Vitamin and Mineral Supplements Have a Nutritionally Significant Impact on Micronutrient Intakes of Older Adults Attending Senior Centers

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ALLISHA WEEDEN, PhD, RD
Department of Health and Nutrition Sciences, Idaho State University, Pocatello, Idaho, USA

VALENTINA REMIG, PhD, RD, FADA and CAROL ANN HOLCOMB, PhD
Department of Human Nutrition, Kansas State University, Manhattan, KS, USA

THOMAS J. HERALD, PhD
U.S. Department of Agriculture, Grain Quality and Structure Research Unit, Manhattan, Kansas, USA

RICHARD C. BAYBUTT, PhD
Department of Applied Health Science, Wheaton College, Wheaton, Illinois, USA

ABSTRACT: Older adults frequently report use of vitamin and mineral (VM) supplements, although the impact of supplements on dietary adequacy remains largely unknown. The purpose of the current study was to evaluate micronutrient intakes of older adults with emphasis on identifying nutrients most improved by VM supplements, nutrients most likely to remain inadequate, and nutrients most likely consumed in excess. Community-based volunteers were recruited from senior centers and completed a questionnaire querying demographic data, current health status, and VM supplement use. Participants (n = 263) were then contacted by telephone to complete two 24-hour diet recalls and confirm VM supplement use. Dietary adequacy was determined by comparing the ratio of mean dietary intake to the Dietary Reference Intakes (DRI). Dietary consumption was lowest for vitamins D and E, calcium, and magnesium. VM supplementation most improved intakes of vitamins E, D, B6, folic acid, and calcium. Participants were most likely to exceed the Tolerable Upper Limit with supplementation of niacin, folic acid, and vitamin A.

Address correspondence to Valentina Remig, PhD, RD, FADA, Department of Human Nutrition, Kansas State University, 206 Justin Hall, Manhattan, KS 66506-1407. E-mail: remig@ksu.edu
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INTRODUCTION

Classic vitamin and mineral deficiencies are rarely seen in the United States, although inadequate micronutrient intakes are seen, especially among the older adult population (1). Previous studies, including the Continuing Survey of Food Intakes by Individuals (CSFII), 1994–1996, NHANES III, and NHANES 1999–2000, have shown micronutrient inadequacies within the older adult population (2–5). Intakes of calcium, magnesium, and vitamin E were particularly low among sampled populations in the aforementioned studies (2, 3, 6). A mid-1990s study designed to guide public policy and evaluate the Elderly Nutrition Program found that older adults attending congregate meal sites had intakes below the recommendation for vitamin D, vitamin E, folate, calcium, and magnesium (7). Sampled participants consumed less than 50% of the recommended amount for vitamins D and E (7). Low intake of vitamins and minerals can increase risk for chronic conditions like heart disease, some cancers, and osteoporosis (1, 8), but low intakes can be improved through increased dietary consumption, food fortification, or use of dietary supplements (9).

Recent studies estimated more than 60% of adults aged 60 years and older used a multivitamin/mineral supplement regularly (10, 11); up from slightly more than 45% estimated by NHANES III (11). Besides the use of the multivitamin/mineral supplement, older adults also frequently reported the use of supplements of calcium, vitamin E, and vitamin C (10, 13). Previous studies have shown that vitamin/mineral (VM) supplement use significantly increased the number of participants achieving adequate nutrient intakes (2, 14, 15).

In addition to the potential benefits of VM supplementation, there are risks with VM supplementation. The American Dietetic Association recognizes that VM supplement use may be of benefit to some older adults, but acknowledges that dietary supplements greatly increase risk for toxicities (16). Dietary supplement use has been shown in previous studies to occasionally exceed the Tolerable Upper Limit (UL) for some nutrients (2, 14). Specifically, excessive intakes of iron, zinc, folic acid, and vitamin A have been associated with VM supplement use (2, 14).

With greater numbers of older adults using VM supplements, discussions regarding the potential benefits and risks of use have increased. The purpose of this study was to evaluate the impact of vitamin and mineral supplementation on the micronutrient intake of older adults attending senior centers in Kansas. The specific objectives were to identify (a) micronutrients most improved by supplement use, (b) micronutrients most likely to remain inadequate with supplementation, and (c) micronutrients most likely consumed in excess.

METHODS

Study Participants

This cross-sectional study enrolled participants from 35 randomly selected senior centers across the state of Kansas. Senior center participants were selected to represent a mixed audience of older adults residing in Kansas. Approval for this study was obtained from the Institutional Review Board of Kansas State University. All participants provided informed written consent on the day of study enrollment.

