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Estimation of Total Usual Calcium and Vitamin D Intakes in the United States[1–3]

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Abstract

Our objective in this study was to estimate calcium intakes from food, water, dietary supplements, and antacids for U.S. citizens aged ≥1 y using NHANES 2003–2006 data and the Dietary Reference Intake panel age groupings. Similar estimates were calculated for vitamin D intake from food and dietary supplements using NHANES 2005–2006. Diet was assessed with 2 24-h recalls; dietary supplement and antacid use were determined by questionnaire. The National Cancer Institute method was used to estimate usual nutrient intake from dietary sources. The mean daily nutrient intake from supplemental sources was added to the adjusted dietary intake estimates to produce total usual nutrient intakes for calcium and vitamin D. A total of 53% of the U.S. population reported using any dietary supplement (2003–2006), 43% used calcium (2003–2006), and 37% used vitamin D (2005–2006). For users, dietary supplements provided the adequate intake (AI) recommendation for calcium intake for ~12% of those ≥71 y. Males and females aged 1–3 y had the highest prevalence of meeting the AI from dietary and total calcium intakes. For total vitamin D intake, males and females ≥71, and females 14–18 y had the lowest prevalence of meeting the AI. Dietary supplement use is associated with higher prevalence of groups meeting the AI for calcium and vitamin D. Monitoring usual total nutrient intake is necessary to adequately characterize and evaluate the population's nutritional status and adherence to recommendations for nutrient intake. J. Nutr. 140: 817–822, 2010.

Introduction

Calcium is one of the major mineral components of the skeletal system and is also an essential nutrient required for nerve conduction, muscle contraction, hormone and enzyme secretion, and blood clotting. Adequate calcium intake is essential for normal growth and development of the skeleton and teeth and for adequate bone mineralization. Optimizing bone mass accretion in youth and adolescence is critical to attaining peak bone mass in adulthood (1). In adulthood, low calcium intake has been associated with increased risk for osteoporosis (2), bone fractures, and falls (3,4). Monitoring of calcium intake is necessary to evaluate one of the goals for Healthy People 2010, which is to increase the proportion of people aged ≥2 y who meet the dietary recommendations for calcium (5). Only 32% of U.S. adults met the adequate intake (AI)[8] for calcium through diet in 1999–2004 (6); however, that report did not include all sources of intake, which is necessary for the accurate and precise estimation of total usual calcium intake. Data from the NHANES provide information on intakes of calcium from all sources, the diet, water, dietary supplement use, and antacid consumption, and permits estimation of total calcium intake.

Vitamin D works to aid calcium absorption and its role in bone health has been well characterized (7). An accumulating body of evidence suggests that it may have other roles in human health and that vitamin D deficiency may contribute to certain chronic diseases (8). Vitamin D occurs naturally in only a few foods and is also available in fortified foods (milk and milk products, margarines, some juices, and breakfast cereals). Fortified foods constitute the major food sources of vitamin D in the United States (9). Data on dietary intakes of vitamin D were not available in the continuous NHANES (1999–2004) because of incomplete values for the nutrient in survey food composition tables. Recently, the NHANES 2005–2006 vitamin D

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[1] The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Office of Dietary Supplements, the National Cancer Institute, the NIH, CDC, the USDA, or any other entity of the U.S. Government.

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[3] Supplemental Tables 1 and 2 are available with the online posting of this paper at jn.nutrition.org.

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[8] Abbreviations used: AI, adequate intake; DRI, Dietary Reference Intake; NCI, National Cancer Institute; UL, tolerable upper intake level.

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intake data from the diet were released (10). Estimates of usual vitamin D and calcium intake are necessary for setting the Dietary Reference Intake (DRI) intake levels (11). We analyzed recent NHANES survey data to provide national estimates of total usual intake of calcium and vitamin D from all sources by gender and age groups and compared them to the appropriate DRI recommendations.

Materials and Methods

The NHANES is a nationally representative, cross-sectional survey that samples noninstitutionalized, civilian U.S. residents using a complex, stratified, multistage probability cluster sampling design (12). The NHANES data are collected by the National Center for Health Statistics of the CDC. Written informed consent was obtained from all participants or proxies and the survey protocol was approved by the Research Ethics Review Board at the National Center for Health Statistics.

