Vitamin D status and risk factors among pregnancy of shanghai in China

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Research Article

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Abstract

Background

This study was to assess vitamin D nutritional status and risk factors among pregnancy of shanghai in China.

Methods

A cross-sectional study conducted in the Sixth Affiliated People's Hospital of Shanghai Jiao Tong University. All pregnancy was measured for plasma vitamin D, total blood cholesterol (TCh), high-density lipoprotein (HDL), low-density lipoprotein (LDL) or very-low-density lipoprotein (VLDL) cholesterol and triglycerides, and completed OGTTs test. Age, height, and weight variables came from their electronic medical records. Criteria for vitamin D status were: <12 ng/ml: severe deficiency; 12–19 ng/ml: deficiency; 20–29 ng/ml: insufficiency; 30–50 ng/ml: normal; and > 50 ng/ml (particularly > 60 ng/ml): possibly leading to adverse effects. Vitamin D was measured from December 2016 to April 2017.

Results

Our study included 953 pregnant women. The mean vitamin D level of pregnancy was 16.06 (range 10.90 to 20.60) ng/ml,and severe vitamin D deficiency was 31.79%(303); vitamin D deficiency was 40.71 % (388); vitamin D insufficiency was 25.08%(239); normal vitamin D was 2.42%(23). Vitamin D deficiency risk factors were age over 30, parity over 2, overweight, obese, gestational diabetes mellitus, and hyperglycemia.

Conclusions

It is a high prevalence of vitamin D deficiency of Chinese pregnancy in shanghai. Aging more than 30 years, the parity of more than 2, overweight and obesity, gestational diabetes mellitus and hyperglycemia are risk factors for vitamin D deficiency. Public health strategies should focus on the population of pregnancy in shanghai in China.

Background

Vitamin D is an essential fat solubility vitamin that is a requirement to regulate calcium metabolism and promote human health [1]. Vitamin D in the human body is acquired through dietary intake and cutaneous synthesis under ultraviolet radiation. Vitamin D keeps balance normal homeostasis of calcium and phosphorus and plays an essential part in the development and maintenance of bone tissue [2-4]. Vitamin D status has been found to associate with cancers, immune deregulation, diabetes mellitus, cardiovascular health, muscle function, and mental health [5].

Vitamin D deficiency (VDD) is taken for a public health issue in both developing and developed nations, and pregnant women have been considered to be high-risk groups, in which the prevalence of VDD ranges from 20% to 80%[6, 7]. Low vitamin D status during pregnancy is associated with adverse health effects, such as depression[8], breast cancer, type 2 diabetes, type 1 diabetes [9], cardiovascular diseases[10], autoimmune diseases[11], infections[12]and autism[13]. Several previous studies have associated vitamin D deficiency with low birth weight [14, 15], preterm births [16], and autoimmune disorders such as type I diabetes mellitus [17] and impaired blood vessel function [18]. The latter may lead to preeclampsia, which is a common cause of maternal death [19]. Moreover, inadequate vitamin D among mothers may lead to bone impairment and osteoporosis [20], gestational hypertension/preeclampsia [21-23], gestational diabetes [24], small for gestational age (SGA)[25]. Most recently, low vitamin D levels are associated with depressive symptoms during pregnancy and postpartum depression [26]. Low vitamin D levels are also related to an increased risk of gestational diabetes, preeclampsia, small for gestational age infants, and low birth weight infants, but no association was found with delivery by cesarean section [27].

Vitamin D status and metabolism during pregnancy affect the absorption of calcium from the intestinal tract and outdoor activities. The Chinese traditional dietary pattern is mainly based on vegetable and grain, which raised the possibility of low levels of vitamin D status. Better understanding of vitamin D status and metabolism during pregnancy and lactation are needed, particularly in regions of the world where mothers are at risk of suboptimal vitamin D status. Therefore, the aim of the study was to determine vitamin D status and its determinants among pregnancy of shanghai in China.

Methods

The study was carried out in accordance with the guidelines proposed in the Declaration of Helsinki and all procedures involving human subjects went through ethical approval by the Ethics committee of Sixth Affiliated People’s Hospital of Shanghai Jiao Tong University (2016016). All participants signed an informed consent form. All pregnant women in their late second or early third trimester of pregnancy in the obstetrics department from December 2016 to April 2017 were identified and their data were reviewed retrospectively. Individuals who had presence of symptoms or signs of active infectious disease or chronic illness; abnormal renal/liver function (serum glutamate pyruvate transaminase [SGPT] ≥ 18 IU/L, serum glutamate oxaloacetate [SGOT] ≥16 IU/L, serum urea concentration ≥7.5 mmol/L, serum alkaline phosphatase concentration ≥280 IU/L); presence of Hepatitis B surface antigen (HBSAg) or antibodies to Hepatitis C virus (HCV) or Human Immunodeficiency Virus (HIV) were excluded.

