Current Research

Continuing Education Questionnaire, page 2034
Meets Learning Need Codes 3000, 3020, 3100, and 4160

Vitamin Supplement Intake Is Related to Dietary Intake and Physical Activity: The Child and Adolescent Trial for Cardiovascular Health (CATCH)

LINDSAY REAVES, MPH; LYN M. STEFFEN, PhD, MPH, RD; JOHANNA T. DWYER, PhD, RD; LARRY S. WEBBER, PhD; LESLIE A. LYTLE, PhD, RD; HENRY A. FELDMAN, PhD; DEANNA M. HOELSCHER, PhD, RD; MICHELLE M. ZIVE, MS, RD; STAVROULA K. OSGANIAN, MD, ScD

ABSTRACT

Objective To explore the relationship of multiple-vitamin supplement use with selected food groups, physical activity, lifestyle behaviors, and weight status.

Subjects and methods Two thousand seven hundred sixty-one adolescents in the 12th grade who participated in the fourth Child and Adolescent Trial for Cardiovascular Health study had height and weight measured and completed health behavior survey and food frequency questionnaires. Logistic regression models were used to determine the likelihood of supplement use with health and activity behaviors and dietary intake.

Results Prevalence of multiple-vitamin supplement use among adolescents was 25% and varied by sex and race/ethnicity. Supplement users had higher mean daily intakes of most food groups, but lower intakes of total fat and saturated fat than nonusers. Higher food index scores were positively associated with the likelihood of using multiple-vitamin supplements. Supplement users were more likely to be physically active, participate in team and organized sports, and less likely to be overweight and to watch more than an hour of television per day.

Conclusions Adolescents who use multiple vitamin supplements have more healthful dietary and lifestyle behaviors than nonusers. Further study on supplement use by adolescents, including other types of supplements used and reasons for use, is warranted.

J Am Diet Assoc. 2006;106:2018-2023.

L. Reaves is a graduate student, L. M. Steffen is an assistant professor of Epidemiology, and L. A. Lytle is a professor of Epidemiology, the University of Minneapolis School of Public Health, Division of Epidemiology and Community Health, Minneapolis. J. T. Dwyer is a professor of Nutrition, Friedman School of Nutrition Science and Policy and Medical School, Tufts University, and New England Medical Center Hospital, Boston, MA. L. S. Webber is professor of Biostatistics, Tulane University School of Public Health and Tropical Medicine, Department of Biostatistics, New Orleans, LA. H. A. Feldman is lead biostatistician and associate professor, Clinical Research Program and Division of Endocrinology, Department of Medicine, Children's Hospital Boston and Department of Pediatrics, Harvard Medical School, Boston, MA; at the time of the study, he was with the New England Research Institute, Watertown, MA. S. K. Osganian is director, Clinical Research Program, Children's Hospital, Boston and assistant professor of Pediatrics, Division of Endocrinology, Department of Medicine, Harvard Medical School, Boston, MA; at the time of the study, she was also with the University of Massachusetts Medical School, Worcester. D. M. Hoelscher is an associate professor in Health Promotion and Behavioral Sciences, and director, Michael & Susan Dell Center for Advancement of Healthy Living, University of Texas School of Public Health, Houston. M. M. Zive is a registered dietitian, the University of California-San Diego.

Address correspondence to: Lyn M. Steffen, PhD, MPH, University of Minnesota School of Public Health, Division of Epidemiology and Community Health, 1300 S Second St, Ste 300, Minneapolis, MN 55454. E-mail: steffen@epi.umn.edu

0002-8223/06/10612-0012$32.00/0
doi: 10.1016/j.jada.2006.09.001

The American Dietetic Association suggests that the best strategy for optimal health and lower risk of chronic disease is to consume a wide variety of foods (1). However, many adolescents and adults are also using vitamin and mineral supplements regularly (2-11). Adolescent vitamin and mineral supplement users have better nutrient intakes and are more likely to have adequate dietary intake than nonusers (2,3). Among adults, supplement users are more likely to be women, older, physically active, have a higher education than nonusers (4,5), and are more likely to be at or below normal weight (5,6,12). Few studies conducted in adolescents have explored the relationship between supplement use and food intake or lifestyle behaviors such as physical activity or weight status. This study explores the relationships of

multiple-vitamin supplement use with dietary intake of selected food groups, physical activity, other lifestyle behaviors, and weight status in adolescents who were enrolled in the Child and Adolescent Trial for Cardiovascular Health (CATCH) study.

