Do Dietary Supplements Improve Micronutrient Sufficiency in Children and Adolescents?

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Objective To examine if children use supplements to fill gaps in nutritionally inadequate diets or whether supplements contribute to already adequate or excessive micronutrient intakes from foods.

Study design Data were analyzed for children (2-18 years) from the National Health and Nutrition Examination Survey 2003-2006, a nationally representative, cross-sectional survey (n = 7250). Diet was assessed using two 24-hour recalls, and dietary supplement use was assessed with a 30-day questionnaire.

Results Prevalence of supplements use was 21% (<2 years) and 42% (2-8 years). Supplement users had higher micronutrient intakes than nonusers. Calcium and vitamin D intakes were low for all children. Inadequate intakes of phosphorus, copper, selenium, folate, and vitamins B-6 and B-12 were minimal from foods alone among 2-8 year olds. However, among 9-18 year olds, a higher prevalence of inadequate intakes of magnesium, phosphorus, and vitamins A, C, and E were observed. Supplement use increased the likelihood of intakes above the upper tolerable intake level for iron, zinc, copper, selenium, folic acid, and vitamins A and C.

Conclusions Even with the use of supplements, more than a one-third of children failed to meet calcium and vitamin D recommendations. Children 2-8 years old had nutritionally adequate diets regardless of supplement use. However, in children older than 8 years, dietary supplements added micronutrients to diets that would have otherwise been inadequate for magnesium, phosphorus, vitamins A, C, and E. Supplement use contributed to the potential for excess intakes of some nutrients. These findings may have implications for reformulating dietary supplements for children. *(J Pediatr 2012;161:837-42)*.

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More than one-half of adults in the United States report using dietary supplements, most commonly multivitamin/mineral supplements[1-3] Among adults, dietary supplement users are more likely to be female,[4,5] leaner,[4,5] more physically active,[5,6] and to have higher levels of educational attainment and socioeconomic status than nonusers.[4,7] Adult supplement users have higher total intakes of most micronutrients than nonusers.[5,8,9] However, very little is known about the differences in micronutrient intakes in children who do or do not use dietary supplements. Data from the National Health and Nutrition Examination Survey (NHANES) II (1976-1980) indicate that children who used supplements (<19 years old) had higher intakes of vitamin C and fruit and vegetables than nonusers.[10]

Parents who use dietary supplements are more likely to have children who do so (Dwyer J, Nahin R, Rodgers G, et al, unpublished data, June 2012). More than one-third of infants, children, and adolescents (henceforth children) in the United States are reported to use a dietary supplement.[1,11] Picciano et al reported that multivitamin/mineral supplements were the most commonly used type of dietary supplement and other frequently used supplements were vitamins A, C, D, and calcium and iron.[11] It remains unclear whether dietary supplements provide micronutrient intakes to help children meet the micronutrient targets specified in the dietary reference intakes (DRI) or whether supplements simply provide an excess of nutrients to children who already have adequate intakes from foods.

Methods

The National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention collects the NHANES data. Written informed consent

EAR	Estimated average requirement
DRI	Dietary reference intake
NCHS	National Center for Health Statistics
NCI	National Cancer Institute
NHANES	National Health and Nutrition Examination Survey
UL	Tolerable upper intake level

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Supported in part by the United States Department of Agriculture Research Service (agreement 58-1950-7-707) and the Office of Dietary Supplements at the National Institutes of Health. Data generation was funded by the Fortification Committee of the International Life Sciences Institute, North American Branch. The authors declare no conflicts of interest.

10.1016/j.jpeds.2012.05.009

was obtained for all participants and the survey protocol was approved by the Research Ethics Review Board at the NCHS. The NHANES data are publicly available and NCHS recommends that analysts combine 4 or more years of data to improve the reliability and stability of statistical estimates.[12] This analysis was completed using NHANES 2003-2004 and NHANES 2005-2006 datasets. The combined sample included 18 063 participants who had provided 24-hour dietary intake data. Of these, those who were 19 years or older, pregnant, or lactating were excluded, leaving an analytical sample of 7250 for children ages 2 to 18 years. We also examined prevalence of dietary supplement use in those <2 years of age (n = 1703); however, complete dietary recall data is not available on this age group so that analysis is limited to basic descriptive data.

