D deficient group, 69.60% patients and in vitamin D sufficient group, 72% had vaginal delivery. In vitamin D deficient group 30.40% patients and in vitamin D sufficient group 28% patients underwent C-section.

Table 5 summarizes in vitamin D deficient group 46.4% of them had developed complications, while in vitamin D sufficient group 20% of them had complications. Table 6 shows pregnancy with complication in vitamin D deficient include GDM (8.80%), preterm (7.20%), gestational HTN (6.40%), pre-eclampsia (3.6%), eclampsia (2.4%), PROM (4.80%), abruption (3.20%), cord prolapse (0.40%), DTA (1.60%), malpresentation (1.60%), meconium-stained liquor (2.40%), obstructed labor (0.80%), post-partum haemorrhage (PPH) (2.80%), fetal distress (4%), and prolonged labor (1.60%).

Table 6 categorize HDOP, where out of total HDOP, 88.50% were vitamin D deficient and only 11.50% had sufficient vitamin D level. This include gestational HTN (84.2% in deficient group, 15.78% in sufficient group), pre-eclampsia (90% in deficient group, 10% in sufficient group) and eclampsia patient (100% vitamin D deficient).

Table 7 summarizes live birth (96.80%) in vitamin D deficient group and (100%) in sufficient group. Low birth weight group included 7.20% in vitamin D deficient group and (4%) in sufficient group. NICU admission in vitamin D deficient group (8.26%) and no admission in vitamin D sufficient group.

Table 8 shows in vitamin D deficient group 5.60% had IUGR, 3.20% had asphyxia and 3.20% were IUD and 88% had no complications. As compared to in vitamin D sufficient group 4% had IUGR, 2% had asphyxia and 94% had no complications with no IUD.

Table 2: Socio-demographic factors.

Sociodemographic parameters	Vitamin D deficient		Vitamin D sufficient		Total		Chi square and p value
	N	%	N	%	N	%	
Age (years)							
≤30	218	87.20	34	68.00	252	84.00	Chi square=11.42
>30	32	12.80	16	32.00	48	16.00	P value=0.0007 (S)
Parity							
Primigravida	114	45.60	20	40.00	134	44.67	Chi square=0.528
Multigravida	136	54.40	30	60.00	166	55.33	P value=0.467 (NS)
Home							
Rural	150	60.00	34	68.00	184	61.33	Chi square=1.124
Urban	100	40.00	16	32.00	116	38.67	P value=0.289 (NS)
Occupation							
Housewife	230	92.00	22	44.00	252	84.00	Chi square=71.42
Working	20	8.00	28	56.00	48	16.00	P value <0.0001 (S)
Supplement							
Yes	32	12.80	28	56.00	60	20.00	Chi square=48.60
No	218	87.20	22	44.00	240	80.00	P value <0.0001 (S)

S: significant, NS: non-significant.

Table 3: Non-stress test.

NST	Deficient		Sufficient		Total		Fisher exact test, P value
	N	%	N	%	N	%	
Reactive	220	88.00	50	100.00	270	90.00	0.004 (S)
Non-reactive	30	12.00	0	0.00	30	10.00	

S: significant

Table 4: Mode of delivery.

Mode of delivery	Deficient		Sufficient		Total		Fisher exact test, P value
	N	%	N	%	N	%	
Vaginal	174	69.60	36	72.00	210	70.00	Chi square=0.114,
C-section	76	30.40	14	28.00	90	30.00	P value=0.735 (NS)

NS: non-significant.

Table 5: Pregnancy outcome.

Pregnancy outcome	Vitamin D deficient		Vitamin D sufficient		Fisher exact test, P value
	N	%	N	%	
Pregnancy without complication	134	53.6	40	80	Chi square=11.92, P value=0.0006 (NS)
Pregnancy with complication	116	46.4	10	20	

NS: non-significant.

Table 6: Pregnancy complication.

Pregnancy complications	Deficient		Sufficient		Total	
	N	%	N	%	N	%
Abruption	8	3.20	1	2.00	9	3.00
Cord prolapse	1	0.40	0	0.00	1	0.33
Deep-transverse arrest	4	1.60	0	0.00	4	1.33
Eclampsia	6	2.40	0	0.00	6	2.00
GDM	22	8.80	2	4.00	24	8.00
Pre-eclampsia	9	3.60	1	2.00	10	3.33
Gestational HTN	16	6.40	3	6.00	19	6.33
Malpresentation	4	1.60	0	0.00	4	1.33
Meconium-stained liquor	6	2.40	0	0.00	6	2.00
Obstructed labor	2	0.80	0	0.00	2	0.66
PPH	7	2.80	0	0.00	7	2.33
Preterm	18	7.20	1	2.00	19	6.33
Fetal distress	10	4.00	1	2.00	11	3.66
Prolonged labor	4	1.60	0	0.00	4	1.33
PROM	12	4.80	1	2.00	13	4.33
No complication	134	53.60	40	80.00	174	58.00

Table 7: Hypertensive disorders of pregnancy.

