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Research Article

Prevalence of Vitamin D Deficiency and Insufficiency Across Trimesters of Pregnancy in Maiduguri, Nigeria: A Cross-Sectional Study

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ABSTRACT

To determine the prevalence of Vitamin D deficiency and insufficiency across trimesters of pregnancy. A cross-sectional study involving 160 women (40 in each trimester of pregnancy making a total 120 and 40 non-pregnant controls) was conducted at the University of Maiduguri Teaching Hospital, Maiduguri from 1st January 2018 to 31st December 2018. The subjects of the study were randomly recruited at the booking clinic. Socio-demographic characteristics, staple food and gestational age were obtained. Blood sample was collected for 1,25(OH)2 D3, total protein and albumin. The data was analyzed using the Minitab statistical software version 12.21 (Minitab Inc, Pennsylvania, USA). The Mean±SD age of the patients studied was 28.2±4.1 year and 114 (71.3%) were city dweller. There were no statistically significant differences in the parity, BMI, total protein and albumin in both the subjects and controls. On the other hand, the Mean±SD Vitamin D level was lower (23.11±4.27Miu) among the pregnant women compared to 34.78±2.96 Miu in the non-pregnant (F=17.40, P<0.001). Vitamin D deficiency was 52.5% in the first trimester, increased to 55.0% in the second trimester and dropped to 22.5% in the third trimester. While, vitamin D insufficiency roused from 40.0% in the first trimester to 60.0% in the third trimester. There is high prevalence of Vitamin D deficiency and insufficiency among pregnant women in Maiduguri. There is need to provide vitamin D supplementation preconception or early in the antenatal period so that the women will achieve Vitamin D sufficiency in pregnancy and beyond.

Keywords: *Deficiency, Insufficiency, Pregnancy, Prevalence, Trimester, Vitamin D*

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INTRODUCTION

Vitamin D is an essential fat-soluble vitamin that modulates the absorption of calcium and phosphate. In pregnancy there is increased demand for calcium especially in the third trimester and sufficient Vitamin D status becomes crucial to meet up with the heightened calcium absorption for optimal maternal and fetal outcomes. Studies have shown that vitamin D status of the infant at birth and in early infancy depends on the vitamin D status of the mother during pregnancy (Marwaha *et al*, 2011; Abbasian *et al*, 2016).

Vitamin D synthesis is essentially endogenous (90%) but the remaining 10% is of dietary source and in case of inadequate exposure to sunlight, women will have to depend on diet or supplements to achieve sufficient vitamin D status. In a tropical environment, 30-35 minutes exposure of 12% - 18% of body surface area to sunlight provides equivalent of 600-1000 IU of vitamin D (Harinarayan, 2018). Cutaneous synthesis of vitamin D depends on the time of the day, latitude of the area and increased skin pigmentation (Harinarayan, 2018). Despite the abundance of sunlight, the risk factors for vitamin D deficiency such as obesity, house bound women and women at risk of Pre-eclampsia abound in our environment (Mackillop, 2017). In addition, our situation is further compounded by the high cost of vitamin D rich diets such as egg, liver, salmon, sardines, canned fish and diary product.

Meta-analyses of observational studies have documented that low serum vitamin D concentrations in pregnancy is associated with increased risk of small for gestational age (SGA) and preterm birth (Qin, 2016; Chen *et al*, 2017). Maternal Vitamin D deficiency is also associated with reduced fetal bone growth and neonatal lung maturation leading to rickets and chest infections in childhood (Galthen-Sørensen, 2014, Lykkedegn, 2015). Sufficient maternal Vitamin D status will positively influence both mother's and child's immune system. Newer evidence suggests that vitamin D supplementation in pregnancy in a single or continued dose increases serum 25-hydroxyvitamin D at term and will reduce the risk of pre-eclampsia, low birthweight and preterm birth (De-Regil *et al*, 2016: Maugeri *et al*, 2019). These studies highlight the need for improved maternal calcium and vitamin D status in developing countries in an effort to support best maternal and child health outcomes across these regions.

