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What factors influences dietary and non-dietary vitamin D intake among pregnant women in an African population?

A. Kofi Amegah Ph.D. [a,*], Moses Nsoh B.Sc. [a], Gifty Ashley-Amegah B.Sc. [b], Judith Anaman-Togbor Ph.D. [c]

[a] Public Health Research Group, Department of Biomedical Sciences, University of Cape Coast, Cape Coast, Ghana
[b] Ashgin Pharmacy, Adisadel, Cape Coast, Ghana
[c] Department of Nursing, University of Health and Allied Sciences, Ho, Ghana

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ABSTRACT

Objective: Data on dietary vitamin D (vitD) intake, sunlight exposure, and the associated determinants are lacking in Africa. The aim of this study was to establish the factors influencing vitD intake and sunlight exposure among pregnant women in an African population with the goal of improving maternal vitD nutrition.
Methods: A population-based cross-sectional study was conducted among 703 mother–infant pairs accessing postnatal care at the five main health facilities in Cape Coast, Ghana in 2016. Information on sociodemographic characteristics and sunlight exposure practices during pregnancy were collected using a structured questionnaire. A semiquantitative food frequency questionnaire was used to estimate vitD intake during pregnancy.
Results: VitD nutrition awareness during pregnancy was low in the study area. Education, occupation, ethnicity, and marital status influenced vitD intake in this population. In a multivariable linear regression adjusting for potential confounders, lack of information on essential nutrients needed in pregnancy, and infrequent consumption of recommended foods resulted in 10.51 μg (95% confidence interval [CI], –19.59 to –1.42) and 26.18 μg (95% CI, –47.18 to –5.17) reduction in vitD intake, respectively. Lack of information on the importance of vitD in pregnancy, and on their dietary and non-dietary sources resulted in 11.76 μg (95% CI, –21.53 to –2.00) and 26.34 μg (95% CI, –52.47 to –0.21) reduction in vitD intake, respectively. Employment status of mothers was associated with statistically significant higher sunlight exposure.
Conclusions: The study findings call for rolling out literacy and nutrition education programs targeted at women in sub-Saharan African countries to help improve maternal nutrition.

Introduction

Vitamin D (vitD) is a prehormone with its concentration in the body determined primarily by two factors: exposure of the skin to sunlight [1] and dietary consumption of vitD-rich food such as mushrooms (shiitake and sun-exposed), tuna and other oily fishes, and cooked egg [2]. The reliance on dietary sources of vitD, however, is insufficient to meet the body's requirements, hence it is recommended that individuals get maximum sunlight exposure [3]. This is particularly important for pregnant women because decreased vitD concentration during pregnancy has been associated with adverse pregnancy outcomes including low birthweight, preterm birth, small for gestational age, stillbirth, and spontaneous abortion [4–8]. Pregnancy-related conditions such as gestational diabetes, preeclampsia, and bacterial vaginosis also have been associated with decreased vitD concentration during pregnancy [5,8,9].

Neonatal vitD status is directly related to maternal vitD status through transplacental transfer of vitD [10]. The concentration of vitD in umbilical cord blood is between 50% and 80% of the maternal blood [11]. VitD intake during pregnancy is important for fetal bone development [12,13]. Insufficient vitD intake during pregnancy will thus have adverse implications for fetal and neonatal health.

There is a lack of consensus on the definition of optimal vitD status during pregnancy and the amount of vitD needed to

* Corresponding author: Tel.: +23 324 303 2676; fax: +23 333 209 5792.
E-mail address: aamegah@ucc.edu.gh (A. K. Amegah).

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maintain adequate levels [14]. The Endocrine Society [15] and a committee of vitD experts [16] recommended serum 25-hydroxyvitamin D [25(OH)D] concentration of >75 nmol/L and recommended a daily vitD intake of 37.5 to 50 µg. However, vitD recommendations vary from country to country. In Scandinavian countries, for instance, where there is limited sunlight, it has been recommended that all pregnant women consume 10 µg/d of vitD to optimize vitD status [17]. This is to ensure circulating 25[OH]D concentration of ≥25 nmol/L [17,18]. In the United States and Canada, a dietary allowance of 15 µg/d is recommended for pregnant and lactating women to achieve the Institute of Medicine–targeted serum 25(OH)D concentration of 50 nmol/L [19]. In Australia and New Zealand, the recommended intake for pregnant women is 5 µg/d and a supplement intake of 10 µg/d with insufficient sunlight exposure [20]. In the United Kingdom, 10 µg/d is recommended [21], whereas in Germany, Austria, and Switzerland, 20 µg/d is recommended [22].

In Africa, where there is plentiful sunlight year-round, vitD deficiency is considered a major public health problem. Studies conducted in Tunisia [23], Tanzania [24], Ethiopia [25], and Nigeria [26,27] have reported a high prevalence of vitD deficiency among women, including pregnant mothers. The study conducted in Tanzania recommends a mean serum 25(OH)D concentration of 115 and 139 nmol/L in non-pregnant and pregnant women, respectively [24].