METHODS

Study Population

The CATCH study was a multicenter intervention that evaluated the effectiveness of an elementary school-based cardiovascular health promotion program. The study enrolled 5,106 ethnically diverse students in grades three through five at 56 intervention and 40 control schools in California, Louisiana, Minnesota, and Texas from 1991 to 1994 (13). Follow-up surveys were conducted in years 1996-1997 (14) and 2000-2001 (15), when students were in grades eight and 12, respectively.

For these analyses the 2000-2001 survey data, which included 2,761 male and female adolescents in 12th grade (54% of the original cohort) were used. Exclusions made for analysis included 41 students with outlying energy intakes, 178 with other missing data, 229 who did not return consent forms, 177 who dropped out of the study, and 1,968 students who moved out of the survey area or did not participate in the 2000-2001 follow-up survey. The CATCH study was approved by all study center institutional review boards. Signed informed consent forms were obtained from all participants and their parents; at some sites, students over age 18 years were able to give their own consent. All data were collected by trained, certified CATCH staff at schools or designated measurement sites.

Health Behavior Survey

The Health Behavior Survey was used to collect information about multiple-vitamin supplement use, hours of television watching, physical activities, and smoking. Supplement users were classified as adolescents who reported usually consuming multiple-vitamin supplements from the question: "Do you usually take multiple vitamins?" Television watching was divided into two categories: adolescents who reported usually watching less than an hour of television per day and those who reported usually watching more than 1 hour of television per day. Physical activity was categorized as sedentary (defined as being active 3 days or less during the past week) or active (defined as being physically active 4 days or more during the past week). Team sports participants were adolescents who reported participating in team sports or other organized sports participation such as dance, gymnastics, or swimming. Smoking categorized adolescents who defined themselves as current smokers and those who defined themselves as nonsmokers.

Anthropometrics

Height was measured without shoes using a portable stadiometer and weight was measured using the SECA Integra 815 portable scale (SECA, Rumilly, France). Body mass index was calculated as kg/m^2. A healthful weight was defined as body mass index <25 and an unhealthful weight as body mass index ≥ 25, using adult reference values because the average age of students was 18 years. Quality control checks were conducted to ensure accuracy of measures and scales were calibrated before measurement periods.

Diet Assessment

Dietary intake was assessed using the 149-item Youth Adolescent Food Frequency Questionnaire that had been previously validated in a sample of 261 youths aged 9 to 18 years (16). Food intake was grouped into major food categories: whole grains; refined grains; fruit and fruit juice; vegetables; dairy; meat; fish and seafood; fried foods, including fried food eaten away from home and french fries; soft drinks; candy; and desserts. Whole and refined grains were categorized using previously developed procedures (17): whole grains (ready-to-eat breakfast cereal containing at least 25% whole grain or bran by weight, as determined from the package label or from records shared by cereal manufacturers; cooked oatmeal; dark bread; brown rice; bulgar; kasha; couscous; bran; wheat germ; and popcorn), refined grains (ready-to-eat breakfast cereals with less than 25% whole grain or bran, white bread, bagels, muffins, rolls, pasta, white rice, pancakes and waffles, and doughnuts), fruit and fruit juice (10 different fruits and juices), vegetables (24 vegetables, legumes, and nuts), dairy products (milk, cheese, yogurt, and ice cream), meat (red and processed meats and poultry), fish and seafood, and desserts (cakes, cookies, bars, and pies; candy including chocolate and nonchocolate candies) and soft drinks (including high-sugar, carbonated soft drinks and fruit drinks).

Because the food frequency questionnaire did not differentiate between whole grains and refined grains, any misclassification of foods would attenuate associations. For example, hot cereals were classified as refined grain so whole-grain hot cereals would have been classified as refined grain, thereby, underestimating the association between whole-grain intake and supplement use.

