Introduction

Despite the growing number of centenarians (1), little is known about their nutritional status. Several investigators have explored nutrition-related factors such as low energy intakes (2), antioxidant status (3-5), and cardiovascular diseases in centenarians and their offspring (6-9). However, common nutritional problems in older adults, such as poor vitamin D status, have received little attention in centenarians. A study from Italy suggested that the vast majority of centenarians may have vitamin D deficiency (10, 11), but to our knowledge there are no reported studies of vitamin D status in centenarians in the United States.

Poor vitamin D status is prevalent in older adults and has been associated with osteoporosis, falls, cardiovascular diseases, cancer, autoimmune diseases, pain, nursing home placement, and other age-related conditions, but little is known about the prevalence and predictors of vitamin D status in those aged 80 and older. Thus, this study tested the hypothesis that vitamin D status would be 1) poorer in a population-based multi-ethnic sample of centenarians as compared with octogenarians and 2) predicted by specific dietary, demographic or environmental factors.

The objective of this study was to determine the prevalence and predictors of poor vitamin D status in a population based multi-ethnic sample of adults aged 80 to 89 and 98 and above from northern Georgia in the US. It was hypothesized that vitamin D deficiency would be prevalent and that age, gender, race, living arrangements, dairy food intake, supplement intake, and season would predict vitamin D status. Vitamin D status was assessed by measuring serum 25-hydroxyvitamin D [25(OH)D] concentration, which is the preferred biomarker of vitamin D status and assesses vitamin D input from cutaneous synthesis and dietary and supplemental sources (12,13,16). The suggested optimal concentration may be as high as 80 nmol/L, insufficiency is considered less than 50 nmol/L, and frank deficiency is less than 25 nmol/L (12, 13, 16, 18, 23).

VITAMIN D STATUS IN GEORGIA CENTENARIANS

AGE, RACE AND SEASON PREDICT VITAMIN D STATUS IN AFRICAN AMERICAN AND WHITE OCTOGENARIANS AND CENTENARIANS

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FOR THE GEORGIA CENTENARIAN STUDY

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Abstract: Objective: Poor vitamin D status has been associated with osteoporosis, falls, cardiovascular diseases, cancer, autoimmune diseases, pain, nursing home placement, and other age-related conditions, but little is known about their prevalence and predictors of vitamin D status in those aged 80 and older. Thus, this study tested the hypothesis that vitamin D status would be 1) poorer in a population-based multi-ethnic sample of centenarians as compared with octogenarians and 2) predicted by specific dietary, demographic or environmental factors.

Design: Cross-sectional population-based analyses. Setting: Northern Georgia in the United States. Participants: Men and women aged 80 to 89 (octogenarians, n = 80) and 98 and older (centenarians, n = 237). Measurements: Regression analyses were used to examine the associations of serum 25-hydroxyvitamin D [25(OH)D] with age, gender, race, living arrangements, dairy food intake, supplement intake, and season. Results: The prevalence of vitamin D insufficiency [25(OH)D < 50 nmol/L] was higher in centenarians than in octogenarians (p < 0.02). In logistic regression analyses, the risk of being vitamin D insufficient was significantly increased by being a centenarian vs. octogenarian (p<0.005) and by being African American vs. white (p < 0.001) and decreased by taking a supplement with vitamin D (p < 0.001) or by having vitamin D status measured in the summer or fall (each p < 0.05), compared with spring. Conclusions: Centenarians and octogenarians are at high risk for vitamin D insufficiency for many of the same reasons identified in younger populations. Given the numerous potential adverse consequences of poor vitamin D status, efforts are needed to ensure vitamin D adequacy in these older adults.

Key words: Centenarians, elderly, 25(OH)vitamin D, nutrition risk factors, nutrition supplements.

Received November 8, 2007
Accepted for publication November 12, 2007
Methods

Study Population

Study participants were part of the Georgia Centenarian Study, a population-based multidisciplinary study of centenarians conducted in 44 counties in northern Georgia (USA) from 2002 to 2005. The study included 244 centenarians (defined in this study as age 98 and older) and 80 octogenarians recruited from the community, personal care homes and skilled nursing facilities. The sampling procedures and data collection methods have been described elsewhere (24). All questionnaires and procedures were approved by the University of Georgia Institutional Review Board on Human Subjects.