Available evidence suggests that the contribution of dietary sources to vitD nutrition in the Africa region is minimal owing to limited consumption of vitD-rich food such as oily fish, egg yolk, mushrooms, and fortified dairy products [28–30]. Additionally, data on the contribution of sunlight exposure in the region is nonexistent. Dietary practices of pregnant women in Africa and other developing regions have been documented to be poor as a result of poverty, socioeconomic constraints, and ignorance [31–33]. A systematic review reported the usual dietary intake of pregnant women in Africa to be predominantly plant based [32], a situation that could lead to deficiency of important micronutrients needed in pregnancy including vitD [34].

This study, therefore, sought to establish the factors influencing vitD intake and sunlight exposure in pregnant women in Cape Coast, Ghana. The results will provide a better understanding of the factors related to dietary and non-dietary vitD intake and create awareness among pregnant women in Ghana and other sub-Saharan African countries for improved vitD nutrition.

Methods

Study design and site

A population-based cross-sectional study was conducted among mothers and their newborns at the postnatal clinic of the five main health facilities in the Cape Coast metropolis: Teaching Hospital, Metropolitan Hospital, University Hospital, Ewim Polyclinic, and Adisadel Urban Health Centre. Cape Coast covers an area of 122 km^2 with an estimated population of 169 894, according to the 2010 census. Cape Coast is the capital city of the Central Region of Ghana and the smallest of the country's six metropolitan areas.

Study population and data collection

The source population comprised of all nursing mothers residing in Cape Coast and accessing postnatal services at the selected health facilities. Eight hundred mothers who had singleton births with no gross anatomic deformities were randomly sampled and interviewed at the facility. Of the study population, 301 (42.8%) were from the Teaching Hospital, 50 (7.1%) from the Metropolitan Hospital, 150 (21.3%) from the University Hospital, 100 (14.2%) from Ewim Polyclinic, and 102 (14.5%) from the Adisadel Urban Health Centre. The study population included 703 mothers (87.9% response rate).

Assessment of sunlight exposure

Information on mothers' exposure to sunlight was collected using a structured questionnaire. The following information was collected:

- Working or spending time outdoors during pregnancy;
- Period of pregnancy when most outdoor visits were made;
- Frequency of work or time spent outdoors;
- Amount of time spent outdoors during each visit or working activity; and
- Participant's rating of sunlight exposure during their outdoor visits/activities.

The level of exposure to sunlight was defined as follows:

Step 1
1. Classify the following as high sunlight exposure practices: visiting outdoors throughout the duration of pregnancy, visiting outdoors daily or four to five times per week, spending ≥7 h outdoors during each visit, and respondent sunlight exposure rating of high and moderate; and
2. Classify the following as low sunlight exposure practices: visiting outdoors during either the first, second, or third trimester of pregnancy, visiting outdoors two or three times per week, once per week or occasionally, spending ≤6 h outdoors during each visit, and respondent sunlight exposure rating of low and no. A score of 1 and 2 was respectively assigned to the low and high sunlight exposure practices.

Step 2
1. Classify all four high-exposure practices (score of 8) as very high sunlight exposure;
2. Classify any three high-exposure practices and any one low exposure practice (score of 7) as high sunlight exposure;
3. Classify any two high-exposure practices and any two low-exposure practices (score of 6) as moderate sunlight exposure;
4. Classify any one high-exposure practice and any three low-exposure practices (score of 5) as low sunlight exposure;
5. Classify all four low-exposure practices (score of 4) as very low sunlight exposure; and
6. Classify mothers who indicated that they did not spend time or worked outdoors during pregnancy as no exposure (score of 0).

Assessment of vitamin D nutritional status

A semiquantitative food frequency questionnaire (FFQ) was used to establish the frequency of consumption of eight vitD-rich foods together with the usual portion size during the period of pregnancy. In the FFQ, frequency of consumption was assessed on a scale ranging from 0 (*never*) to 8 (*>3 times per day*). Portion sizes (g) were estimated from color photographs of the listed food items. This information was used to estimate vitD intake (µg) of mothers.

Step 1 involved assigning a score to the frequency of consumption of each of the listed food items. The score ranged from 0 to 8 and were assigned to *never, once per month, 2 to 3 times per month, once per week, 2 to 3 times per week, 4 to 5 times per week, once per day, 2 to 3 times per day,* and *more than 3 times per day,* respectively. Step 2 involved multiplying the frequency scores assigned in step 1 with their portion sizes to obtain for each of the listed food items, the quantity consumed. Step 3 involved estimating the amount of vitD intake in each of the foods consumed based on vitamin D content of the food photographs shown to the participants. Step 4 involved summing up the estimates from step 3 to obtain daily vitD intake of the participants.

The listed vitD-rich foods were salmon, mackerel, tuna, sardine, herring, mushrooms (sun-exposed), pork (raised outdoors), and cooked egg yolk.

Ethical considerations

The Institutional Review Board of the University of Cape Coast, Cape Coast, Ghana approved the study (Ethical clearance ID No: UCCIRB/CANS/2015/03). Approval was also sought from the management of the selected health facilities. An informed consent form attached to the questionnaires was used to seek the consent of all participants before inclusion in the study.

Statistical analysis

We compared average vitD intake and sunlight exposure score, according to categories of the sociodemographic characteristics, and nutritional awareness and practices of the participants using *t* test and one-way analysis of variance (ANOVA) to assess the role of chance. With regard to the ANOVA, Tukey's post hoc test was applied to examine the difference in mean concentrations between groups that statistical significance was noted. Linear regression modeling was used to