HDOP	Deficient	%	Sufficient	%	Total	%	Chi square and p value
Gestational HTN	16	84.2	3	15.78	19	100	P value=0.002 (S)
Pre-eclampsia	9	90	1	10	10	100	
Eclampsia	6	100	0	0	6	100	
Total	31	88.50	4	11.50	35	100	

S: significant.

Table 8: Preterm.

Preterm	Deficient	%	Sufficient	%	Total	%	Fisher exact test, P value
Preterm	18	7.2	1	2	19	6.33	P value=0.217 (NS)
Term	232	92.8	49	98	281	93.67	
Total	250	100	50	100	300	100	

NS: non-significant.

Table 9: Neonatal outcome.

Neonatal outcomes	Deficient		Sufficient		Total		Fisher exact test, P value
	N	%	N	%	N	%	
Birth outcome							
Live	242	96.80	50	100.00	292	97.33	P value=0.360 (NS)
IUD	8	3.20	0	0.00	8	2.67	
Birth weight							
VLBW (<1.5 kg)	4	1.60	0	0.00	4	1.33	

Continued.

Neonatal outcomes	Deficient		Sufficient		Total		Fisher exact test, P value
	N	%	N	%	N	%	
LBW (1.5-2.49 kg)	18	7.20	2	4.00	20	6.67	Chi square=1.659, p value=0.436 (NS)
Normal (2.5-3.5 kg)	228	91.20	48	96.00	276	92.00	
Admission in NICU							
Mother	222	91.74	50	100.00	272	93.15	Fisher exact test, p value=0.030 (S)
NICU	20	8.26	0	0.00	20	6.85	
Fetal complications							
Asphyxia	8	3.20	1	2.00	9	3.33	
IUD	8	3.20	0	0.00	8	2.67	
IUGR	14	5.60	2	4.00	16	5.33	
MAS	0	0.00	0	0.00	0	0.00	
No complications	220	88.00	47	94.00	267	89.00	

NS: non-significant, S: significant.

DISCUSSION

Vitamin D deficiency is a global public health problem and it is very common in pregnancy. Vitamin D status during pregnancy is very much important as mother is the sole source of vitamin D substrate for her developing fetus.

Table 1 revealed that the prevalence of vitamin D was 83.33% in spite of abundant sunshine. The finding was similar to the study conducted by Prasad et al (88%) and Mahfooth et al (87%).[19,30] Navaneethan et al found the prevalence of vitamin D deficiency in pregnant women of South India to be more than 60%.[16] According to the study done by Arora et al, the prevalence was 95.5% and similar rate of 93.5% was reported by Sharma et al.[25,26] This difference is probably due to the difference in the amount of sunshine between the different parts of the country.

Vitamin D deficiency is attributed to various risk factors including age, parity, skin tone, mother dressing habit, dietary vitamin D intake, Vitamin supplementation, duration and timing of sunlight exposure. Table 2 shows vitamin D deficiency significantly associated with age group of <30 years. Maternal age has been positively associated with higher vitamin D level in some studies. These results might be due to reason that most pregnancies enrolled in our hospital are under age group <30. Table 2 shows occupation and vitamin D are highly associated. The risk of vitamin D deficiency was higher in housewives who mostly preferred to live indoor and reduced exposure to direct sunlight. Our study also shows statistically significant association with vitamin D deficiency and supplementation of vitamin D which is in agreement with Shiraishi et al.

In our study, we found no correlation of parity and residency with vitamin D deficiency. Though rural group patients had more vitamin D deficiency than urban group but results were similar in vitamin D sufficient group. These results might be affected because most of patient enrolment in our hospital is from rural sector. These results were similar to study conducted Dipali et al and Mahfooth et al.[19,30]

Table 3 shows vitamin D status is significantly associated with non-stress test. Though yet no sufficient data available to support these associations and more studies need to be done.