NHANES participants are asked to complete an in-person household interview and a health examination in a mobile examination center that includes an in-person 24-h dietary recall. A second 24-h dietary recall is collected via telephone ~3–10 d after the mobile examination center exam. Both 24-h recalls were collected using USDA's Automated Multiple-Pass method (13,14). For both 24-h recalls, proxy respondents report for children who are 5 y and younger and proxy-assisted interviews are conducted with children 6–11 y of age (15). Dietary supplement use information was collected during the household interview as part of the Dietary Supplement Questionnaire. Information included the participant's use of vitamins, minerals, herbs, and other dietary supplements over the past 30 d. Detailed information about type, consumption frequency, duration, and amount taken was also collected for each reported dietary supplement. The average daily intake of nutrients from dietary supplements was calculated for individuals using the number of days supplement use was reported, the reported amount taken per day, and the serving size unit from the product label. Calcium from antacids was collected as part of the NHANES nonprescription drug questionnaire that participants self-completed at the home interview. For this analysis, calcium was standardized to the elemental form in milligrams and vitamin D was standardized to the microgram metric for comparison to the DRI recommendations.

The unweighted examination response rate for all participants, calculated as the number of participants per component divided by the total number selected into the sample, was 79% for the interview component and 76% for the exam component in NHANES 2003–2004 and 80% for the interview component and 77% for the exam component in NHANES 2005–2006. Survey years 2003–2004 (n = 10,122) were combined with 2005–2006 (n = 10,348) for the calcium analysis. The vitamin D analysis is only for 2005–2006, because dietary data are only available for this NHANES wave at this time. Exclusions were made in the following sequence: individuals under the age of 1 y (n = 477 in 2003–4, n = 526 in 2005–6) or who were pregnant (n = 477 in 2003–4, n = 526 in 2005–6) or lactating (n = 44 in 2003–4, n = 46 in 2005–6) and those who did not complete or who had incomplete dietary recall data (n = 1050 in 2003–4, n = 957 in 2005–6).

Usual total nutrient intake. The National Cancer Institute (NCI) method (16) was used to produce usual nutrient intake estimates utilizing the amount-only part of the NCI method. The first step in the NCI method for nutrients (assumed to be consumed every day by every member of the population) replaces reported zero intakes with one-half of the minimum nonzero value reported in the data set (this was necessary for <1% of the data and only for the vitamin D analyses). The second step in the NCI method models Box-Cox–transformed 24-h recall observations as a function of observed fixed-effect covariates, unobserved individual-level random effects, and within-individual error. For these analyses, the covariates were: *1*) sequence of the 24-h recall; *2*) day of the week the 24-h recall was collected, dichotomized as weekend (Friday–Sunday) or weekday (Monday–Thursday); and *3*) dietary supplement use. The amount of calcium provided from dietary supplements and antacids (0–100, 101–400, >400 mg/d) and the amount of vitamin D from dietary supplements (0–2.5, 2.5–5, 5–10, and >10 μg/d) was used in the model. The first 2 covariates (sequence and weekend) are examples of "nuisance effects" that are explicitly adjusted for in the estimation of usual intake, as described below. The Box-Cox transformation is chosen such that the differences ("residuals") between transformed observations and their predictions based on the fixed-effect parameter estimates are separable into normally distributed random effects (representing between-individual differences not explained by covariates) and normally distributed within-person errors. Within- and between-individual variance components of the residuals are estimated in the transformed scale.

The estimated distribution of usual dietary intake is constructed to reflect only between-person variability; the within-person variability is eliminated because it does not reflect usual intake. For the model under consideration, between-person variation in usual intake arises from differences in measured covariate values across individuals and from the random effects. Within-individual variation is also partly due to measured covariate values (interview sequence and weekend effects). The first step in constructing the usual dietary intake distribution is to obtain a set of representative values whose empirical distribution approximates the assumed distribution of between-individual random effects. The NCI method as described in Tooze et al. (16) uses a Monte Carlo simulation method to obtain a large set (by default, 100/individual) of such values assuming the random effects are exactly normally distributed. An alternative approach that is more robust to the normality assumption at the expense of some efficiency applies the procedure of Dodd et al. (17) to the individual's mean residual to construct a smaller set (one per individual) of representative values "shrunk" to the group mean of the residuals. Using either method, the empirical distribution of these initial representative values reflects between-individual variation that is not explained by covariates. Next, the covariate information in the data set is used to calculate 2 fixed effect predictions for each individual. The first of the 2 predictions is computed as if it were a first interview on a weekend day, the second is computed as it if were the first interview on a weekday. Other values of the covariates are held at their observed values for the individual. Corresponding representative value from the first step are added to each individual's 2 predictions and the resulting quantities are each back-transformed to the original scale using the procedure described by Dodd et al. (17). Next, the 2 original-scale predictions are combined in a weighted average giving weight 3/7 to the weekend prediction and 4/7 to the weekday prediction. The empirical distribution function of the resulting quantities, weighted according to the survey sampling weights, is an estimate of the usual dietary intake distribution. Finally, each individual's reported daily intake of the nutrient from supplement sources is added to his or her corresponding value(s) computed from the previous step, and the empirical distribution of these final sums, weighted according to the survey sampling weights, is an estimate of the usual total intake distribution.

