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Dietary Supplementation in Children with Autism Spectrum Disorders: Common, Insufficient, and Excessive

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ABSTRACT

Background Little is known about the effect on dietary adequacy of supplements given to children with autism spectrum disorder (ASD).

Objective This cross-sectional study examines dietary supplement use and micronutrient intake in children with ASD.

Design Three-day diet/supplement records and use of a gluten/casein-free diet (GFCF) were documented. Estimates of usual intake of micronutrients from food and supplements were compared with the Dietary Reference Intakes.

Participants Children aged 2 to 11 years (N=288) with ASD from five Autism Treatment Network sites from 2009-2011.

Main outcome measures Percentage of children meeting or exceeding upper limits of micronutrient intake with or without supplements and relative to GFCF diet status.

Statistical analysis Micronutrient intake from food and supplements was compared by Spearman rank correlation. Usual intake was estimated by the National Cancer Institute method adjusted for age, sex, supplement use, and GFCF diet. Adequacy of intake was compared between supplement use status and between food and total intake in supplement users relative to Dietary Reference Intakes limits.

Results Dietary supplements, especially multivitamin/minerals, were used by 56% of children with ASD. The most common micronutrient deficits were not corrected (vitamin D, calcium, potassium, pantothenic acid, and choline) by supplements. Almost one-third of children remained deficient for vitamin D and up to 54% for calcium. Children receiving GFCF diets had similar micronutrient intake but were more likely to use supplements (78% vs 56%; $P=0.01$). Supplementation led to excess vitamin A, folate, and zinc intake across the sample, vitamin C, and copper among children aged 2 to 3 years, and manganese and copper for children aged 4 to 8 years.

Conclusions Few children with ASD need most of the micronutrients they are commonly given as supplements, which often leads to excess intake. Even when supplements are used, careful attention should be given to adequacy of vitamin D and calcium intake.
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CHILDREN WITH AUTISM SPECTRUM DISORDER (ASD) often demonstrate selective eating behaviors that may place them at risk for inadequate vitamin and mineral intake. However, previous analysis of dietary intake data collected from five of 17 Autism Speaks Autism Treatment Network (AS ATN) sites demonstrated that nutrient intake from food is similar for children with ASD and children in the general population in the National Health and Nutrition Examination Survey (NHANES).[1] The specific areas of deficient micronutrient intake (vitamin D, calcium, potassium, and choline) were similar in children with ASD and children in NHANES with some variation by age.[1,2] Parents often provide supplements to their children to compensate for what they believe to be insufficient nutrient intake or to promote wellness.[3] For children in NHANES this was often in the form of a multivitamin/mineral supplement (MVM), which typically contains the micronutrients children already consume adequately, without correcting for the micronutrients consumed in inadequate

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amounts.[4,5] In fact, some nutrients in MVMs cause children to exceed the Upper Limit (UL) of intake. The UL is the highest recommended intake level above which risk for side effects increases.[6] While 31% of children included in NHANES 2007-2010 used a nutritional supplement,[3] more than 50% of children with ASD are given supplements.[7] Little is known about the effect supplementation has on micronutrient insufficiency and excess in children in either population. The use and effect of supplements could be different in children with ASD because of rigid choice of highly fortified foods, use of dietary restriction as a therapeutic intervention, and use of high doses of supplements as nutriceutical therapy.[8-10] In this observational study, use of nutritional supplements in a large and well-characterized group of children with ASD was examined to identify the types and frequency of nutritional supplements provided to children with ASD, determine whether these supplements provide micronutrients the children typically consume in inadequate amounts and whether they adequately correct for nutritional deficits, evaluate adequacy of intake and use of supplements in children on restricted diets, and determine whether supplementation results in micronutrient intake beyond the UL.

METHODS

Sample

Children aged 2 to 11 years with ASD were recruited from five participating AS ATN sites between 2009 and 2011.[1] AS ATN is a network funded by Autism Speaks to promote research and a standard of care regarding health conditions associated with ASD. All children entering or previously enrolled in the AS ATN who met the age requirement and consumed food by mouth were eligible for participation in this study. The five participating AS ATN sites in this study were Cincinnati Children's Hospital, University of Arkansas, University of Colorado, University of Pittsburgh, and University of Rochester. Diagnosis of ASD was confirmed using Diagnostic and Statistical Manual of Mental Disorders IV criteria[11] and the Autism Diagnostic Observation Schedule.[12] The diagnostic classifications of Autistic Disorder, Asperger Disorder, and Pervasive Developmental Disorder as defined by the Diagnostic and Statistical

Analyses of nutrient intake used modifications of SAS macros (SAS Institute Inc) supplied by the National Cancer Institute.[18] Predictors of differential nutrient intake were first identified and their association with intake estimated in a nonlinear mixed effects model. Given parameter estimates from the models for consumption of a given nutrient from food and from supplements and the observed distribution of covariates in our sample, distributions of usual intake from food and supplements were generated by Monte Carlo simulation for 1,000 replicates of each participant. Simulated usual intake from food and supplements was summed for each replicate participant, and the proportion above or below a given Dietary Reference Intake threshold was estimated by the cut-point method. Although variable iron requirements of menstruating women often motivates use of a full-distribution estimate of proportions above or below Dietary Reference Intake thresholds when analyzing iron intake, in our population, no girls had reached menarche, so the assumptions required for application of the cut-point method applied equally well to iron as to the other nutrients analyzed.

Standard errors of estimated proportions were obtained by jackknifing. Models for nutrient intake from food and supplements were refit and cut-point proportions estimated as above after dropping out each participant in sequence. The jackknifed standard error for a given estimated proportion is the standard error of pseudovalues calculated as

$$pseudovalue_i = n\,Pct_{full} - (n-1)Pct_{-i}$$

where n=288 is the number of participants, Pct_{full} is the percentage estimated from the full dataset, and Pct_{-i} is the percentage estimated after dropping out the ith participant. Confidence intervals were calculated using a complementary log-log transformation,

$$\exp\left[\log(Pct_{full}) \times t_{1-\alpha/2,n-1} SE_{jack} / (Pct_{full} \times \log(Pct_{full}))\right]$$

where $t_{1-\alpha/2,n-1}$ is the 100 × (1- α/2)th percentile of Student's t distribution with $n-1$ degrees of freedom and α=0.05 for 95% confidence bounds. Differences in proportions were tested using one- and two-group z tests. One-group z statistics were calculated as

$$(Pct_{full,comb} - Pct_{full,food}) / SE_{diff.jack}$$

where $Pct_{full,comb}$ is the proportion for food and supplements combined, $Pct_{full,food}$ is the proportion from food alone, and $SE_{diff,jack}$ is the standard error of jackknifed pseudovalues for the difference in proportions. Two-group z statistics were calculated as

$$\left(Pct_{full,i} - Pct_{full,j}\right) \Big/ \sqrt{SE^2_{jack,i} - SE^2_{jack,j}}$$

for comparison between groups i and j.

Figure 1. Details on hypothesis testing and calculation of CIs in a study examining dietary supplement use and micronutrient intake in children with autism spectrum disorder.