Serum Vitamin D

Non-fasting blood samples were collected from the centenarians and octogenarians in their place of residence, allowed to clot at room temperature for 30 min, and transported to the laboratory in a chilled biotransport container within 4 hrs of collection (mean transport time was 2.81 and 2.44 hr for octogenarian and centenarians, respectively). Upon arrival in the lab, samples were centrifuged at 800 x g for 20 min to separate the serum and clot, and the serum was stored at -80° C until time of assay. Serum concentrations of 25(OH)D concentrations were measured by radioimmunoassay (RIA kit, Diasorin Laboratories, Stillwater, MN, USA), similar to the method used for NHANES III (25). This method detects both the D2 and D3 forms of vitamin D metabolites and thus detects vitamin D derived from the diet, dietary supplements and fortified foods as well as that formed in vivo by UV exposure (26). The inter-assay and intra-assay coefficients of variation for 25(OH)D in the present study were 9.2% to 9.5% and 3.8% to 8.0%, respectively.

Various ranges for frank deficiency, insufficiency, and optimal serum concentrations of 25(OH)D have been suggested by others (12,13,16,18,23,27). Based on these suggestions, we defined frank deficiency as < 25 nmol/L, insufficiency as < 50 nmol/L, and optimal as ≥ 80 nmol/L.

Covariates and Predictors

Covariates and predictors included age (80-89 or ≥ 98 years), gender, and race (white or African American, by design). The proportion of participants from each age group recruited from skilled nursing facilities was based on estimates of the “institutionalized” population of the study area according to the 2000 U.S. Census figures (24). Thus, 15% of the octogenarians and 43% of the centenarians resided in skilled nursing facilities. The remaining “community dwelling” participants resided in private residences and personal care homes.

Questions regarding eating patterns and current medications (including supplement use) were read to each participant (or to his or her caregiver), and the answers were recorded by the interviewer. The question regarding dairy food intake was adapted from the Mini-Nutritional Assessment (28) and was “How many servings of milk, yogurt, or cheese does this individual usually consume?” Response categories were frequency per day or per week. Participants were classified as taking a supplement if they reported using a vitamin D-containing supplement such as a multivitamin and/or a calcium supplement that contained vitamin D. The frequency of use of supplements and the amount of vitamin D in supplements were not determined.

Participants were assessed in 2003, 2004 and 2005. Based on the date of blood collection, samples were coded for season with winter defined as December, January, and February; spring defined as March, April, and May; summer defined as June, July and August; and fall defined as September, October, and November consistent with seasonal classifications from the National Health and Nutrition Examination Survey (29; Kelly Scanlon, personal communication).

Exclusions

In the original sample of 244 centenarians, we excluded seven participants (2.9%) from whom we were unable to obtain sufficient serum for vitamin D assessment, resulting in an analysis sample of 237 centenarians. In the multivariate regression modeling, three centenarians were excluded because of missing data (one was missing supplement information, one was missing dairy food intake, and one was missing both supplement and dairy food intake information). There were no exclusions for the octogenarians and their sample size was 80. The total sample for bivariate analyses was 317 and the total sample for multivariate regression modeling was 314.

Statistical Analyses

Because of the unique nature of the centenarian sample, bivariate analyses of the relationships of the covariates within the octogenarian and centenarian samples were conducted separately. In bivariate analyses, the relationship of mean serum 25(OH)D with age group, gender, race, living arrangements, dairy food intake, and supplement use were compared by Student’s T-test and season was compared by ANOVA (Table 1). Significant associations for categorical analyses were determined by Fisher’s exact tests (Table 1). Probabilities reported are unadjusted for multiple tests.

Multiple linear regression analysis was used to examine the associations of serum 25(OH)D as a continuous variable with age (0 = octogenarian, 1 = centenarian), gender (0 = male, 1 = female), race (0 = white, 1 = African American), living arrangements (0 = community, 1 = skilled nursing facility), dairy food intake (0 = less than one serving daily, 1 = greater than or equal to one serving daily), takes a vitamin D-containing supplement (0 = no, 1 = yes), and season (Table 2). Logistic regression analyses with serum 25(OH)D as a dichotomous variable (1 = less than 50 nmol/L, and 0 = greater than or equal to 50 nmol/L) was used to examine the associations of vitamin D insufficiency with age (0 = octogenarian, 1 = centenarian), gender, race, living...