Many studies have reported increased prevalence of both maternal hypocalcaemia (Sanchez *et al*, 1997; Kumar *et al*, 2010; Gupta *et al*, 2016; Egesie and Dike, 2018) and Vitamin D deficiency in developing countries (Marwaha *et al*, 2011; Sanchez *et al*, 1997; Owie and Afolabi 2018; Enkhmaa *et al*, 2019; van der Pligt *et al*, 2018). Also coinciding with the incessant reports of malnutrition in our region (United Nations, 2016), we noticed many patients presenting during the antenatal period with hypocalcaemic tetany with dramatic responds to calcium infusion and supplementation.

The study on serum calcium and Vitamin D in Maiduguri conducted about 2 decades ago showed reduced levels of both calcium and vitamin D amongst teenage mothers but the older mothers were not included in the study.[11] It is imperative to review the vitamin D levels in pregnancy and suggest the need or otherwise for regular supplementation in pregnancy in our environment. This study aimed to determine the prevalence of Vitamin D deficiency across the trimesters of pregnancy and compare with healthy non-pregnant controls in Maiduguri, Nigeria.

PATIENTS AND METHODS

This was a hospital based cross-sectional study to determine the serum levels of Vitamin D among pregnant women who booked for antenatal care at the UMTH Maiduguri from 1st January 2018 to 31st December 2018. After obtaining Ethical approval was obtained from the hospital research and ethic committee, the subjects of the study were randomly recruited from the population of pregnant women for a larger study for serum calcium in pregnancy at the booking clinic. All participants were counselled and gave informed consent before been enrolled in to the study. One hundred and twenty pregnant women that satisfied the inclusion criteria were selected randomly and they were compared with 40 non-pregnant healthy women from the family planning clinic. Women on calcium or Vitamin D supplements prior to booking and women with other diseases such as HIV infection, sepsis, pregnancy induced hypertension, diabetes mellitus, sickle cell disease were excluded.

Socio-demographic variables and clinical characteristics such as age, parity, staple food, educational status and gestational age were noted and recorded on a profoma designed for the study. Allocation into one of three social classes was based on the Participant's husband's occupation and the participant's educational level according to a scoring system designed by Olusanya *et al* (1985) for Nigeria and other African countries. Gestational age was determined by the last menstrual period and/or the result of early ultrasonographic examination.

For each participant, 3 millilitre of blood was collected under aseptic conditions without venous stasis in the antecubital fossa with subject lying to exclude posture effect. The blood samples collected in plain containers were allowed to clot and centrifuged at 4000 rpm for 5 minutes. The serum was collected and labelled appropriately and stored at -20^{0}C for batch analysis of total protein, albumin and 1,25(OH)2 D3. Serum Vitamin D was determined using Elisa technique and it was done before the expiration date. Total protein was estimated using the Biuret method while albumin was determined by bromocresol green method.

The data obtained was analyzed using the Minitab statistical software for windows version 12.21 (Minitab Inc, Pennsylvania, USA). Where appropriate, risk was estimated using odd ratio at 95% confidence interval. Chi-square was used to test for association between categorical variables. Means for continuous variables were compared using Students t-test and Analysis of Variance (ANOVA) was used to compare means between trimesters of pregnancy. P value of less than 0.05 was set for statistical significance. Tables and graphs were also used to illustrate pattern in the variables. Women with serum vitamin D levels < 20ng/ml were considered to have vitamin D deficiency, levels between 20-29ng/ml were considered to have vitamin D insufficiency and 30ng/ml or more as Vitamin D sufficient (Marwaha *et al*, 2011; Owie and Afolabi 2018).

RESULTS

A total of 160 women were recruited for the study, 40 in each trimester of pregnancy and 40 non-pregnant controls. Married women constituted 152 (95.0%), 114 (71.3%) were city dweller and 54 (33.8%) were unemployed housewives. Both the pregnant women and the non-pregnant controls were similar in age, parity and BMI as shown in table 1. Similarly, majority of the women used cereal crops as their staple food, 107(89.2%) and 34(85.0%) of the pregnant and non-pregnant participants respectively with X^2=2.81, P=0.25. Educational attainment was also comparable in the two groups with majority of them having had at least secondary school education: 79(65.8%) of the pregnant versus 29(72.5%) of the non-pregnant participants with the X^2=0.61, P=0.43.