A 75 g oral glucose tolerance test (OGTT) was ordered at 24–28 weeks’ gestation to screen for Gestational diabetes mellitus (GDM). It may be repeated in the third trimester for women with normal test results if there is suspicion of GDM. Diagnosis of GDM was made with either fasting plasma glucose levels ≥5.1, plasma glucose levels for 1h after glucose intake ≥10.0, or plasma glucose levels for 1h after glucose intake ≥8.5 mmol/L [28].

Vitamin D status was determined with Serum 25(OH) D levels. Blood samples were gathered in the morning in the pregnant women with after a 10–12 h fasting period, and were centrifuged 0.5-1 h after collection. Serum 25(OH) D levels were measured by electrochemiluminescence immunoassay with Roche Cobas 6000's module e601 (Roche Diagnostics GmbH, Mannheim, Germany) (29). Participants with a serum 25(OH)D concentration of less than 12 ng/ml, between 12 and less than 20 ng/ml and between 20 and less than 30 ng/ml were regarded to present severe vitamin D deficiency, vitamin D deficiency, and vitamin D insufficiency. Concentrations between 30 and 50 ng/ml were considered normal, while those over 50 ng/ml (particularly >60 ng/ml) were regarded to possibly cause adverse effects[30, 31]. According to the adult BMI classification standards for the Chinese population[32], pre-pregnancy BMI, calculated as weight (kg) divided by height (m) squared, was categorized into four groups: underweight (<18.5 kg/m^2), normal (18.5 kg/m^2 to 24.0 kg/m^2), overweight (24.0 kg/m^2 to 28.0 kg/m^2) and obese (≥28.0 kg/m^2).

Participants were screened for total blood cholesterol (TCh), high-density lipoprotein (HDL), low-density lipoprotein (LDL) or very-low-density lipoprotein (VLDL) cholesterol, and triglycerides were measured with an automatic biochemical analyzer (Hitachi 7600 120, Hitachi, Japan). Women with <280 mg/dL 7.28mmol/Lat term or ≥280mg/dL TCh were considered as maternal physiological hypercholesterolemia (MPH) or maternal supraphysiological hypercholesterolemia (MSPH) [33]. The cut-off point of 280 mg/dL TCh for MSPH was established for the following reasons: (1) all assays performed in samples from women with ≥280 mg/dL TCh were found to exhibit significant differences from those from women with <280 mg/dL TCh, (2) patients with a TCh level approaching this point are associated with fetal fatty streaks, and (3) this value is above the mean TCh level (~247mg/dL, range 184-315 mg/dL) considered normal in pregnancy of different groups [34].

Statistical analysis

Participants were classified into sub-groups according to hypothesized vitamin D status predictors: age group, parity, pre-pregnancy BMI, gestational hypertension, and gestational diabetes. To determine associations between vitamin D levels and the hypothesized predictors, a Kruskal-Wallis test followed by a Mann–Whitney U test was conducted as Kolmogorov–Smirnov test did not reveal a normal distribution for most sub-groups.Associations between vitamin D deficiency and possible predictors (age group, pre-pregnancy BMIparity, gestational hypertension, and gestational diabetes) were assessed with a multinomial logistic regression analysis. Data were analyzed with the statistical software package SAS version 9.2. The primary analysis is descriptive and 95 % Cite significance level was set at P <0.05 using two-sided tests.

Results

Our study found that the level of vitamin D of Chinese pregnant women in shanghai was 16.06 (10.90-20.60) ng/mland 31.79% (303) pregnant women had severe vitamin D deficiency; 40.71 %(388) had vitamin D deficiency; 25.08%(239) had vitamin D insufficiency ; only 2.42%23had normal vitamin D;

None were found to have vitamin D above 50 ng/ml. Our study found that the level of vitamin D increased with age groups（t=8.48，p=0.04）; Vitamin D deficiency decreased with age groups (X^2=17.62, P=0.04). As the parity of Chinese pregnancy in Shanghai increased, the level of vitamin D was decreased （t=2.70，p=0.04） and Vitamin D deficiency was increased（X^2=44.90, P=0.00）. As pre-BMI levels increased, the level of vitamin D decreased（t=14.00，p=0.00），Vitamin D deficiency is increased（X^2=29.28, P=0.01）. The level of vitamin D in pregnancy of gestational diabetes mellitus was lower than non-gestational diabetes mellitus pregnancy (t=12.05，p=0.02) and the prevalence of Vitamin D deficiency was higher than non-gestational diabetes mellitus pregnancy（X^2=2.35, P=0.01）. There was no statistical significance of other variables (Table 1).