This construction of the distribution estimator accounts for both kinds of between-individual variation mentioned above and explicitly adjusts for the nuisance effects of interview sequence and weekend/weekday differences. Choosing to compute fixed effect predictions as if for a first recall implicitly assumes that the first recall for an individual is the most accurate. The weighted averaging of back-transformed weekend and weekday predictions assumes that the desired usual intake in the original scale is an average over many weeks, where weekends and weekdays occur with frequencies 3 and 4 of 7, respectively. Finally, using categorized supplement intake as a covariate allows groups of individuals with different levels of supplemental intake to have a different mean usual intake from food sources.

Complete details of the NCI method and the SAS macros necessary to fit this model and to perform the Monte Carlo-based estimation of usual intake distributions can be found at the NCI Web site (18). Custom SAS macros were created to estimate usual dietary and total intake distributions using the shrinkage technique and to perform Fay's (19,20) Modified Balanced Repeated Replication variance calculations. The shrinkage technique produced estimates of usual dietary intake that were practically identical to the ones produced by the Monte Carlo technique. In the results that follow, distributions of dietary intake are based on the Monte Carlo technique supported by the official NCI macros. However, distributions of total nutrient intake are based on the shrinkage technique. Because the shrinkage technique operates on person-specific residuals, it was thought to be more robust in case the relationship between individual dietary intake and individual supplement intake was not adequately modeled simply by inclusion of the supplement-use covariates.

Statistical analysis. All statistical analyses were performed using SAS (version 9, SAS Institute) and SAS-callable SUDAAN (version 9, Research Triangle Institute) software. Sample weights were used to account for differential nonresponse and noncoverage and to adjust for planned oversampling of some groups. For statistical procedures not specifically designed to analyze survey data, the sample weights were treated as counts of individuals with identical data. SE for all statistics of interest were approximated by the Balanced Repeated Replication technique (19,20) using 32 sets of replicate weights (for 2003–2006) and 16 sets of replicate weights (for 2005–2006) constructed with an initial perturbation factor of 0.7. Each set of replicate weights was poststratified to control totals computed from the initial sample weights.

The prevalence of use and mean contribution of calcium and vitamin D from supplemental sources was calculated. Mean calcium and vitamin D intake were calculated from the estimated usual intake distributions (dietary and total). Each adjusted intake was compared with the AI and tolerable upper intake level (UL) (21) appropriate to the individual, and the fraction of individuals above the cutoffs was used as the estimate of the proportion of the population that is meeting the DRI recommendations. We tabulated statistics for 16 DRI age and gender groups. Each gender/age group was analyzed independently of the others.

Rather than making all possible pairwise comparisons, we used Hsu's (22) procedure to determine (within gender) which age groups had the highest and lowest population value(s) for: *1*) calcium/vitamin D dietary supplement use prevalence; *2*) mean calcium/vitamin D intake from dietary supplements; *3*) proportions meeting DRI recommendations for calcium/vitamin D from dietary sources only; and *4*) proportions meeting DRI recommendations calcium/vitamin D from all sources. The procedure also allows construction of simultaneous CI for differences between each age group's population value and that of the largest/smallest population value. This procedure controls the experiment-wise Type I error rate in a manner more appropriate for this purpose than the classic Bonferroni approach. Hsu's (22) procedure, with an α of 0.025, was performed twice per gender for each of the 4 types of outcomes; once to find the largest and once to find the smallest population values(s). Thus, the experiment-wise error rate is held at an $\alpha \leq 0.05$, where an "experiment" refers to pinpointing age groups with the highest and age groups with the lowest population values for a given outcome/gender combination.