The Mean±SD serum total protein and albumin of the pregnant and non-pregnant participant were 63.8±7.21 and 64.3±4.92 versus 36.72±3.74 and 36.44±2.23 with F=0.26, P=0.67 and F=0.16, P=0.69 respectively as shown in Table 1.

Table 1:
Sociodemographic characteristics, total protein and albumin of women studied

	Variable	Pregnant	Non-Pregnant	F Value	P value
1	Age in years	28.1 ±5.6	28.6 ± 7.13	F = 0.24	P = 0.65
2	Parity	2.1 ± 1.9	2.2 ±1.72	F = 0.34	P = 0.45
3	BMI in kg/m^2	26.4 ±4.9	25.4 ±5.14	F = 2.45	P = 0.23

4	Total Protein in g/ml	63.8 ±7.2	64.3 ±4.92	F = 0.26	P = 0.67
5	Serum Albumin in g/ml	36.7 ±3.7	36.4 ±2.23	F= 0.16	P = 0.69

Table 2:
Level of Vitamin D deficiency among pregnant and non-pregnant participant.

	Vitamin D level	Pregnant (%)	Non-pregnancy (%)
1	Vitamin D deficiency (<20ng/ml)	52(43.33)	7(17.5)
2	Vitamin D insufficiency (20-29ng/ml)	53(44.17)	10(25.0)
3	Vitamin D Sufficient (>30ng/ml or more)	15(12.5)	23(57.5)
4	Total	120(100)	40(100)
	X^2=33.81, P=0.0001		

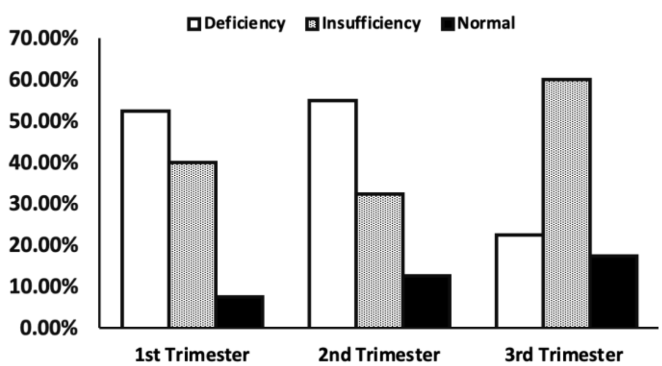

Figure 1:
Vitamin D Level in Pregnancy

The Mean±SD serum Vitamin D level was significantly lower among the pregnant women compared to the non-pregnant (23.11±4.27 versus 34.78±2.96 with F=17.40, P=0.001).

Both Vitamin D deficiency and insufficiency were more prevalent in pregnancy as shown in table 2. One hundred and five (87.50%) of the pregnant participants have either vitamin D deficiency or are vitamin D insufficient compared to 17(42.50%) of the non-pregnant participants. In the same vain, the Vitamin D deficiency and insufficiency were variable across the trimester of pregnancy as shown in Figure 1. Vitamin D deficiency was 52.5% in the first trimester and it increased to 55.0% in the second trimester and dropped to 22.5% in the third trimester. while, the percentage of vitamin D insufficiency roused from 40.0% in the first trimester to 60.0% in the third trimester

DISCUSSION

This is the first study in the northeast Nigeria to review the vitamin D levels among women in the 3 trimesters of pregnancy and also compared with non-pregnant controls. It gives an idea of the variation in the vitamin D across the different stages of pregnancy and suggest the need or otherwise for vitamin D supplementation and the best time to commence it. The women are age-matched, BMI and protein levels are similar which suggest that they are of comparable nutritional background. The serum protein and albumin can be used to infer the nutrition background of an individual (Sanchez et al 1997). The normal protein and albumin levels in the pregnant and non-pregnant women also suggest that the patients are not in any malnourished state. However, they are from a typical African family with majority depending on cereal crops for energy. Most traditional African families staple food is mainly cereals (Ismaila et al 2010).