A food index score was created to reflect intakes of whole grain, fruit, vegetables, dairy, fish, meat, fried foods, desserts, and soft drinks. An individual was assigned the sum of scores of zero through four that corresponded to the quintile of intakes in whole grain, fruit, vegetables, dairy, and fish (Q1=0, Q2=1, Q3=2, Q4=3, and Q5=4) and reversed for meat, fried food, soft drink, and dessert intakes (Q1=4, Q2=3, Q3=2, Q4=1, and Q5=0). For example, a person who was in Q1 for meat, fried food, dessert, and soft drink intakes would score a four on each of these four food groups, and if he were in Q5 for each of whole grain, fruit, vegetable, dairy, and fish, these five food groups would be assigned a score of four, with a total score of 36.

Statistical Methods

Analyses were conducted using SAS (version 9.1, 2002, SAS Institute, Cary, NC). The sampling design was considered in all models, treating the school as a random effect within site. To test the differences in baseline characteristics between multiple vitamin users and nonusers, Student t tests were performed for continuous variables

and Mantel-Haenszel χ^2 was used for categorical variables. Mean daily intakes of nutrients and foods were calculated using linear regression models, controlling for age, sex, race/ethnicity, site, school, and energy intake. To determine whether or not users of multiple-vitamin supplements had more healthful lifestyle behaviors compared with nonusers, logistic regression models were used to evaluate the relationship of multiple-vitamin supplement use with weight status, smoking, physical activity behaviors, television watching, and dietary intake controlling for age, sex, race, site, school, and energy intake. Interaction terms were included in models to determine if sex and race/ethnicity modified the relation between dietary pattern and supplement use.

RESULTS

Among the 2,761 adolescents who participated in the CATCH 2000-2001 study, 25% were multiple-vitamin supplement users. The average age for supplement users and nonusers was 18.2±0.5 and 18.3±0.5 years, respectively. Among multiple-vitamin supplement users, 58% were female. A larger proportion of multiple-vitamin supplement users were white (79%); approximately 10% were African American, 8% were Hispanic, and the rest belonged to other ethnic groups. Supplement use varied by sex, race/ethnic group, and region of the country (Table 1).

Lifestyle Behaviors

As shown in Table 1, there were significant differences in lifestyle behaviors between multiple-vitamin supplement users and nonusers. Only 29% of supplement users reported smoking, compared with 33% of nonusers ($P=0.04$). Among supplement users, only 31% were classified as overweight in contrast to 37% of nonusers ($P=0.004$). More supplement users were physically active than nonusers ($P=0.006$), and 47% of supplement users compared with 40% of nonusers participated in team sports ($P<0.001$). Thirty-nine percent of supplement users participated in other organized sports compared with 31% of nonusers ($P=0.001$). Less than 60% of supplement users reported watching an hour of television per day compared with 70% of nonusers ($P<0.001$). No significant differences were found between users and nonusers for other lifestyle behaviors, including video and computer game playing, physical education class participation, and alcohol use. After adjusting for age, sex, race, center, and energy intake, supplement users were less likely to be overweight (odds ratio [OR]: 0.81; 95% confidence interval [CI]: 0.68, 0.99) and smoke (OR: 0.80; 95% CI: 0.66, 0.97). Compared with nonusers, adolescents who consumed multiple-vitamin supplements were more likely to be physically active (OR: 1.30; 95% CI: 1.09, 1.55), participate in team sports (OR: 1.42; 95% CI: 1.19, 1.70) or other organized sports (OR: 1.32; 95% CI: 1.10, 1.59), and less likely to watch more than an hour of television per day (OR: 0.66; 95% CI: 0.55, 0.77).

Food and Nutrient Intakes

Most nutrient intakes were significantly different between the two groups (Table 2). Compared with nonusers, supplement users consumed more energy ($P=0.03$) and fiber ($P<0.001$), and a greater proportion of energy from carbohydrates ($P=0.009$) and protein ($P<0.001$), but a smaller proportion of energy from total fat and saturated fat ($P\leq0.001$), although not dietary cholesterol intake. Supplement users consumed more daily servings of whole grain ($P<0.001$), fruit and juice ($P<0.001$), vegetables ($P=0.003$), and fish and seafood ($P=0.05$) than nonusers. Supplement users consumed a greater number of daily servings of desserts than nonusers ($P=0.04$), but fewer servings of fried foods ($P<0.001$) and carbonated soft drinks ($P<0.001$) than nonusers. No significant differences were reported between the two groups for consumption of refined grains, dairy, and meat. The likelihood of consuming a supplement was greater across increasing

