

# Position of the Academy of Nutrition and Dietetics: Micronutrient Supplementation



## ABSTRACT

It is the position of the Academy of Nutrition and Dietetics that micronutrient supplements are warranted when requirements are not being met through the diet alone. Those with increased requirements secondary to growth, chronic disease, medication use, malabsorption, pregnancy and lactation, and aging may be at particular risk for inadequate dietary intakes. However, the routine and indiscriminate use of micronutrient supplements for the prevention of chronic disease is not recommended, given the lack of available scientific evidence. A few specific age and disease states that may benefit from micronutrient supplementation are discussed. The most common dietary supplements used by both children and adults in the United States contain micronutrients. Consumers may not be well informed about the safety and use of these products, and some may have difficulty interpreting product labels. Thus, the expertise of registered dietitian nutritionists and nutrition and dietetic technicians, registered, is needed to guide the safe and appropriate selection and use of micronutrient supplements. To accomplish this, registered dietitian nutritionists and nutrition and dietetic technicians, registered, must keep up to date on efficacy, safety, and the regulatory issues influencing the use of these products. This position paper aims to increase awareness of current issues relevant to micronutrient supplementation and of the resources available to assist registered dietitian nutritionists and nutrition and dietetic technicians, registered, in evaluating their potential benefits and adverse outcomes.

J Acad Nutr Diet. 2018;118(11):2162-2173.

## POSITION STATEMENT

It is the position of the Academy of Nutrition and Dietetics that micronutrient supplements are warranted when requirements are not being met through the diet alone. Those with increased requirements secondary to growth, chronic disease, medication use, malabsorption, pregnancy and lactation, and aging may be at particular risk for inadequate dietary intakes. However, the routine and indiscriminate use of micronutrient supplements for the prevention of chronic disease is not recommended, given the lack of available scientific evidence.

**T**HE FOCUS OF THIS ACADEMY of Nutrition and Dietetics position paper is on the safe and appropriate use of vitamin and mineral containing dietary supplements to help individuals meet their micronutrient requirements when dietary intake is insufficient. Micronutrients are essential vitamins and minerals required in small amounts from the diet to sustain virtually all normal cellular and molecular functions.<sup>1</sup> For the purposes of this position paper, the term *micronutrient supplements* is used to indicate a category of dietary supplements that contain single or multiple vitamins and minerals. The most common dietary supplement used in the United States is the multivitamin mineral (MVM); however, there is no legal or regulatory definition of MVM. MVMs have been defined

previously by the manufacturer or by researchers, but heterogeneity of the MVM definition exists. However, to be consistent with the literature, *MVM* may be used in this position paper to reflect the term used by investigators and other sources. This position paper does not address other dietary supplements such as amino acids, fatty acids, enzymes, herbs, or other botanicals.

MVMs continue to be the most commonly used dietary supplement in the United States. According to one authoritative estimate, total supplement sales in 2016 were \$41.2 billion, with the majority being composed of micronutrient supplements.<sup>2</sup> Despite the widespread use, consumers may not be well informed about the safety and use of micronutrient supplements and some may have difficulty interpreting product labels. Thus, the expertise of registered dietitian nutritionists (RDNs) and nutrition and dietetic technicians, registered (NDTRs), is needed to guide the safe and appropriate selection and use of

micronutrient supplements. To accomplish this, RDNs and NDTRs must keep up-to-date on efficacy, safety, and the regulatory issues influencing the use of these products. This position paper aims to increase awareness of current issues relevant to micronutrient supplementation, and of the resources available to assist RDNs and NDTRs in evaluating the potential benefits and adverse outcomes of their use as part of the Nutrition Care Process.