Our results of the multinomial logistic regression model for screening for vitamin D deficiency risk factors found that aging over 30, parity over 2, overweight and obesity, gestational diabetes mellitus and gestational hyperglycemia of pregnancy were risk factors for vitamin D deficiency. Risks for presenting with vitamin D deficiency in pregnant women aging over 30 were 3.54 times that of women under 30; and risks for women with over parity 2 of pregnancy were 2.79 times that of women below parity 2. Risks of vitamin D deficiency for overweight and obese and gestational diabetes mellitus and hyperlipemia pregnancy were 2.12 and 2.16 and 2.58 and 1.49 times that of normal pregnancy（Table 2）.

Discussion

Our study assessed the vitamin D status of Chinese pregnant women in Shanghai. Over 97.58% of pregnant women had less than optimal levels of vitamin D level. Among all the 953 pregnant women, 691 were deficient, 239 were insufficient, only 23 were sufficient, and none was at risk of hypervitaminosis. The results of our study were consistent with other study results，in which serum appropriate vitamin D level detection rate is less than 5% in China[35]. While vitamin D deficiency was highly prevalent, the reason maybe our serum samples were gathered during the winter and spring months, pregnant women put on more clothes to protect against ultraviolet rays during this period. The high prevalence of low vitamin D status is consistent with previous studies of pregnant women living in the Chinese Guiyang region [7] . A recent study of pregnant women living in Chinese south-western showed that 83.6% exhibit vitamin D levels of <20 ng/ml[36]. Another research showed that 68.6 % pregnant women of southeastern China showed vitamin D levels of <20 ng/ml [37]. The high proportion of low vitamin D status is common in pregnant women of other countries. The study from Egypt[38], reported that only 35.8% of pregnant women had blood levels over 30 ng/mL, In a study from India, it has been reported that in pregnant women, 86% were presented with vitamin D deficiency, 9.5% with insufficiency, and only 4.5% had sufficient vitamin D level[39]. A national survey from Belgium found 74.1% women with vitamin D insufficiency (<30 ng/mL) and 44.6% with deficiency (<20 ng/mL) [40], and in northern Spain the deficiency and insufficiency rates were 27.4% and 35.3% in pregnant women [41].

Our study found the level of vitamin D of pregnant women was in positive correlation with age and was in negative correlation with parity. Pregnant women who were under 30 and had over 2 parturition experience were more likely to suffer from vitamin D deficiency. Our study results showed that more attention should be given to this particular risky group of pregnant women particularly under the current Second Child Policy of the Chinese government.

In our study, overweight and obese pregnant women had lower vitamin D levels and there was a higher possibility for them to show vitamin D insufficient based on the 30nmol/l cut-off, indicating that they need to consume vitamin D supplement. Previous studies showed that for overweight and obese adults, daily vitamin D intake should be 1.5 times and 2–3 times higher than those with normal weight [42, 43], indicating that it is essential for people with excess body weights to take vitamin D supplements.

Preliminary studies showed that vitamin D take part in glucose homeostasis. The mechanism possibly refers to both insulin secretion and insulin action [44]. Lower vitamin D level increases the risk of type-2 diabetes and metabolic syndrome [45]. Moreover, a recent meta-analysis showed that maternal low vitamin D status accelerated the risk of GDM [45]. Our results displayed gestational diabetes mellitus patients has a lower vitamin D level and were more likely to present vitamin D deficiency. The reason may be vitamin D is known to impact insulin secretion. Vitamin D regulates insulin secretion by pancreatic β-cells and thereby affects glucose levels in the circulation[46]. So, low vitamin D level is a risk factor for insulin resistance, glucose intolerance, and features of metabolic syndrome in norm glycemic participants. Vitamin D deficiency during early pregnancy significantly increases the risk of gestational diabetes in late pregnancy[47].

Our study found gestational hyperglycemia was a factor of vitamin D deficiency; however, vitamin D status was no difference between pregnancy of gestational hyperglycemia and normal pregnancy. This conflicting finding may have occurred because vitamin D and lipid metabolism in pregnancy is a complex process. Some studies reported vitamin D supplementation in pregnancy reduced serum total and LDL cholesterol level but did not affect serum triglyceride and HDL-cholesterol level [48, 49]. However, some researchers found vitamin D supplementation does not impact on serum lipid profiles while lipid profiles might decrease as a result of increased insulin sensitivity and parathyroid hormone reduction after vitamin D intake [50, 51]. Impact of Vitamin D on blood lipid levels was a complicated process and more researches were needed to explore the reason.

Our study has some limitations that should be mentioned. First, this study was a cross-sectional study; the associations it demonstrated do not imply a causal relationship between the level of vitamin D and risk in our study participants. Second, the study may be confounded by a lack of data on some relevant variables such as information on dietary factors, especially, vitamin D supplement intake, and different season factors. Moreover, this study did not perform a sample size calculation; therefore, the limited number of samples may affect the statistical significance of our results. Further studies are needed to evaluate the limitations of this study.

