Adherence to a Vitamin D Supplement Intervention in Urban Schoolchildren

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ABSTRACT
Vitamin D supplementation is an important strategy for preventing low levels of serum 25OHD and improving bone health and consequent associated health risks, especially in children at risk of deficiency. Although vitamin D supplements are recommended, there is limited research on the factors that influence adherence to taking them. In a cross-sectional sample of 256 child (aged 9 to 15 years) and parent pairs in the Boston, MA, area during January to March 2012, analysis of covariance was used to determine associations between health beliefs about vitamin D, parental vitamin D–containing supplement use, and the individual responsible for pill administration with supplement adherence measured by pill counts. Mean and median supplement pill count adherence over 3 months were 84% and 89%, respectively. Adherence was positively associated with parents' use of vitamin D–containing supplements (7% higher, $P=0.008$) and with combined child and parent responsibility for administration of the supplement compared with child only (9% higher, $P=0.03$). Parents' beliefs about vitamin D neither predicted their children's beliefs nor positively influenced children's adherence. Adherence was higher when parents took vitamin D–containing supplements and when parents and children shared responsibility for administering the supplement. Promoting child supplement use through parent involvement and role modeling may be a practical solution for registered dietitians who are aiming to improve vitamin D adherence in at-risk youth.
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VITAMIN D IS KNOWN MAINLY FOR ITS ROLE IN bone health, but it can also reduce risks of diseases in children, such as upper respiratory infections[1] and autoimmune and cardiometabolic diseases.[2] It can also affect skeletal muscle and physical performance.[3-5] In 2010, the Institute of Medicine increased its vitamin D recommendations for children aged 1 to 18 years from an Adequate Intake of 200 IU to an Estimated Average Requirement (EAR) of 400 IU/day, and set 600 IU daily as the Recommended Dietary Allowance (RDA).[6] The American Academy of Pediatrics also recommended a daily vitamin D supplement of 400 IU for children who drink <4 cups of vitamin D–fortified milk per day and who do not take a daily supplement containing at least 400 IU of vitamin D.[7]

The major sources of vitamin D are sunlight exposure, which catalyzes conversion of 7-dehydrocholesterol in the skin to vitamin D, and diet. Because few foods naturally contain a significant amount of vitamin D,[2] it is difficult to obtain through dietary sources alone. Vitamin D supplementation is an important strategy for preventing low levels of serum 25OHD and improving bone health and consequent associated health risks, especially in children at risk of deficiency. Although vitamin D supplements are recommended, there is limited research on the factors that influence adherence to taking them.

This study examined how health beliefs about vitamin D, parental use of supplements containing vitamin D, and whether parents involved in administering the supplement influenced children's adherence to daily vitamin D supplements. Our findings may be helpful in the design of future supplementation trials and may also inform public health efforts to promote appropriate vitamin D intakes in children.

METHODS

Schoolchildren were enrolled in the Daily D Health Study, a randomized, double-blind trial assessing the impact of vitamin D supplementation on serum 25OHD and cardiometabolic risk factors in 4th- to 8th-grade schoolchildren (9 to 15 years). They were recruited from three urban school districts north of Boston, MA (42° N) during October to December of 2011. Previous research in children of similar age from the Boston area showed a very high prevalence of low 25OHD.[8,9] Recruitment was done in five elementary/middle schools through classroom presentations, school newsletters, and flyers sent home with the children. Children were excluded if they were currently taking vitamin D or multivitamin supplements, were taking oral glucocorticoids, or had certain chronic diseases (rickets, cystic fibrosis, kidney disease, sarcoidosis, irritable bowel syndrome, epilepsy, or human immunodeficiency virus/acquired immunodeficiency

syndrome). Each student was given a gift card to a large local retailer for participating. Consent forms and study information materials were available in the major languages spoken in the communities. Both parental informed consent and the child's assent were obtained. The study protocol was approved by Tufts University's Institutional Review Board.

Study visits were conducted at the child's school before the start of the school day. At baseline, each child was randomly assigned to one of three (600 IU, 1,000 IU, or 2,000 IU) supplementation groups. Each child received one pill bottle containing 100 vitamin D pills and a calendar and set of stickers to mark the days they took their vitamin. Children were instructed to take one pill each day and to avoid taking any other supplements containing vitamin D during the study period. Three months after baseline, children and parents returned for a 3-month follow-up visit to complete self-administered questionnaires on beliefs related to vitamin D and to collect pill bottles and calendars.