## DEFINITION AND REGULATORY FRAMEWORK

Dietary supplements, and therefore micronutrient supplements, are regulated by the Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition as a subcategory of food. The Dietary Supplement Health and Education Act of 1994 (DSHEA), which amended the Federal Food, Drug, and Cosmetic Act of 1938, defines and sets safety and labeling requirements for dietary supplements.<sup>3</sup>

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<https://doi.org/10.1016/j.jand.2018.07.022>

DSHEA defines a dietary supplement as a product intended to supplement the diet that contains any of the following: “a vitamin; a mineral; an herb or other botanical; an amino acid; a dietary substance for use by man to supplement the diet by increasing the total dietary intake; or a concentrate, metabolite, a constituent, extract, or combination of any ingredient mentioned above.”<sup>3</sup> However, there is not a legal or regulatory definition of the term *micronutrient supplement* or *MVM*. Dietary supplements are available as pills, capsules, tablets, liquids, powders, or other forms taken orally, as long as they are not represented for use as a conventional food or as a sole item of a meal or diet.<sup>3</sup> They must also be identified as a dietary supplement on the label.<sup>3</sup>

### Label Claims

Like food labels, dietary supplement labels can bear authorized and qualified health claims, nutrient content claims, and structure/function claims.<sup>4</sup> Health claims characterize the relationship between a supplement ingredient and reducing the risk of a disease or health-related condition.<sup>4</sup> Nutrient content claims characterize the amount of a nutrient in a dietary supplement.<sup>5</sup> For example, “high potency multivitamin, multimineral dietary supplement tablets” can be used on a product label in the case that it contains 100% or more of the Reference Daily Intakes for at least two-thirds of the vitamins and minerals with Reference Daily Intakes in the product.<sup>5</sup> Both health claims and nutrient content claims must be preapproved by the FDA.<sup>4</sup> Structure/function claims are the most commonly used claims on supplement labels. There are three types of structure/function claims,<sup>5</sup> those that describe:

- the nutrient’s role on normal structure or function of the body or means by which it works to maintain a structure or function (eg, antioxidants maintain cell integrity);
- general well-being from intake of a nutrient; or
- a benefit related to a nutrient deficiency.

Labels cannot make statements that are disease claims. Structure/function

claims are not pre-approved by the FDA.<sup>4</sup> However, the manufacturer must provide the FDA with the text of structure/function claims no later than 30 days after marketing the supplement and ensure that the claims are truthful and not misleading.<sup>4</sup> Labels with structure/function claims must carry this disclaimer: “These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.”<sup>6</sup> Although the FDA is responsible for product label claims, the Federal Trade Commission regulates dietary supplements advertising claims.<sup>7</sup> All claims must be truthful, not misleading, and substantiated by credible scientific evidence.<sup>7</sup> Health professionals can contact the Federal Trade Commission to report products they believed are falsely advertised or labeled.

### Safety

Manufacturers and/or distributors are responsible for ensuring product safety before placing them on the market.<sup>6</sup> Because micronutrients were referenced and sold as dietary supplements before DSHEA was implemented, they are presumed to be safe based on their history of use; thus, they do not require an FDA premarket review of safety or efficacy. For any new dietary ingredient sold after DSHEA’s implementation and not recognized as a food substance present in the food supply, the manufacturer and distributor must notify the FDA of the intention to market the product and provide the FDA with the information used to conclude that the ingredient was generally regarded as safe to consume.<sup>6</sup> Once marketed, the FDA has the authority to remove a product in the case that they prove it to be unsafe.<sup>6</sup> The FDA monitors safety largely by collecting adverse event reports from consumers, health professionals, and manufacturers through MedWatch, the FDA Safety Information and Adverse Event Reporting Program.<sup>8</sup> The Dietary Supplement and Nonprescription Drug Consumer Protection Act<sup>9</sup> requires the responsible party (ie, the manufacturers, packers, or distributors whose name appears on the label) to submit serious adverse event reports (AERs) to the FDA within 15 business days of receiving a report, and to maintain records of all adverse

event reports they receive for 6 years.<sup>10</sup> As defined by the FDA, adverse events are considered serious if “they result in death, a life-threatening experience, inpatient hospitalization, a persistent or significant disability or incapacity, or a congenital anomaly or birth defect, or requires, based on reasonable medical judgment, a medical or surgical intervention to prevent an outcome” listed above.<sup>11</sup>

The FDA received 6,307 mandatory serious AERs for dietary supplements from 2008 through 2011.<sup>12</sup> Six of the 10 dietary supplements receiving the most mandatory AERs were MVM supplements. However, an AER alone does not indicate a causal relationship between adverse events and the associated product, because other products consumed at the same time and pre-existing health conditions could each contribute to the reported adverse event.<sup>12</sup>