Results

Dietary supplement use. Over one-half (53.4%) of NHANES 2003–2006 participants reported use of any dietary supplement over the last 30 d and 43% of the U.S. population over the age of 1 y used supplemental calcium. Among supplement users, the overall mean intake of calcium from supplemental sources was 331 mg/d (**Table 1**); dietary supplements provided the AI level of calcium for 8 ± 1% of the population. Taking calcium supplements was reported by 62 ± 2% among those aged ≥71 y when genders were combined. For males, mean calcium intake from supplemental sources was significantly higher in the ≥71-y age group than all others. Similarly, females aged ≥71 y had a significantly higher prevalence of use of and a higher mean calcium intake from supplemental sources than every other age group with the exception of those 51–70 y. Among users of dietary supplements, ~17% of females ≥71 y met the AI simply through their use of dietary supplements.

In 2005–2006, 37% of the U.S. population used a dietary supplement containing vitamin D (**Table 2**); fewer males (33 ± 1%) then females (40 ± 1%) reported use. Males 14–18 y and females 19–30 y had the lowest prevalence of use of vitamin D dietary supplements, whereas individuals ≥71 y had the highest reported use regardless of gender. For bother genders, those ≥51 y had the highest mean intakes of vitamin D provided by supplemental sources.

TABLE 1 Prevalence of use and daily contribution of supplemental calcium in the United States, 2003–2006[1]

	Age group, *y*	*n*	Users,[2] %	Calcium,[3] *mg/d*
Supplement users		5217	43 ± 1	331 ± 9.6
Males	1–3	97	18 ± 2^{a}	66 ± 6.8^{a}
	4–8	183	29 ± 2	99 ± 17.6^{a}
	9–13	159	20 ± 2^{a}	104 ± 16.2^{a}
	14–18	185	19 ± 2^{a}	143 ± 16.4
	19–30	285	34 ± 2	151 ± 12.6
	31–50	556	45 ± 2	234 ± 17.7
	51–70	537	51 ± 2^{b}	268 ± 16.3
	≥71	409	56 ± 3^{b}	372 ± 23.1^{b}
Females	1–3	110	20 ± 2^{a}	55 ± 4.8^{a}
	4–8	193	26 ± 3^{a}	87 ± 10.8^{a}
	9–13	181	24 ± 3^{a}	80 ± 5.2^{a}
	14–18	196	24 ± 2^{a}	182 ± 16.4
	19–30	280	39 ± 2	283 ± 18.7
	31–50	599	52 ± 2	359 ± 16.5
	51–70	752	67 ± 1^{b}	578 ± 21.7^{b}
	≥71	495	65 ± 2^{b}	608 ± 26.9^{b}

[1] Superscripts denote sets of within-gender age groupings with means or prevalence estimates that are statistically indistinguishable from the lowest (^{a}) or highest (^{b}) population mean, as determined by Hsu's procedure (22) with $\alpha = 0.025$.

[2] Data are percent ± SE.

[3] Data are mean ± SE.

TABLE 2 Prevalence of use and daily contribution for users of supplemental vitamin D in the United States, 2005–2006[1]

	Age group, *y*	*n*	Users,[2] %	Vitamin D,[3] *μg/d*
Supplement users		2396	37 ± 1	8.6 ± 0.3
Males	1–3	110	33 ± 4	6.3 ± 0.4^{a}
	4–8	153	43 ± 4	6.6 ± 0.4
	9–13	109	24 ± 4	8.4 ± 2.2
	14–18	74	16 ± 2^{a}	5.7 ± 0.8^{a}
	19–30	109	27 ± 4	6.0 ± 0.6^{a}
	31–50	225	34 ± 2	7.3 ± 0.5
	51–70	203	40 ± 3	9.4 ± 0.9^{b}
	≥71	157	49 ± 3^{b}	10.9 ± 0.9^{b}
Females	1–3	103	34 ± 3	5.0 ± 0.5^{a}
	4–8	132	34 ± 3	7.9 ± 1.3
	9–13	100	32 ± 3	8.0 ± 1.7
	14–18	87	27 ± 5	6.1 ± 0.5
	19–30	122	21 ± 4^{a}	7.5 ± 0.7
	31–50	250	34 ± 2	7.9 ± 0.3
	51–70	284	40 ± 3	11.2 ± 1.1^{b}
	≥71	178	49 ± 3^{b}	10.7 ± 0.3^{b}

[1] Superscripts denote sets of within-gender age groupings with means or prevalence estimates that are statistically indistinguishable from the lowest (^{a}) or highest (^{b}) population mean, as determined by Hsu's procedure (22) with $\alpha = 0.025$.