Table 1. Baseline characteristics of adolescent multiple-vitamin supplement users and nonusers as reported in the Child and Adolescent Trial for Cardiovascular Health (CATCH) (n=2,761)

	Nonsupplement Users (n=2,073)		Supplement Users (n=688)		
Characteristic	**n**	**%**	**n**	**%**	***P* value[a]**
Sex					
Male	1,054	50.9	291	42.3	<0.001
Female	1,018	49.1	397	57.7	
Race					
White	1,501	72.4	543	78.9	0.009
African American	257	12.4	66	9.6	
Hispanic	230	11.1	55	8.0	
Other	84	4.1	24	3.5	
Site					
California	491	24	217	32	0.001
Louisiana	623	30	185	27	
Minnesota	561	27	169	24	
Texas	398	19	117	17	
Smoking					
Yes	687	33	200	29	0.04
No	1,486	67	488	71	
Weight status					
Normal weight	1,298	63	472	69	0.004
Overweight	769	37	214	31	
Physical activity					
Sedentary	1,057	51	309	45	0.006
Active	1,015	49	378	55	
Team sport activity					
Yes	822	40	325	47	<0.001
No	1,251	60	363	53	
Other organized sports activity					
Yes	660	31	269	39	<0.001
No	1,413	69	419	61	
Hours of television watching					
0-1 h	632	31	282	41	<0.001
≥1 h	1,440	69	406	59	

[a] *P* value calculated by Student *t* tests for continuous variables and Mantel-Haenszel χ^2 for categorical variables.

NOTE: Data from this table are available online at www.adajournal.org as part of a PowerPoint presentation featuring additional online-only content.

Table 2. Average daily servings of nutrient and food intake among adolescent multiple-vitamin supplement users and nonusers according to data from the Child and Adolescent Trial for Cardiovascular Health (CATCH) (n=2,761)

Daily dietary intake	Nonsupplement users (n=2,073)	Supplement users (n=688)	*P* value
	← *mean±standard error*[a] →		
Nutrient intake			
Energy (kcal)	1,935±17	2,008±29	0.03
Total fat (% kcal)	31.5±11	30.5±0.19	<0.001
Saturated fat (% kcal)	11.0±0.05	10.6±0.09	<0.001
Carbohydrates (% kcal)	54.8±0.14	55.5±0.24	0.009
Protein (% kcal)	14.5±0.06	15.0±0.10	<0.001
Fiber (g)	14.0±0.16	15.6±0.26	<0.001
Cholesterol (mg)	214±2.3	217±2.9	0.49
Food intake (servings/d)			
Whole grains	0.7±0.01	0.8±0.02	<0.001
Refined grains	4.3±0.03	4.2±0.05	0.12
Fruit and fruit juice	1.6±0.03	1.9±0.04	<0.001
Vegetables	1.9±0.02	2.1±0.04	0.003
Dairy	2.4±0.03	2.5±0.04	0.22
Meat	0.99±0.01	0.96±0.01	0.09
Fish and seafood	0.14±0.003	0.16±0.005	0.05
Fried food	0.47±0.01	0.40±0.01	<0.001
Soft drinks	1.36±0.02	1.22±0.03	<0.001
Desserts	0.22±0.005	0.26±0.008	0.04
Diet pattern			
Food index score	15.7±0.10	16.9±0.16	<0.001

[a]Linear regression models were adjusted for age, sex, race, site, school, and energy intake, except for energy, which was not adjusted for energy intake.
NOTE: Data from this table are available online at www.adajournal.org as part of a PowerPoint presentation featuring additional online-only content.

quintiles of whole grain, fruit, vegetables, and dairy intake, although increasing intake of carbonated soft drinks was negatively associated with the likelihood of regularly taking a supplement (Table 3). Consumption of refined grains, meat, fish and seafood, candy, and desserts was not related to using multiple-vitamin supplements.

As measured by food index scores, dietary patterns were different between supplement users and nonusers (Table 2). Supplement users had higher food index scores, indicating more healthful dietary intakes. Furthermore, a positive dose–response relationship was observed across increasing quintiles of the food index with the likelihood of using multiple-vitamin supplements after adjusting for age, sex, race, site, school, and energy intake (Table 3). Two- and three-way interaction terms were included in the models to determine whether or not the relationship of supplement use with food index scores was different by sex, race, or sex–race groups. However, no significant interactions were observed.