Adults 60 years of age and older with self-reported cognitive ability and telephone access were recruited. Individuals were asked to consider their own cognitive ability with regard to the capacity needed to complete the required 24-hour dietary recalls. A total of 374 volunteers were enrolled in the study. Six individuals younger than 60 years of age, one person with an incomplete questionnaire, and one person with a diagnosis of Alzheimer disease were excluded. Volunteers were not provided compensation for their participation, but names were entered into a drawing for a raffle prize ($8 value) presented at each center.

Procedures

Data collection occurred between June 2007 and January 2008 and began with a visit to each participating senior center to recruit participants. At enrollment, participants completed a questionnaire developed for this study, providing demographic information, current health status, and information on dietary supplement use. Participants were contacted twice by telephone to complete two 24-hour diet recalls and confirm and/or clarify dietary supplement use. The 24-hour diet recalls were conducted by a trained researcher, who is a Registered Dietitian, using the multi-pass technique. Dietary supplement use and frequency of use was originally reported in the questionnaire at the time of enrollment. In addition to confirming dietary supplement use and frequency of use, the telephone interview also inquired as to the specific supplement brand taken, dose taken, and any supplements that may have been added since enrollment or previous interview. Required telephone interviews were not completed for 44 participants due to the request for no further contact, inability to be reached by telephone, or withdrawal due to cognitive or medical reasons.

Dietary intake was analyzed using Nutritionist Pro (Version 3.1, 2006, Stafford, Texas). Intakes were analyzed in 2 groups: diet only and diet + supplementation. Standardized supplement entries and dosages were applied for all VM supplements reported as an unknown brand or amount. The standardized dosages were developed based on the dose used by other participants and brands carried in stores where the participants reported purchasing dietary supplements. Any VM supplements not included in the dietary analysis software (e.g., folic acid, copper, etc.) were manually added to the mean dietary intakes of each subject. Adequacy of micronutrient intake was determined by comparing intake from the 24-hour diet recalls to the Estimated Average Requirement (EAR) and Adequate Intake (AI) from the Dietary Reference Intake (DRI) values (17). These ratios represent the portion of the DRI met. Ratios were also calculated to compare micronutrient intake to the UL to determine excessive intakes. The current analyses included only those participants reporting VM supplement use (n = 263) and therefore excluded all participants not using a VM supplement (n = 49).

Statistical Analyses

All statistical analyses were performed using SPSS (Version 15.0, 2006, SPSS, Inc., Chicago, IL). Chi-square tests were used to identify differences in micronutrient intakes by gender and age groups (18). The Mann-Whitney test was used to determine differences in mean supplements consumed by gender (18). Statistical significance was set at $p < .05$. Dietary adequacy was evaluated by creating ratios comparing dietary intake to the EAR. Nutrients without EAR values were evaluated for sufficient intake by comparing the ratio of dietary intake to the AI. Micronutrient intakes with ratios greater than 1.0 were considered adequate or sufficient. Any micronutrient intake ratio below 1.0 was considered inadequate or insufficient. Excessive intake was determined by creating ratios to compare dietary intake to the UL. Micronutrients with ratios above 1.0 were considered excessive.

Results

Two hundred sixty-three participants completed two 24-hour diet recalls and confirmed usage of at least one VM supplement. The study participants were predominately female, white (non-Hispanic), and widowed with an annual income below $24,000. Most participants had at least a high school education and participated in a meal program through the senior center. Alcohol and tobacco use were rare among study participants. Chronic health conditions were reported by more than 90% of participants, and the use of multiple prescription medications was common. Mean age of participants was 77.0 years (±7.3), 77.3 years (±7.5) for females and 76.1 years (±6.8) for males. Additional demographic and health characteristics can be found in Table 1.