Sociodemographics

Birth date, race/ethnicity, and maternal education were reported by parents during the informed consent procedure. Age in months was calculated as examination date minus birth date and converted to age in years. Parents were asked to choose one of the following to describe their children: white/Caucasian, black/African American, Mexican/Mexican-American, other Hispanic/Latino, Asian/Asian-American/Asian-Indian, Native American/American Indian, multiracial/ethnic, or other.[10] Parents were asked to provide the highest level of education received by the mother: no formal schooling, <8th grade, ≥8th grade but less than high school, high school graduate, post-high school trade/technical school, 1 to 3 years of college, college graduate, or graduate work/higher degree. Maternal education was used as a proxy for socioeconomic status, as mothers primarily attended data-collection visits with their children.

Anthropometric Measurements

Height and weight were measured in triplicate with light clothing and without shoes. Height was measured using a portable stadiometer (Model 214, Seca Weighing and Measuring Systems) with the head in the Frankfurt plane made with a right-angle height procedure[11]and recorded to the closest 1/8-inch. Weight was measured on a portable balance-beam scale (Healthometer) and recorded to the closest 0.25 lb. Body mass index (BMI) was calculated and then expressed as a *z* score using the US Centers for Disease Control sex-specific growth charts.[12]

Assessment of Health Beliefs and Adherence

A parent-and-child–administered questionnaire, modeled after the 2009-2010 National Health and Nutrition Examination Survey Dietary Supplements and Prescription Medications Questionnaire,[13] was administered at the 3-month follow-up visit. Questions included health beliefs related to vitamin D, whether the parent or child was responsible for the child taking the supplement, and whether the child planned on continuing taking vitamin D supplements after the study stopped providing them. Health beliefs included vitamin D being taken for overall health, energy, supplementing diet, strength, bones, colds, and heart health. Similar questions were completed by parents. Children and parents completed questionnaires independently from each other and research assistants provided assistance as needed.

Adherence was assessed by pill counts. In general, pill counts are regarded as being more accurate than self report or refill history.[14-16] Children were given bottles containing 100 pills and instructed to return the bottle with unused pills at their 3-month follow-up visit. The 100 pills corresponded to an excess of roughly 10 pills for a 3-month supply. Pill count adherence was calculated using the following formula: pill count adherence=[(100−number of pills left in bottle)×100]/(number of days between dispensing date and return date of pill bottle). Similar to pill count adherence, adherence was also calculated from a calendar on which children put a sticker on the days they took the supplement using the following formula: calendar count adherence=[(number of stickered days)×100]/(number of days between dispensing date and return date of calendar).

Statistical Analyses

Analysis was conducted on 256 of 311 enrolled child and parent pairs who completed the 3-month follow-up questionnaire. Of these, 214 children returned calendars, 193 returned pill bottles, and 188 had all data points complete for the main analysis. Race/ethnicity categories were aggregated to white, Hispanic, black, Asian, and multiracial/other. Maternal education was dichotomized to post-secondary education (yes/no). Health beliefs about vitamin D were categorized as "condition-specific" (bone or heart health) or "strength or energy" for the main analysis. Questions about taking vitamin D for overall health, supplementing diets, and preventing colds were not included in the main analysis.

χ^2 analyses were used to compare demographic characteristics of children who returned and did not return their pill bottles and health beliefs about vitamin D in children compared with their parents. Further analyses were conducted to examine how health beliefs were related to parent and child demographic characteristics. χ^2 was also used to test whether maternal education influenced parents' health beliefs. Logistic regression was used to compare children's health beliefs across race/ethnicity and sex groups.

Analysis of covariance was used to determine associations between health beliefs about vitamin D, parental vitamin D–containing supplement use, and individual (parent, child, both) primarily responsible for administration with pill count adherence. Covariates that were controlled for included age, sex, BMI *z* score, race/ethnicity, and maternal education. Data were analyzed using SAS version 9.2 (2008, SAS Institute). A P value <0.05 was considered statistically significant in all analyses.

RESULTS AND DISCUSSION

This study explored adherence to a vitamin D supplement intervention in an urban, racially/ethnically diverse sample of schoolchildren. Mean pill count adherence over 3 months was high, with the majority of children taking their supplement almost every day. Adherence was higher when parents reported taking vitamin D–containing supplements themselves and when responsibility for administering the vitamin was shared between parents and children. Adherence was