[2] Data are percent ± SE.

[3] Data are mean ± SE.

Dietary and total nutrient intakes. Males and females aged 1–3 y had the highest proportion meeting the AI for dietary and total intake of calcium across all age groups (**Table 3**). The prevalence of intake above the UL was higher for total calcium intake compared with calcium intake from diet only, but the prevalence of excessive intake (i.e. above the UL) was still very small (<2%) except among males aged 14–18 y (4% SE ± 1), females 51–70 y (4% SE ± 1), and females ≥71 y (4% SE ± 1) (data not shown). However, very high calcium total intakes were observed in the 99th percentile for both males and females of all ages (**Supplemental Table 1**).

For males, the highest prevalence of meeting the vitamin D AI from dietary sources alone was among 1- to 3-y and 4- to 8-y olds. Among females, age groups 1–3, 4–8, and 9–13 y had the highest prevalence of meeting the AI from the diet (**Table 4**). Less than 7% of males and females over the age of 51 y met the AI for vitamin D through the diet. When dietary supplement use was included, the prevalence of those meeting the AI was higher for all age groups, but most dramatically for those aged 51 y and older. For total vitamin D intake, males and females ≥71 y and females 14–18 y had the lowest prevalence of meeting the AI. As a group, <1% exceeded the UL through diet or when total vitamin D intake was examined (data not shown).

Discussion

This report is the first, to our knowledge, to present national estimates of usual calcium and vitamin D intake from all sources for the U.S. population using the most recently available data from NHANES. More than one-half of the U.S. population uses dietary supplements; our data indicate some individuals meet the AI from dietary supplement use alone. Thus, nutrient intakes from dietary supplements must be included to accurately characterize total exposure to nutrients and to estimate the distribution of total usual nutrient intake. Without the inclusion of supplemental nutrients, mean nutrient intakes are underestimated, the prevalence of inadequate intakes is overestimated, and the prevalence of excessive intakes is underestimated (23).

In public health nutrition research, the distribution of usual total nutrient intake is a necessary cornerstone (24). The estimates and the distributions presented in this paper were adjusted to reflect usual nutrient intake using the NCI method. The NCI model we employed for the dietary intakes removes the effect of within-person variability and adjusts for the effects of known covariates: sequence of 24-h dietary recall, day of the week that the data were collected, and the amount of the nutrient provided from supplemental sources. The amount of the nutrients supplied from supplemental sources is an important covariate; previous reports suggest that dietary supplement users tend to have high dietary intakes of nutrients (23,25). Thus, the relationship between nutrient intakes from food and from dietary supplements are complex and should be addressed (26). The model we developed addressed this covariate statistically by allowing those who used dietary supplements to have a different group mean nutrient intake from the diet compared with those who did not use supplements; this allowed for a more accurate estimation of total usual nutrient intakes. Another strength of this study is that it provides independently estimated tabulations of usual intake means, percentiles, and proportions meeting recommendations for all of the DRI gender/age groups. Therefore, researchers and policy makers can make pairwise comparisons between as many DRI age groups as they desire, although care should be taken to control the Type I error rate when making many such comparisons. We chose to use Hsu's (22) procedure to statistically assess selected a priori hypotheses but recognize that additional comparisons might be of interest. Some limitations should also be addressed. First, all estimates of dietary intake assume that reported nutrient intake from food sources on the 24-h recalls are unbiased and that the self-reported dietary supplement intake reflects true long-term

TABLE 3 Calcium intake from the diet and all sources compared with the AI recommendations by gender and age group in the United States, 2003–2006[1]