Table 1 - Demographic and Health Characteristics of Older Kansans Using Vitamin and Mineral Supplements

	Male (%)	Female (%)
Gender	22.8	77.1
Race/Ethnicity (n=263)		
White, non-Hispanic	21.7	73.0
African American	0.8	2.7
Hispanic	0.0	1.5
Native American	0.4	0.0
Marital Status (n=262)		
Widowed	5.7	43.9
Married	11.8	22.5
Divorced	3.8	8.4
Single	1.5	2.3
Yearly Income (n=263)		
<$24,000	10.6	39.9
>$24,000	7.2	13.7
Did not report	4.9	23.6
Education (n=260)		
<High school	4.2	7.3
High school	8.5	28.1
Some college	5.4	31.9
College grad	5.0	9.6
Current Health Status (n=263)		
Excellent	1.5	5.3
Very good	7.6	19.8
Good	8.7	32.7
Fair	4.6	17.9
Poor	0.4	1.5
Alcohol Use (n=251)		
Never use	19.5	66.5
Consumes weekly	4.0	10.0
Tobacco Use (n=256)		
Never used	8.2	56.3
Current user	1.2	1.6
Former user	13.7	19.1
Meal at Senior Center (n=260)		
Yes	20.7	65.0
No	1.9	12.3

A multivitamin/mineral supplement was the most commonly used type of VM supplement. Other frequently reported VM supplements included calcium, vitamin D, vitamin E, and vitamin C. Female participants used significantly ($p < .01$) more VM supplements than males, 3.1 ± 2.1 and

1.9 ± 2.0, respectively. Additionally, female participants were significantly more likely to use calcium, vitamin D, and vitamin B12 than male participants. A complete listing of VM supplements used is provided in Table 2.

Table 2 - Types and Frequency of Vitamin and Mineral Supplements used by Older Kansans

Supplement	Total (n=263) %	Male (n=59) %	Female (n=204) %
Multivitamin/Mineral	72.6	67.8	74.0
Calcium	61.6y	33.9	69.6
Vitamin D	54.4‡	33.9	60.3
Vitamin C	24.0	20.3	25.0
Vitamin E	22.4	22.0	22.5
B-complex	15.6	15.3	9.3
Magnesium	12.9	13.6	12.7
Vitamin B12	12.5†	3.4	15.2
Eye vitamin/mineral*	10.6	18.6	14.7
Iron	9.1	10.2	8.8
Folic acid	8.4	8.5	8.3
Zinc	8.4	8.5	8.3
Vitamin B6	3.8	1.7	4.4
Vitamin A	3.4	1.7	3.9
Chromium	3.0	5.1	2.5
Niacin	2.7	5.1	2.0
Selenium	2.3	1.7	2.5
Thiamin	0.8	0.0	1.0

*Formulation designed to help maintain eye function, usually containing b-carotene, vitamin C, vitamin E, copper, and zinc.
†$p < .01$.
‡$p < .001$.

Dietary micronutrient intakes are reported in Table 3. Vitamin intakes below recommended levels were most common for vitamin D in 100% of participants, vitamin E in 97.0% of participants, and folic acid in 71.5% of participants. All participants met the DRI for niacin, 92.0% met the DRI for riboflavin, and 81.4% met the DRI for vitamin A. Mineral intakes most frequently below DRI levels were calcium in 97.7% of participants and magnesium in 86.3% of participants. The DRI was most commonly met for iron and selenium in 97.7% of participants and 68.4% of participants, respectively. Statistical differences were found by gender for achieving adequate intake levels of vitamin B12, folic acid, thiamin, calcium, chromium, copper, and selenium from food only.

The changes in the number of participants achieving recommended intakes with VM supplements are located in Table 3. VM supplementation significantly impacted the micronutrient intake for a large number of participants. The number of participants achieving adequate intakes was most improved for vitamin B6, vitamin D, vitamin E, folic acid, and calcium following the inclusion of VM supplements. No statistical gender differences were found in the number of participants achieving recommended intakes with the use of VM supplements.

Table 3 - Micronutrient Intakes below the Estimated Average Requirement (EAR) and Adequate Intake (AI) Reference Values for Subjects by Gender[a]

	Food Only			Food + supplement		
	Total	Male	Female	Total	Male	Female
% Below EAR/AI						
Vitamins						
Vitamin A	18.6	16.9	19.1	3.8	1.7	4.4
Vitamin B6	61.2	55.9	62.7	13.3	8.5	14.7
Vitamin B12	23.2*	10.2	27.0	6.1	0.0	7.8
Vitamin C	52.9	59.3	51.0	16.7	18.6	16.2
Vitamin D[b]	100.0	100.0	100.0	51.7	57.6	50.0
Vitamin E	97.0	96.6	97.1	22.1	18.6	23.0
Folic Acid	71.5*	57.6	75.5	17.5	8.5	20.1
Niacin	0.0	0.0	0.0	0.0	0.0	0.0
Riboflavin	8.0	3.4	9.3	1.5	0.0	2.0
Thiamin	35.4*	23.7	38.7	9.1	5.1	10.3
Minerals						
Calcium[b]	97.7*	93.2	99.0	49.8	59.3	47.1
Chromium	29.7**	44.1	25.0	12.5	15.3	11.8
Copper	37.3**	20.3	43.6	17.1	6.8	20.1
Iron	2.3	0.0	2.9	1.5	0.0	2.0
Magnesium	86.3	84.7	86.8	67.3	78.0	64.2
Selenium	31.6***	6.8	38.7	17.5	0.0	22.5
Zinc	53.2	57.6	52.0	15.6	13.6	16.2