DISCUSSION

The prevalence of multiple-vitamin supplement use was 25% among adolescents enrolled in the large, multiethnic CATCH study. Compared with nonusers, supplement users had more healthful nutrient intakes of dietary fiber, saturated fat, and cholesterol as reflected in their more healthful eating patterns, which included higher intakes of whole grains, fruits, vegetables, fish, and seafood, and higher overall food index scores. Supplement users also were engaged in more healthful lifestyle habits, such as greater participation in physical activity and team and organized sports, and were also more likely to report low amounts of television viewing (less than 1 hour/day). In contrast, supplement nonusers were more likely to be sedentary, smoke, have poor dietary intake, and watched more television. These associations with more healthful behaviors and supplement use are similar to those reported in previous studies among adolescents (18), but our findings show that not only were supplement users more likely to be physically active, but to also have many other healthful characteristics.

Prevalence of Supplement Use

Supplement use was 25% among these 12th graders, which is slightly higher than the 21% of adolescents who reported using supplements during the 8th-grade survey (2). Supplement use in other studies varied from 27% to 49% in most studies of adolescents (3,10,19), and only one small study reported that supplement use, including vitamins, minerals, herbals, and other supplements, was 74% among adolescents enrolled in a vocational high school (11). Results from the National Health and Nutrition Examination Surveys 1971-1974 through 1999-2000 indicate a decreasing trend in dietary supplement use among children aged 1 to 5 years, whereas supplement use remained relatively constant in adolescents (19). In 1999-2000, supplement use among adolescent boys and girls aged 16 to 19 years was 27% and 32%, respectively. Meanwhile, supplement use among adults, especially elderly adults, continued to increase between 1971-1974 and 1999-2000 from 28% to 47% in men and 38% to 57% in women (19). Other studies report higher use of vitamin supplements among adults from 52% to 77% (4-7,12). Although trends in vitamin supplement use increased between adolescence and adulthood across the cross-sectional national surveys, it is not clear whether or not supplement use in adolescence continues into adulthood. Findings between the studies may not be directly comparable due to the differences in definitions of supplement use, timing of the study, and the study populations. Comparison with other studies is further complicated because different methods for measuring vitamin/mineral supplement use were used, including the 24-hour recall (2,3) or food checklists (2), which differ from the items on the health behavior questionnaire used in this study.

Dietary and Lifestyle Behaviors and Supplement Intake

Even though the average consumption of meat was similar between supplement users and nonusers, supplement users achieved higher food index scores. Higher food index scores resembled the prudent or more healthful diet pattern, which is characterized by higher intakes of whole grain, fruit, vegetables, dairy, and fish/seafood and lower in meat, fried food, and soft drinks than a typical

Table 3. Likelihood of using multiple-vitamin supplements across quintiles of food intake and dietary pattern score among adolescents, according to data from the Child and Adolescent Trial for Cardiovascular Health (CATCH) (n=2,761)