Vitamin D status and mode of delivery

Research on the association between vitamin D deficiency and Mode of delivery has produced conflicting results. Our study (Table 4) shows no significant association between increased risk of caesarean section and vitamin D deficiency which is similar to study conducted by Fernandez-Alonso et al, and Mahfooth et al.[30] However, study by Dave et al shows an association of vitamin D deficiency and caesarean deliveries but this association is not statistically correlated. Merewood et al proposed maternal vitamin D status may be associated with risk for primary caesarean section through calcium's role in the initiation of labor, or by increasing preeclampsia risk.[28] Some studies revealed that vitamin D deficiency would cause proximal muscle weakness and reduced lower extremity muscle function might be increased the risk for caesarean section. Segregating the vitamin D deficiency with the indications of caesarean section will be more important to understand the role of vitamin D in initiation of labor or association with the calcium metabolism.[14] WHO suggest vitamin D supplementation probably makes little or no difference to the risk of caesarean section compared with placebo or no vitamin D.[27]

Vitamin D status and pregnancy complication

Table 5 summarizes the maternal outcome where vitamin D deficiency has been associated with several pregnancy complications. These results were similar to study done by Abdulbari and Aghajafari et al.[17,18] Though study by Prasad et al fails to show a direct relation between low maternal vitamin D level and adverse maternal and fetal outcome.[19]

In Table 6, pregnancy with complication include GDM, preterm, gestational HTN, pre-eclampsia, eclampsia. Other complications include PROM, abruption, cord prolapse, DTA, malpresentation meconium-stained liquor,

obstructed labor, PPH, fetal distress, and prolonged labor. Though more studies need to be done to signify these associations.

Vitamin D status and gestational diabetes mellitus

In the current study, numbers of gestational diabetes were 24 patients of which 22 (8.80%) had vitamin D deficiency and 2 (4%) were vitamin sufficient. This shows significant association of GDM and vitamin D deficiency. Similar results found in meta-analysis review of various studies where they reported that pregnant women with diabetes mellitus had significantly lower vitamin D levels than the comparison group. and Zhang et al in their studies stats that maternal vitamin D deficiency in pregnancy has been associated with elevated risk for gestational diabetes mellitus, although findings are still not consistent.[24] Studies suggested vitamin D has important role in glucose and insulin metabolism. There is also a number of evidences about the role of vitamin D in maintaining glucose tolerance through its influence on insulin secretion and sensitivity. WHO suggest that vitamin D supplementation may reduce the risk of developing GDM compared with placebo or no vitamin D.[27]

Vitamin D status and hypertensive disorders of pregnancy

There is conflicting evidence about whether hypovitaminosis D in pregnancy is associated with HDOP. Table 7 reported out of total HDOP, 88.50% were vitamin D deficient and only 11.50% had sufficient vitamin D level. That shows significant association between maternal vitamin D level and HDOP (gestational HTN, pre-eclampsia, and eclampsia).

These results go with various studies by Bodnar et al, and Holick et al, who found that maternal vitamin D deficiency in pregnancy has been associated with an increased risk of HDOP (PIH, eclampsia and pre-eclampsia).[3,20,21] Two meta-analyses, including a metanalysis of eight and thirty-one studies, demonstrated that vitamin D insufficiency was associated with preeclampsia. On contrary, in Cochrane review 2012, showed no difference in the incidence of preeclampsia in study and control groups.[5] So, it is difficult to say whether vitamin D is an independent risk factor for HDOP.

Study found that pre-eclampsia and vitamin D deficiency are directly and indirectly associated through biologic mechanisms including immune dysfunction, placental implantation, abnormal angiogenesis, excessive inflammation, and hypertension.[20,23] The other hypothesis is low circulating levels of insulin-like growth factor-1 (IGF-1) and vitamin D is associated with preeclampsia. The other hypothesis is an abnormal expression of 1α-hydroxylase found in preeclamptic pregnancies. Vitamin D is also hypothesized as an immune modulator which could suppress T-cell receptor-induced T-cell proliferation, change cytokine expression, and decreasing γ-interferon and interleukin-2 production, which may be related to the occurrence of preeclampsia. Vitamin D also influences blood pressure regulation by plasma renin and calcium homeostasis. As per WHO guidelines, 2020 vitamin D supplementation may reduce the risk of developing pre-eclampsia compared with placebo or no vitamin D.[27]

Regarding eclampsia, in our study reported numbers of eclampsia patients were only 6 (2.40%) but serum level of vitamin D of all these patients was low. Since this is a very small sample size to comment on the association further large studies in this perspective would be needed.

Vitamin D status and preterm birth

In our study, there was an increased incidence of preterm birth in the group with vitamin D deficiency. Though the difference was not significant. WHO suggests that vitamin D probably makes little or no difference to the risk of preterm birth (<37 weeks of gestation) compared with placebo or no vitamin D.[27] Singh et al studied the relationship between vitamin D deficiency and preterm labor in the Indian population, which suggest the risk of preterm was higher in the hypovitaminosis group.[4] A potential inverse association between maternal vitamin D status and preterm birth (less than 37 weeks' gestation) has been reported by Dawodu et al and Morley et al.[15,22] Studies shown increased markers of inflammation in both vitamin D deficiency and preterm delivery and PPROM. Some studies shown this may be linked to ability of vitamin D to reduce bacterial infections by inducing the production of the antibacterial compound, cathelicidin, in placental cells. Liu et al reported that the toll-like receptor triggers the vitamin D-mediated human antimicrobial response. The result of some of these studies needs to be interpreted with caution as some of them focused on specific risk factors like the previous history of preterm labor, twin pregnancy, and other risk factors of preterm labor.