[a]Intake was calculated as a ratio of the recommended intakes, actual intakes ÷ recommended intakes. Ratios <1.0 were intakes below recommendation and represented in this table. Ratios >1.0 were above recommendation and considered adequate.
[b]Nutrients with AI values.
***p < .001, **p < .01, *p < .05.

Participants exceeding the UL can be found in Table 4. Supplementation was most likely to exceed the maximum recommended intakes of niacin in 42.2% of participants, vitamin A in 30%, and folic acid in 25.9% of participants. Also included in Table 4 are the mean diet + dietary supplement intake for participants exceeding the UL. Participants exceeding the niacin UL were most likely to be taking multivitamin/mineral supplements + B-complex supplements or multivitamin/mineral supplement only. Thirty-nine participants exceeded the UL through diet intake alone; 13 participants from this group did not take any dietary supplements containing niacin and were excluded from the results in Table 4. Mean intake for individuals exceeding the UL for vitamin A through dietary intake was 15203.2 ± 5149.5 IU. Five participants exceeded the UL for folic acid through diet only; mean intake was 1304.7 ± 213.3 mg DFE. Consumers of B-complex and single nutrient folic acid supplements frequently reported high folic acid intakes. Participants exceeded the UL for magnesium, iron, vitamin E, vitamin B6, vitamin C, or vitamin D from diet + dietary supplement use. The one participant exceeding the UL for vitamin D did so through a physician-prescribed dose.

Table 4 - Percent of Subjects Exceeding the Tolerable Upper Limit (UL) through Use of all Vitamin and Mineral Supplements and Mean Intake of Participants Exceeding the UL

	Exceeding UL (%)	Mean ± standard deviation
Niacin	42.2	133.1 mg ± 141mg
Vitamin A*	30.0	17405.7 IU ± 7401.6 IU
Folic Acid†	25.9	1428.6 mg ± 374.7 mg
Magnesium	14.1	407.8 mg ± 1598.1mg
Iron	2.7	61.9mg ± 17.9mg
Vitamin E	0.8	1627 IU ± 594.5 IU
Vitamin B_6	0.4	551.4 mg
Vitamin C	0.4	3076.1mg
Vitamin D	0.4	2704.21 IU

*Combined intake of provitamin A and b-carotene.
†Recorded in mg DFE.

DISCUSSION

Vitamin/Mineral Supplement Use

Vitamin and mineral supplement use was very common among study participants, especially among females, and the types of VM supplements used were consistent with previous reports (8, 11). As anticipated, multivitamin/ mineral supplements were the most commonly used type of dietary supplement in the current study. Vitamin E, vitamin C, and calcium had previously been reported as the most common single nutrient supplements (2, 10, 11, 19). The high usage of vitamin D in the current study has not been previously reported; the difference may be the result of supplement classification in the current study. Each of the calcium supplement brands reported containing vitamin D; therefore, all participants taking calcium were classified as taking both calcium and vitamin D, resulting in a higher rate of use than reported in previous studies. The current study found no evidence of health care professionals or media influence on vitamin D intake as very few participants took an individual vitamin D supplement. With increasing awareness of the benefits of vitamin D, future studies may find higher supplementation rates and amounts.

Dietary Intakes of Micronutrients

Dietary intakes of vitamin A, vitamin B12, niacin, riboflavin, iron, and selenium were adequate in more than 75% of the current study participants. Similarly, the Continuing Survey of Food Intakes by Individuals, 1994–1996 (CSFII) that focused on older adults also found 75% of all participants had adequate intakes for vitamin B12 and iron, but the CSFII did not report intakes of niacin, riboflavin, or selenium (2). Adequate niacin and riboflavin intakes were reported in greater than 75% of the older adults enrolled in the Salsibury Eye Evaluation (20). NHANES 1999–2000 also reported most participants older than 60 years of age having adequate selenium intakes (20).