	Quintile of Dietary Intake[a] (Odds Ratio, 95% Confidence Interval)					
Food group	**1**	**2**	**3**	**4**	**5**	***P* trend**
Whole grain	1.00	1.18 (0.89, 1.58)	1.22 (0.90, 1.64)	1.49 (1.12, 2.00)	1.86 (1.37, 2.52)	<0.001
Refined grain	1.00	1.11 (0.83, 1.48)	0.94 (0.69, 1.29)	1.02 (0.72, 1.44)	0.76 (0.48, 1.19)	0.22
Fruit/juice	1.00	1.30 (0.96, 1.77)	1.96 (1.45, 2.65)	2.20 (1.62, 2.99)	2.81 (2.03, 3.88)	<0.001
Vegetables	1.00	1.28 (0.95, 1.71)	1.14 (0.84, 1.54)	1.40 (1.03, 1.89)	1.57 (1.13, 2.18)	0.008
Dairy	1.00	1.07 (0.81, 1.43)	1.35 (1.01, 1.82)	1.25 (0.91, 1.72)	1.48 (1.04, 2.11)	0.03
Meat	1.00	0.94 (0.71, 1.24)	0.86 (0.64, 1.15)	0.93 (0.68, 1.26)	0.74 (0.52, 1.07)	0.15
Fish/seafood	1.00	1.05 (0.81, 1.36)	1.36 (1.03, 1.79)	1.13 (0.86, 1.50)	1.31 (0.98, 1.75)	0.07
Fried food	1.00	0.75 (0.52, 1.08)	0.73 (0.57, 0.94)	0.50 (0.39, 0.64)	0.49 (0.35, 0.67)	<0.001
Soft drinks	1.00	0.78 (0.60, 1.02)	0.72 (0.55, 0.94)	0.73 (0.55, 0.96)	0.51 (0.38, 0.69)	<0.001
Desserts	1.00	1.16 (0.85, 1.58)	1.29 (0.91, 1.83)	0.96 (0.67, 1.37)	1.34 (0.94, 1.92)	0.33
Food index score	1.00	1.20 (0.87, 1.65)	1.52 (1.13, 2.05)	1.90 (1.35, 2.66)	2.51 (1.85, 3.41)	<0.001

[a]Logistic regression models were adjusted for age, sex, race, site, school, and energy intake.
NOTE: Data from this table are available online at www.adajournal.org as part of a PowerPoint presentation featuring additional online-only content.

Western diet pattern. To our knowledge this is the first study of adolescent—although not of adult—supplement users who report such a pattern. Adult supplement users have higher intakes of fruits and vegetables compared with nonusers (5). Adolescent supplement users, compared with nonusers, have higher micronutrient intakes of vitamins A, B, C, and E; folic acid; calcium; iron; and zinc from food sources, indicating that their diets are more likely to be adequate for these nutrients (2,3). Similar to other studies in both adolescents and adults, the proportion of energy from the macronutrients total fat and saturated fat was lower among supplement users compared with nonusers (3,5), whereas the proportion of energy from carbohydrate and protein for vitamin/mineral users was higher among vitamin/mineral users (3). A greater number of adolescents using supplements were physically active compared with nonusers. Studies on physical activity and supplement use among adolescents have not been conducted but our findings agree with the previous results found in adults (5,6,12) showing that supplement users were more active compared with nonusers. CATCH study adolescents taking supplements also watched less television, reported participating in more sports activities, and more of them had healthful weights (body mass index <25).

Several limitations of this study may influence the interpretation of the results. The cross-sectional design of the study limits the conclusions that can be drawn; therefore, cause-and-effect relationships cannot be established. The survey tool used to collect the supplement data relied on adolescent recall of use and there was no follow-up to verify supplement use or the brand name of supplements used. Adolescents who answered yes to the multiple-vitamin supplement question are those who usually took a supplement at varying frequencies. The study did not capture those who have irregular use of supplements and does not differentiate between how often supplements are used. Other types of supplements consumed and reasons why supplements were taken were not studied. Nutrient intake from supplements was not reported. Although the food frequency questionnaire permitted adolescents to report usual consumption, which may reflect eating patterns better than a single 24-hour dietary recall, quantitative estimates of intakes of various nutrients are imprecise using such instruments (2).

CONCLUSIONS

One in four adolescents reported using multiple-vitamin supplements, although the prevalence varied by race, sex, dietary intake, and health behaviors. Compared with nonusers, supplement users consumed more healthful diets, watched less television, were more physically active, and had a more healthful weight status. Adolescents may benefit from taking vitamin/mineral supplements to augment dietary intakes that are inadequate, but because they are concentrated sources of nutrients it is important to guard against excess.

The implications from this study for health professionals who work with adolescents include the necessity of remembering that:

- Vitamin/mineral supplements contribute to total nutrient intake and adolescents should be asked about frequency of use, type of supplement taken, and reasons why they are used.
- Healthy adolescents who have more healthful dietary patterns are more likely to be supplement users; therefore, these individuals are likely at a lower risk of having poor nutritional status than healthy nonusers.
- Supplements are not substitutes for healthful dietary patterns, and adolescents should be encouraged to adopt healthful patterns rather than rely on dietary supplementation for adequate nutrient intake.

This study was funded by National Institutes of Health grant No. RO1-HL66643.