	Age group, *y*	*n*	AI	UL	Calcium			
					Diet alone,[2] *mg/d*	Above AI,[3] *%*	Total intake,[4] *mg/d*	Above AI,[3] *%*
Males	1–3	758	500	2500	999 ± 28	94 ± 0.9[b]	1008 ± 28.3	96 ± 1.0[b]
	4–8	807	800	2500	1058 ± 29	80 ± 2.8	1087 ± 31.0	83 ± 2.5
	9–13	1009	1300	2500	1074 ± 31	22 ± 3.4[a]	1093 ± 32.9	23 ± 4.2[a]
	14–18	1351	1300	2500	1266 ± 37	42 ± 2.9	1296 ± 41.1	42 ± 3.2
	19–30	1097	1000	2500	1209 ± 33	63 ± 2.7	1259 ± 33.9	65 ± 3.2
	31–50	1439	1000	2500	1118 ± 25	56 ± 2.6	1220 ± 27.4	64 ± 2.9
	51–70	1215	1200	2500	951 ± 19	22 ± 1.8[a]	1092 ± 21.4	32 ± 2.0[a]
	≥71	808	1200	2500	871 ± 25	15 ± 2.5[a]	1087 ± 28.6	31 ± 2.7[a]
Females								
	1–3	745	500	2500	965 ± 28	96 ± 1.2[b]	977 ± 28.1	97 ± 0.9[b]
	4–8	869	800	2500	951 ± 27	67 ± 3.1	974 ± 27.1	67 ± 4.9
	9–13	1039	1300	2500	968 ± 44	15 ± 4.7[a]	988 ± 47.1	15 ± 4.4[a]
	14–18	1249	1300	2500	876 ± 26	10 ± 2.4[a]	918 ± 29.7	13 ± 2.8[a]
	19–30	914	1000	2500	838 ± 25	26 ± 3.3	945 ± 29.8	38 ± 3.3
	31–50	1350	1000	2500	864 ± 20	30 ± 2.5	1055 ± 28.3	44 ± 2.6
	51–70	1251	1200	2500	788 ± 23	9 ± 1.5[a]	1186 ± 37.3	39 ± 2.6
	≥71	787	1200	2500	748 ± 17	8 ± 1.2[a]	1139 ± 24.9	39 ± 1.7

[1] Superscripts denote sets of within-gender age groupings with prevalence estimates that are statistically indistinguishable from the lowest ([a]) or highest ([b]) population mean, as determined by Hsu's procedure (22) with $\alpha = 0.025$.

[2] Data are mean ± SE food and water only.

[3] Data are percent ± SE.

[4] Data are mean ± SE for total intake: food, water, antacids, and dietary supplements.

TABLE 4 Vitamin D intake from the diet and all sources compared with the AI recommendations by gender and age group in the United States, 2005–2006[1]

					Vitamin D			
	Age group, *y*	*n*	AI	UL	Diet alone,[2] *μg/d*	Above AI,[3] *%*	Total intake,[4] *μg/d*	Above AI,[3] *%*
Males	1–3	405	5	50	7.2 ± 0.2	72 ± 2.9[b]	9.1 ± 0.4	78 ± 3.0[b]
	4–8	431	5	50	6.4 ± 0.3	67 ± 4.4[b]	9.3 ± 0.4	80 ± 3.9[b]
	9–13	522	5	50	5.7 ± 0.2	53 ± 4.9	7.5 ± 0.7	66 ± 4.5[b]
	14–18	654	5	50	6.1 ± 0.4	50 ± 3.9	6.9 ± 0.5	54 ± 3.8
	19–30	549	5	50	5.1 ± 0.3	39 ± 3.2	6.6 ± 0.4	49 ± 2.8
	31–50	758	5	50	5.4 ± 0.3	45 ± 3.4	7.9 ± 0.3	59 ± 3.9
	51–70	614	10	50	5.1 ± 0.3	7 ± 2.0[a]	8.8 ± 0.4	36 ± 2.1
	≥71	368	15	50	5.6 ± 0.4	1 ± 0.5[a,*]	10.7 ± 0.7	24 ± 3.1[a]
Females								
	1–3	384	5	50	6.9 ± 0.4	70 ± 4.1[b]	8.4 ± 0.4	76 ± 4.3[b]
	4–8	468	5	50	5.5 ± 0.3	53 ± 5.3[b]	7.9 ± 0.6	66 ± 4.1[b]
	9–13	525	5	50	5.3 ± 0.6	47 ± 8.8[b]	7.7 ± 1.0	53 ± 8.1[b]
	14–18	643	5	50	3.8 ± 0.2	24 ± 3.5	5.0 ± 0.5	32 ± 4.4[a]
	19–30	481	5	50	3.6 ± 0.3	21 ± 3.4	5.8 ± 0.3	41 ± 3.2
	31–50	693	5	50	4.4 ± 0.3	32 ± 3.1	7.7 ± 0.5	56 ± 2.7
	51–70	610	10	50	3.9 ± 0.4	2.0 ± 1.8[a,*]	10.1 ± 1.0	44 ± 3.2
	≥71	332	15	50	4.5 ± 0.2	0.3 ± 0.1[a,*]	10.0 ± 0.5	22 ± 3.4[a]

[1] Superscripts denote sets of within-gender age groupings with prevalence estimates that are statistically indistinguishable from the lowest ([a]) or highest ([b]) population mean, as determined by Hsu's procedure (22) with $\alpha = 0.025$. * The relative SE is >30%; this estimate is unreliable.