Greater than 50% of the current population had inadequate intakes of vitamin E, magnesium, folic acid, vitamin B6, and insufficient intakes of vitamin D and calcium. Low dietary intakes of vitamin E, magnesium, and calcium have been commonly reported in older adult populations (2–4, 20, 21). The low intake of vitamin B6 was surprising, because previous studies like CSFII and NHANES 1999–2000 reported that a majority of older adults had adequate intakes (2, 4). While studies that have focused on regional populations rather than national samples were more likely to report inadequate vitamin B6 intakes, it is unclear why the current study participants had low intakes (20, 22). Vitamin D is found in limited quantities within the food supply, and intake has not previously been reported in large national studies like CSFII or NHANES. However, a previous report of vitamin D intake among congregate meal participants indicated only 40.2% of the vitamin D recommendation was being consumed (7). The evidence of low vitamin D intakes is supportive of the current findings.

Impact of Vitamin/Mineral Supplements on Dietary Intake

The use of VM supplements significantly improved the dietary intake of all micronutrients analyzed in the current study. Most improved was vitamin E, followed by folic acid, vitamin B6, and zinc. Consistent with previous findings, vitamin E adequacy was most impacted by the inclusion of VM supplements (2, 14, 15).

Despite the evidence that most nutrient intakes significantly improved with VM supplement use, some nutrient intakes still remained inadequate in a large percentage of the current study participants. In particular, magnesium, vitamin D, and calcium were most likely to remain inadequate despite supplementation. Previously reported NHANES 1999–2000 data indicated that magnesium intake decreased with increasing age, and dietary supplements were an important source of the mineral (6). Multivitamin/mineral supplements were the most common sources of supplemental magnesium in the current study, but in most cases still did not provide enough to meet standards. The CSFII study found that 30% of participants still had inadequate intakes despite supplementation (2). The inadequate magnesium intakes found in the current study are a concern because low magnesium levels may cause hypocalcemia and interfere with vitamin D metabolism (8). Further, low magnesium intakes have been associated with higher blood pressure levels (8); over half of the current study participants reported high blood pressure.

Even with widespread use of multivitamin/mineral supplements and calcium supplements containing vitamin D, intakes remained insufficient for nearly half of the study population. With age comes an increased need for some nutrients and the Modified MyPyramid for Older Adults specifically addresses the increased need for nutrients like calcium and vitamin D in addition to vitamin B12 (23). A flag at the top of the pyramid suggests that some older adults may need to supplement calcium, vitamin D, and vitamin B12 to meet the increased need (23). In the current study, most supplemental vitamin D was consumed as part of calcium supplements in dosages of 200–400 IU. The current study results support the potential need for dietary supplements to meet the needs of nutrients like calcium and vitamin D as highlighted by the Modified MyPyramid for Older Adults. Low vitamin D intakes are especially concerning in older adult populations since the body's ability to produce vitamin D decreases with advancing age (24). Impaired calcium absorption, osteoporosis, and increased risk of bone fracture have all been associated with low vitamin D intake in older adults (17, 24).

Calcium intakes remained low despite frequent supplementation with doses of 400–600 mg by participants. NHANES III also reported that calcium intakes were insufficient in 60% of males and 66% of females despite the inclusion of dietary supplements (3). The current study reported slightly lower percentages of older adults with insufficient calcium intakes after the inclusion of dietary supplements. The difference can be explained in part by the greater number of participants taking calcium supplements in addition to multivitamin/mineral supplements in the current study than in NHANES III, 63% versus 27% (3). The major concern of insufficient calcium intakes among older adults is decreased bone mineral density and increased risk of bone fractures (8). Use of antacids was rarely reported in the current study, and even fewer reported use as a calcium supplement.

Excessive Intake

While inadequate intakes remain a concern for older adults, the use of VM supplements increases the risk of excessive intake. Participants in the current study were most likely to exceed the UL for niacin, folic acid, and vitamin A. Excessive niacin intakes have been reported in previous studies. The Hawaii-Los Angeles Multi Ethnic Cohort (MEC) found 61% of participants exceeded the UL for niacin (14). Excessive intakes in the current study were the result of B-complex and single nutrient niacin supplements. Five participants in the current study reported taking therapeutic doses of niacin for treatment of high cholesterol. The UL was set for niacin, not to prevent toxicity but rather to prevent an adverse reaction known as flushing syndrome (25).