References

1. American Dietetic Association. Position of the American Dietetic Association: Fortification and nutri-

tional supplements. *J Am Diet Assoc*. 2005;105:1300-1311.
2. Dwyer J, Garceau A, Evans M, Li D, Lytle L, Hoelscher D, Nicklas T, Zive M. Do adolescent vitamin-mineral supplement users have better nutrient intakes than nonusers? Observations from the CATCH tracking study. *J Am Diet Assoc*. 2001;101:1340-1346.
3. Stang J, Story M, Harnack L, Neumark-Sztainer D. Relationships between vitamin and mineral supplement use, dietary intake, and dietary adequacy among adolescents. *J Am Diet Assoc*. 2000;100:905-910.
4. Ervin RB, Wright JD, Reed-Gillette D. Prevalence of leading types of dietary supplements used in the Third National Health and Nutrition Examination Survey, 1988-1994. *Adv Data*. 2004;349:1-7.
5. Lyle B, Mares-Perlman J, Klein B, Klein R, Greger J. Supplement users differ from nonusers in demographic, lifestyle, dietary, and health characteristics. *J Nutr*. 1998;128:2355-2362.
6. Radimer K, Bindewald B, Hughes J, Ervin B, Swanson C, Picciano M. Dietary supplement use by US adults: Data from the National Health and Nutrition Examination Survey, 1999-2000. *Am J Epidemol*. 2004;160:339-349.
7. Millen K, Dodd K, Subar A. Use of vitamin, mineral, nonvitamin, and nonmineral supplements in the United States: The 1987, 1992, and 2000 National Health Interview survey results. *J Am Diet Assoc*. 2004;104:942-950.
8. Bowering J, Clancy K. Nutritional status of children and teenagers in relation to vitamin and mineral use. *J Am Diet Assoc*. 1986;86:1033-1038.
9. Looker AC, Sempos CT, Johnson CL, Yetley EA. Comparison of dietary intake and iron status of vitamin-mineral supplement users and nonusers, aged 1-19 years. *Am J Clin Nutr*. 1987;46:665-672.
10. O'Dea J. Consumption of nutritional supplements among adolescents: Usage and perceived benefits. *Health Educ Res*. 2003;18:98-107.
11. Herbold N, Vazquez I, Goodman E, Emans J. Vitamin, mineral, herbal, and other supplement use by adolescents. *Top Clin Nutr*. 2004;19:266-272.
12. Bullaz L, Okoro C, Bowman B, Serdula M, Mokdad A. Vitamin or supplement use among adults, behavioral risk factor surveillance system, 13 states, 2001. *Public Health Rep*. 2005;120:117-123.
13. Leupker R, Perry C, McKinlay S, Nader P, Parcel G, Stone E, Webber L, Elder J, Feldman H, Johnson C. Outcomes of a field trial to improve children's dietary patterns and physical activity. *JAMA*. 1996;275:768-776.
14. Osganian S, Stampfer M, Spiegelman D, Rimm E, Cutler JA, Feldman HA, Montgomery DH, Webber LS, Lytle LA, Bausserman L, Nadar PR. Distribution of and factors associated with serum homocysteine levels in children: Child and Adolescent Trial for Cardiovascular Health. *JAMA*. 1999;281:1189-1196.
15. Osganian SK, Feldman HA, Hoelscher DM, Kelder SH, Steffen LM, Luepker RV, Nader PR, Stampfer MJ, Webber LS. Serum homocysteine in US adolescents before and after universal folate supplementation. *Circulation*. 2003;107:e7026.
16. Rockett HR, Breitenbach M, Frazier AL, Witschi J, Wolf AM, Field AE, Colditz GA. Validation of a youth/adolescent food frequency questionnaire. *Prev Med*. 1997;26:808-816.
17. Steffen L, Jacobs D, Stevens J, Shahar E, Carithers T, Folsom A. Associations of whole-grain, refined grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: The Atherosclerosis Risk in Communities (ARIC) study. *Am J Clin Nutr*. 2003;78:383-390.
18. Pate RR, Heath GW, Dowda M, Trost S. Associations between physical activity and other health behaviors in a representative sample of US adolescents. *Am J Public Health*. 1996;86:1577-1581.
19. Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. *Annu Rev Nutr*. 2004;24:401-431.