[2] Data are mean ± SE foods only.

[3] Data are percent ± SE.

[4] Data are mean ± SE for total intake: foods and dietary supplements.

supplement intake. Second, estimates of nutrients from dietary supplements depend largely on label declarations rather than analytical values. Recent analytical data on dietary supplements suggest that actual levels exceed the labeled values for many vitamins and minerals (27,28). For calcium, the average deviation from the label is 14% (29); information on vitamin D deviation from label is not known at this time. Thus, the data presented in this manuscript should be interpreted with these caveats.

Our results indicate that some age and gender groups have low calcium intake. Whereas very few infants and toddlers had low calcium intake, only 15% of 9- to 13-y-old females and ≤10% of females aged 14–18, 51–70, and ≥71 y met the AI for calcium from diet alone. However, when total intake was examined, dietary supplements increased the prevalence of meeting the AI in the older age groups. Nevertheless, considering dietary supplement use, only 15% of 9- to 13-y-old and 13% of 14- to 18-y-old females met the AI for calcium.

Previous NHANES (1999–2004) estimates of the proportion of population subgroups above the AI of calcium intake from food sources are similar to those presented in this updated report (2003–2006) (6). Our data do, however, suggest a decrease in the prevalence of meeting the AI for 4- to 8-y-old females. One potential explanation for this discrepancy could be the methods used to adjust the data; the Iowa State method (30) was used for the 1999–2004 estimates. However, recent simulation studies with calcium indicate that the statistical methods employed to adjust the dietary intakes of calcium using NHANES data do not produce very different prevalence estimates or mean calcium intakes (31). The survey years 1999–2002 have only one 24-h dietary recall, which may influence the usual intake estimates as well. Nevertheless, these findings may indicate a decline in calcium intakes among females 4–8 y of age. The USDA Food Availability Report indicates an increase in the availability of dairy products over this time period (32). Interestingly, an increase in the prevalence of meeting the AI was observed for both 31- to 50-y-old males and females compared with the earlier report.

Gahche et al. (33) found that use of vitamin D supplements has increased over time for U.S. adults (ages 14 y and older) with 26% reporting use in NHANES III, 35% reporting use in NHANES 1999–2002, and 37% in 2003–2006. Our 2005–2006 data on vitamin D supplement use in children were almost identical to an earlier report by Picciano et al. (34) from 1999–2002 indicating that the prevalence of use among U.S. children was 33% in children aged 1–3 y, 36% in children 4- to 8-y olds, 23% in those aged 9–13 y, and 16% in 14- to 18-y olds when genders were combined. Our later data are consistent: 32% use in children aged 1–3 y, 37% in those aged 4–8 y, 23% in those aged 9–13 y, and 17% in those aged 14–18 y. Thus, although use of vitamin D supplements has increased over time in adult populations (33), the use in children and adolescents appears to be stable. Whereas younger Americans tend to have the most favorable total vitamin D intake, a large percentage of older adults in NHANES fail to meet the recommendations from diet alone and only improve marginally with the use of dietary supplements. This may be in part due to the higher AI level in these age groups: 51–70 y (10 μg/d) and ≥71 y (15 μg/d). Regardless, this is of concern given the role of vitamin D in bone health, falls, and fracture risk in these age groups (35).

Dietary supplements constitute an important source of nutrients for large segments of the population. About 43% of the U.S. population and almost 70% of older females report supplemental calcium use. Our data and that of others (36) indicate that dietary supplement use is associated with a higher prevalence of meeting the AI for calcium. Recent media attention on the role of vitamin D in various chronic disease states has dramatically increased sales of this dietary supplement (37). The distributions of usual total nutrient intakes are necessary to accurately monitor the population's nutritional status and adherence to recommendations for calcium and vitamin D intake. Never before has the inclusion of nutrient intakes from dietary supplements been more salient.

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