Dietary Intake

Dietary Intake Using 24-Hour Recalls. NHANES participants were asked to complete 2 dietary recall interviews. The first dietary recall interviews were collected in-person by trained dietary interviewers. Proxy respondents provided dietary information for young children and proxy-assisted interviews were used for 6-11 year olds. The second dietary recall interview was completed by telephone 3 to 10 days after the health examination. Both recalls were collected using the United States Department of Agriculture Automated Multiple-Pass Method dietary interview methodology.[13,14]

Dietary Supplement Use. The dietary supplement questionnaire was collected as part of the household interview.[15] This questionnaire assesses participants' use of vitamins, minerals, herbs, and other dietary supplements over the past 30 days. Survey personnel also collected detailed information about the type, consumption frequency, duration, and amount of each reported dietary supplement that respondents took. The average daily intake of vitamins from dietary supplements was calculated for individuals using the number of days that supplement use was reported, the reported amount taken per day, and the serving size unit from the product label; the details on these procedures are available elsewhere.[16,17] We defined nonusers of supplements as those who did not report taking a dietary supplement within the last 30 days. Users of dietary supplements are defined as those who reported taking a dietary supplement that contained a given vitamin or mineral within the last 30 days.

Comparisons to the DRI Values

The prevalence of inadequate dietary intakes of a group was determined using the estimated average requirement (EAR) cut-point method for all vitamins and minerals except iron.[17] The probability method was used to determine iron intakes below the EAR. Both the probability and the cut-point method require more than one 24-hour dietary recall to adjust the dietary intakes for an individual to produce usual dietary intakes. The EAR cut-point method assumes that there is no correlation between intakes and requirements; the variance in intakes is greater than the variance of requirements; and the distribution of requirements is symmetrical around the EAR. If these assumptions are met, as was the case for all nutrients examined in this study except iron, the number of individuals with usual intakes below the EAR is proportionate to the prevalence of the group with inadequate intakes. Because the distribution of requirements for iron was skewed (ie, not symmetrical), the cut-point method was not appropriate and the probability method was applied.[18]

Vitamin Bioequivalence

Folic acid does not occur naturally in the food supply but, instead, is the form of the vitamin that manufacturers use to fortify foods and in dietary supplements. The bioavailability of food folate is lower than that of folic acid in fortified foods and dietary supplements. For this reason, the Food and Nutrition Board of the National Academies developed the dietary folate equivalent to reflect this differential bioavailability.[19] The EAR for folate is expressed in dietary folate equivalent whereas the tolerable upper intake level (UL) is for synthetic folic acid only. The Food and Nutrition Board established the EAR for vitamin A in μg of retinol activity equivalents to account for the different biologic activities of retinol and the provitamin-A carotenoids.[20] The UL for vitamin A applies only to μg of retinol and does not include the provitamin-A carotenoids. The DRI for vitamin E is established in mg of alpha-tocopherol.[21] The UL for vitamin E is only for supplemental sources and does not include vitamin E that occurs naturally in foods. The UL is set for magnesium only from supplemental sources.[22]

Statistical Analysis

We adjusted the 24-hour dietary recall data for within-person variability and other covariates using the National Cancer Institute (NCI) method[23]; the amount-only part of the NCI method (ie, not the frequency of intake that applies to usual intake of foods) is applicable to estimates of usual nutrient intakes. This method removes the effect of the sequence of the 24-hour dietary recall from the estimated nutrient intake distribution (day 1 or day 2). We also adjusted for the day of the week that the survey personnel collected the 24-hour recall data, which we dichotomized as weekend (Friday-Sunday) or weekday (Monday-Thursday). The final covariate was the use of dietary supplements. Additional details on the NCI method are available elsewhere,[23] and the SAS macros necessary to fit this model and to estimate usual intake distributions are available on the NCI website.[24]

All statistical analyses were performed using SAS (v. 9.2, SAS Institute Inc, Cary, North Carolina) software. Sample weights were used to account for differential nonresponse and non-coverage and to adjust for planned oversampling of some groups. Mean usual dietary and total vitamin and mineral intakes were estimated, and these means were compared between dietary supplement users and nonusers and the proportion meeting the EAR and exceeding the UL by computing a Z-statistic. Significance was set at a Bonferroni-corrected P value of <.003.