Supplementation exceeded the vitamin A upper limit for 30% of participants; all exceeded the UL through a combination of provitamin A and beta-carotene. Single nutrient vitamin A supplements, recorded primarily as the preformed vitamin, may account for some participants' excessive intake. The most common multivitamin/mineral supplements contained 3500 IU of vitamin A. Participants exceeding the UL through the use of preformed vitamin A are at the greatest risk for toxicity (26). The Nurses' Health Study found an increased risk of hip fracture in older adult females consuming high levels of vitamin A (27). Participants in the Nurses' Health

Study with the greatest risk of hip fracture consumed greater than 15,000 IU of total vitamin A (27). The mean intake for participants exceeding the UL in the current study was 17405 IU and significantly higher than the amount associated with increased risk in the Nurses' Health Study. The high intake may be placing some participants at a greater risk for hip fracture.

Excessive folic acid intakes in older adults have been a concern since fortification of grain products began in 1998 (28). Folic acid supplementation has the potential to mask a B12 deficiency in older adults, increasing the risk of pernicious anemia and cognitive impairment (28). More than 84% of participants taking a folic acid supplement exceeded the UL in the current study. The use of B-complex supplements also significantly increased the number of current participants exceeding the folic acid UL.

Only three participants in the current study exceeded the vitamin E UL (1100 IU), but research studies published in the past decade have begun to raise questions regarding the safety of vitamin E at much lower dosages. A metaanalysis of vitamin E supplementation has found that as vitamin E supplementation dose increases above 150 IU/day, the all-cause mortality rate also increases (29). The most common vitamin E supplement dose in the current study was 400 IU. In addition to possible increased risk of mortality, doses of vitamin E above 400 IU have also been associated with increased risk of hemorrhagic stroke in the Physicians' Health Study II (PHSII) (30). Furthermore, PSHII found no evidence that vitamin E supplementation affected cardiovascular events (30), a commonly cited reason for vitamin E supplementation.

Strengths of the Study

The results of the current study were strengthened by the enrollment of participants from across the state. A demographic characterization of the Elderly Nutrition Program (ENP) found participants to be on average 76 years of age, primarily female, white, widowed, and an education level below high school graduate (7). The population described in the ENP characterization is very similar to the population of the current study, although education level is an exception. The similarities indicate that the current study accurately characterizes the typical senior center participant and therefore increases the applicability of the results to other senior center populations throughout the United States. Also, the inclusion of VM supplements not included with the diet analysis software and careful attention to accurate reporting of the nutritional content of each of these supplements improved accuracy and provided strength to the results.

Limitations of the Study

Limitations of the current study include the use of volunteer participants and self-reported data. The current sample of volunteer participants from senior centers may differ from their non-participating counterparts, particularly with regard to dietary supplement use, cognitive function, and general health status. All data were self-reported and relied on the memory of the older adult, lending to the possibility that food items and/or dietary supplements were underreported, over-reported, or omitted entirely. Also, the population of the study was not ethnically diverse and limited the ability to determine differences in dietary supplement use.

Future work should continue to investigate the dietary intake of older adults and focus specifically on food selection to identify why dietary intakes of some micronutrients are so low. Investigation should also focus on improvement of micronutrient intakes in community-based older adults through better food selection.

CONCLUSION

The current study shows micronutrient intake of older adults is significantly impacted by the use of VM supplements. The number of participants with sufficient levels of consumption greatly improved with the addition of VM supplements, especially multivitamin/minerals. Despite the improvement, nearly half of the participants still had insufficient intakes of calcium, magnesium, and vitamin D. Intakes above the UL were reported but were not likely to cause severe adverse effects. The current results support older adults taking a daily, low-dose multivitamin/mineral supplements. This is contrary to the current position of the American Dietetic Association (ADA) to obtain nutrients through food only rather than supplement the diet. Given the large number of participants with insufficient dietary intakes, significant dietary changes must happen in order for current older adults to meet their requirements as suggested in the ADA position paper. Therefore, without major dietary changes, the findings from this study show adults benefit from a low dose multivitamin/mineral supplement.

TAKE AWAY POINTS

- Vitamin and mineral supplements, especially a general multivitamin/multimineral, calcium with vitamin D, vitamin E, and vitamin C, were frequently used by participants. .
- Older adults participating in the study were most likely to have inadequate dietary intakes of vitamins D and E, folic acid, calcium, and magnesium. .

- Vitamin and mineral supplements significantly improved the micronutrient intake for most participants, although in some cases supplements did cause the Tolerable Upper Intake Level to be exceeded.
- Even though the current study has minimal diversity among the participants, results may still be applicable to other senior center populations as the general demographic distribution is similar to nationally sampled senior center participants.

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