Conclusions

In summary, there is a high prevalence of vitamin D deficiency of Chinese pregnancy in shanghai. Aging more than 30 years, the parity of more than 2, overweight and obesity, gestational diabetes mellitus and hyperglycemia are risk factors for vitamin D deficiency. Public health strategies should target the above-mentioned population and vitamin D supplements should be considered for pregnancy of shanghai in China.

Declarations

Ethics approval and consent to participate

The study was carried out in accordance with the guidelines proposed in the Declaration of Helsinki and all procedures involving human subjects went through ethical approval by the Ethics committee of Sixth Affiliated People's Hospital of Shanghai Jiao Tong University (2016016). All participants signed an informed consent form.

Consent for publication

Written informed consent for publication was obtained from all participants.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

The authors declare that they have no competing interests.

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Author Contributions

Wenguang Sun and Sheng Ge designed research; Sheng Ge conducted research; WuJing analyzed data and Chun Yang wrote the paper. Wenguang Sun and Sheng Ge had primary responsibility for final content. All authors read and approved the final manuscript.

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Tables

Table 1 Characteristics of Chinese pregnant women in Shanghai (n= 953)

Variable/group	25(OH)D (ng/ml)					Percentage with 25(OH)D (ng/ml)				P value
	n	Mean	95%CI	P value	n	<12	12–19	20–29	30–50	
Total	953	16.06	10.90-20.60		953	31.79% (303)	40.71% (388)	25.08% (239)	2.42% (23)	
Age (years)										
20-25	120	15.64	14.55-16.72	8.48	120	31.67% (38)	42.5% (51)	25.83%(31)	0% (0)	17.62
25-30	471	15.63	15.00-16.24		471	36.52% (172)	38.43% (181)	22.51% (106)	2.54% (12)	
30-35	274	16.77	15.97-17.56		274	26.28% (72)	41.61% (114)	29.56%(81)	2.55% (7)	
≥35	88	16.79	15.45-18.11	0.04	88	23.86% (21)	47.73% (42)	23.86%(21)	4.55% (4)	0.04
Parity										
0	671	16.38	15.86-16.91	2.70	671	30.70% (206)	41.28% (277)	26.08% (175)	1.94% (13)	44.90
1	248	15.29	14.54-16.03		248	35.08% (87)	40.73% (101)	23.39% (58)	0.80% (2)	
≥2	34	14.25	12.25-15.26	0.04	34	29.41% (10)	29.41% (10)	17.65% (6)	23.53% (80)	0.00
Pre-pregnancy BMI (kg/m^2)										
underweight	119	17.13	16.01-18.25	14.00	119	15.97% (19)	52.10% (62)	28.58% (34)	21.05% (4)	29.28
normal	623	16.36	15.81-16.90		623	32.10% (200)	38.20% (238)	27.13% (169)	2.57% (16)	
overweight	162	14.66	13.74-15.57		162	40.74% (66)	40.74% (66)	17.90% (29)	0.62% (1)	
obese	49	14.29	12.76-15.82	0.00	49	36.73% (18)	44.90% (22)	14.29% (7)	4.08% (2)	0.01
Gestational diabetes mellitus										
Yes	56	16.13	15.21-17.52	12.5	56	39.29% (22)	32.14% (18)	25.00% (14)	3.57% (2)	2.35
No	897	14.96	13.98-16.07	0.02	897	31.33% (281)	41.25% (370)	25.08% (225)	2.34% (21)	0.01
Gestational Hyperlipemia										
No	931	16.08	15.01-17.02	0.44	931	31.90% (297)	40.71% (379)	25.13% (234)	2.26% (21)	0.56
Yes	22	15.42	12.95-16.27	0.66	22	27.27% (6)	40.91% (9)	22.73% (5)	9.09% (2)	0.91

Table 2. Multinomial logistic regression model for vitamin D deficiency among pregnant of shanghai in China (n =953)

Variable/group	n	OR	95% CI	P value
Age (years)				
<30	591	ref		
≥ 30	362	3.54	1.76-4.35	0.02
Parity				
<2	921	ref		
≥2	32	2.79	1.64-4.92	0.03
Pre-pregnancy BMI (kg/m^2)				
underweight	119	1.14	0.84-2.11	0.41
normal	623	ref		
overweight	162	2.12	1.65-4.79	0.03
obese	49	2.16	1.84-5.05	0.02
Gestational diabetes mellitus				
No	56	ref		
Yes	897	2. 58	2. 43-3. 74	0.02
Gestational Hyperlipemia				
No	931	ref		
Yes	22	1. 49	1. 26-2.43	0.04

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