Vitamin D deficiency and insufficiency are quite prevalent in pregnancy in our environment. The deficiency been worst in the first and second trimester with gradual improvement in the third trimester coinciding with the time of heightened calcium absorption to cater for the rapid growth and development of the bones and teeth of the fetus. Vitamin D insufficiency, was highest in the third trimester but this could be because so many of the women with deficiency earlier in pregnancy improved to become vitamin D insufficient in the third trimester. Even in the third trimester only 17.5% of the women had sufficient serum vitamin D levels. A similar trend in the level of Vitamin D through the trimesters of pregnancy was also observed in China (Zhao et al 2014), but the difference in vitamin D levels between 2nd and 3rd trimester was not significant in their study. Choi et al (2015) in their study among Korean women also noted a high prevalence of Vitamin D deficiency in the first trimester compared to the third trimester.

The Vitamin D rich food such as egg, liver, salmon, sardines, canned fish and diary products are expensive and not affordable by most households in a developing economy like ours. This coupled with high occurrence of risk factors for Vitamin D deficiency provides a perfect environment for Vitamin D deficiency to thrive.

The level of Vitamin D deficiency in pregnancy in this study is higher than 1.12% in Shahroud, Iran (Abbasian et al 2016), 4.8% in Lagos, Nigeria (Owie and Afolabi 2018) but is lower than 77.3% in Seoul, Korea (Choi et al 2015) and 90.3% in Western, Turkey (Halicioglu et al 2012). These differences may be because of geographical locations, life style and eating habit. While the level of Vitamin D insufficiency in pregnancy in this study is higher than the 28.3% in Lagos, Nigeria (Owie and Afolabi 2018), 60.2% in Shahroud, Iran (Abbasian et al 2016). The vitamin D deficiency among the non-pregnant women in this study is lower than the 79.2% in Seoul Korea (Choi et al 2015).

The mean±SD serum concentration of Vitamin D in pregnancy is higher than 11.5±.4ng/ml reported by Halicioglu et al in Turkey (2012). The lower value in their study can be attributed to the life style of the Turkish ladies that involved covering most of the bodies thereby reducing exposure of their skins to sunlight. Our finding is similar to the study by Marwaha et al (2011) in New Delhi (23.2±12.2ng/ml) but their finding on the inter trimester vitamin D levels contrast with this study.

In view of the high prevalence of vitamin D deficiency, there is urgent need to educate the populace on the dangers of Vitamin D deficiency and the essence of correcting it before pregnancy. This is even more important in view of the recent link between calcium deficiency, vitamin D deficiency and Pre-eclampsia. Vitamin D supplementation can be an important way of reducing the occurrence of Pre-eclampsia in our setting. Apart from increasing calcium absorption in the gut, its anti-inflammatory property at the placental bed may be very vital (Azizieh et al 2016).

Like most similar studies (Kumar et al, 2010; Marwahaet al, 2011; Abbasian et al, 2016), the deficiency of Vitamin D is observed amongst healthy pregnant women and in view of its role in calcium and phosphorous homeostasis that is necessary for skeletal bone, teeth and immune modulation in the fetus, it pertinent to device ways of preventing the deficiency (Roth et al 2018). Life style modification by engaging in outdoor activities with increased exposure to sunlight together with the use of food items that are fortified with Vitamin D should be encouraged.

Pilz et al (2018) suggested that, for a woman to achieve Vitamin D sufficiency and ensure adequate supply to the fetus or infant, an intake of vitamin D supplement at a dose of 800 to 1000 IU per day should be encouraged during preconception or pregnancy. A recent study in a population with high prevalence of antenatal vitamin D deficiency and fetal and infant growth restriction showed that commencement of supplementation from mid-pregnancy did not improve fetal or infant growth (Thorne-Lyman and Fawzi 2012). This underscores the need to commence supplementation in the preconception period.

In conclusion, The prevalence of Vitamin D deficiency and insufficiency in pregnancy in Maiduguri is high. There is need to provide vitamin D supplementation during preconception or early in the antenatal period so that the women will achieve Vitamin D sufficiency in pregnancy and lactation.

The major limitation of the study is the small sample size. We recommend a larger study to elucidate our finding and its consequences on pregnancy outcome.

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