Vitamin D status and fetal outcome

In our study, Table 9 shows maternal vitamin D level status had no statistical correlation with baby outcome and low birth weight which was similar to the study done in France and study by Thorne-Lyman while study by Leffelaar et al showed significant association.[29] WHO says it is unclear whether or not vitamin D makes any difference to the risk of having a low birthweight neonate compared with placebo or no vitamin D, as the certainty of the evidence is very low. In contrast, the overall meta-analysis from 10 studies by Fariba et al showed a significant association between SGA infants and vitamin D insufficiency compared with the comparison group.[18]

Table 9 shows significant association between vitamin D status and NICU admission. These may be due to preterm birth and associated maternal and fetal complications in vitamin D deficient group. In these study in vitamin D

deficient group 5.60% had IUGR, 3.20% had asphyxia and 3.20% were IUD and 88% had no complications. However, this is a very small sample size to comment on the association of maternal vitamin D level and fetal outcome. Multiple confounding factors could be implicated for the vitamin D effects on gestational baby size and fetal complications such as ethnicity, nutritional status, sunlight exposure, maternal condition, gestational age. Many studies have emphasized that vitamin D has effects on fetal programming and gene regulation might explain why it has been associated with many health benefits throughout life.[9,21]

Screening for vitamin D deficiency during pregnancy

There is no evidence supporting the use of universal screening for vitamin D deficiency in pregnancy regarding cost-effectiveness or health benefits. Also, there is little data on telling us which groups of women this might be most useful for. However, our study recommends measurement of vitamin D in the high-risk group women, including with low sun exposure area, dressing habits, high risk pregnancies, women having history of GDM in previous pregnancy, women at high risk of GDM or HDOP in current pregnancy, history of pre-eclampsia/eclampsia in previous pregnancy, women having gestational HTN, previous child with rickets.

Vitamin D supplementation

Despite the plethora of literature on role of vitamin D in pregnancy and related complications, role of supplementation of vitamin D during pregnancy is unclear. Furthermore, there is little evidence on "optimal" supplement of vitamin D. In 2011, the Institute of Medicine recommended 600 IU per day of 25 (OH)D for pregnant women and no more than 4000 IU per day to avoid hypercalcemia.[10] ACOG propose 1000-2000 IU per day of 25 (OH)D when deficiency is identified (<20 ng/ml). WHO does not recommend routine supplementation but for pregnant women with suspected vitamin D deficiency, vitamin D supplements may be given at the current recommended nutrient intake of 200 IU (5 µg) per day.[27]

There are several ongoing RCTs on vitamin D in pregnancy. But the final words on following questions are awaited: universal screening, cut off value of vitamin D level, effect of maternal vitamin D status on maternal and fetal outcome, effectiveness of vitamin D supplementation, adverse effects of vitamin D supplements, any additional benefits or harms of vitamin D when combined with other vitamins or minerals, particularly calcium, optimal dose and timing, and optimal timing of initiation.

Limitations

These study was done in third trimester of pregnancy and hence the effect of maternal vitamin D level in prenatal period and early pregnancy on pregnancy outcome has not been demonstrated in our study. A consensus on "target" 25-OHD levels in pregnancy is lacking. This observed association between maternal vitamin D and feto-maternal outcome could be affected by multiple confounding factors which need to be addressed through more research.

Further work is needed to determine whether vitamin D level have any effect on pregnancy outcome. New high-quality clinical studies are still needed to throw further light on the subject.

CONCLUSION

Vitamin D has now emerged as a novel micronutrient of concern during pregnancy due to widespread prevalence of vitamin D deficiency. Our study has observed higher rate of vitamin D deficiency in pregnant women and its level had significant effect on maternal and fetal complications. Though routine screening is not beneficial attributed to its high prevalence rate and cost effectiveness but pregnant women should be advised to have adequate sunlight exposure since it is the most important source of vitamin D. In view of wide prevalence of vitamin D deficiency and since supplementation of vitamin D is simple and cost effective with a low likelihood of toxicity, we recommend adequate exposure to sunlight and supplementation of vitamin D in all pregnant women to keep serum level of 25(OH)D in the normal range for adult >30 ng/ml.

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