### Quality

Under DSHEA, the FDA established good manufacturing practices for dietary supplements to ensure proper identity, purity, strength, and composition.<sup>13</sup> Companies are responsible for ensuring their products meet good manufacturing practices, including accurate labeling (eg, products contain the ingredients in the amounts stated on their labels) and are free from contaminants (eg, bacteria, pesticide, glass, lead, and other heavy metals).<sup>13</sup> In addition to the FDA, independent organizations such as [ConsumerLab.com](http://ConsumerLab.com),<sup>14</sup> NSF International,<sup>15</sup> and US Pharmacopeial Convention<sup>16</sup> offer programs that evaluate supplement quality. At a minimum, each organization has a program that allows manufacturers to pay a fee to have its products tested. Supplements conforming to the respective organization’s quality specifications can bear that organization’s seal of approval on their label.<sup>17</sup> The absence of a seal, does not indicate inferior quality because the high costs of analyzing each ingredient may prevent some manufacturers from having its products tested.

## USAGE IN THE UNITED STATES

### Prevalence of Use

The prevalence estimates presented in this position paper focus on large, national survey data to make population

level generalizations, and characterize use of both dietary supplements in general and specific micronutrient supplements, including MVM. Such generalizations do not characterize special groups like elite athletes<sup>18</sup> and individuals in the military,<sup>19</sup> who are more likely to use dietary supplements than the general population, and are more likely to stack products (ie, use multiple products simultaneously).

**Dietary Supplements.** The National Health and Nutrition Examination Survey (NHANES) is a continuous, federally supported monitoring protocol coordinated by the National Center for Health Statistics at the Centers for Disease Control and Prevention. NHANES has continuously monitored dietary supplement use for more than 50 years. Based on the NHANES findings across time, just more than half of adults (aged  $\geq 20$  years among nonpregnant, nonlactating adults) report using a dietary supplement in general.<sup>20-22</sup>

In adult populations, dietary supplement use is more common in women than men, and by non-Hispanic whites when compared with by non-Hispanic blacks and Hispanic and Mexican Americans.<sup>22,23</sup> Dietary supplements are used more often by nonsmokers, people who exercise regularly, those with higher education and incomes, and those who report better overall health.<sup>20,21</sup> Use of dietary supplements in adults does not vary significantly by weight status.<sup>21</sup> In adults, supplement use is noted to be more of a personal preference rather than a health care professional's recommendation.<sup>22</sup> Most adults (53%) use one dietary supplement product,<sup>21</sup> but 8% to 10% of adults use more than four supplements regularly.<sup>23</sup>

Consistently, about one-third of US children take a dietary supplement; but, these are almost exclusively (95%) confined to micronutrient supplements. Among children aged  $< 2$  years (NHANES 2007-2010), 17% reported use of any dietary supplement, 45% in children ages 2 to 5 years, 35% in children ages 6 to 11 years, and  $\sim 23\%$  for those aged 12 to 19 years.<sup>24</sup> Similar to trends observed in adults, dietary supplement use in children is more prevalent in non-Hispanic whites, families with private health insurance, higher incomes, and those less likely to have

screen times (eg, television or computer), and are more physically active.<sup>24,25</sup> Only 16% of the dietary supplements used by children are based on the advice of a health care professional.<sup>24</sup> Health care providers were most likely to recommend dietary supplements to children aged  $< 2$  years compared with children of any other age group.<sup>24</sup>

**Micronutrient Supplements.** Of those using dietary supplements, MVM products are by far the most commonly used dietary supplement in children<sup>24</sup> and adults.<sup>21,23</sup> However, the definition of MVM is not consistent across research studies.<sup>20,21,23</sup> MVM and micronutrient products are used by  $\sim 90\%$  of child dietary supplement users, representing 24% of US children aged  $\leq 19$  years.<sup>24</sup> Depending on the definition, about one-third of US adults use a MVM product.<sup>21-23</sup> Among older adults (aged  $\geq 60$  years), MVM is the most frequently used supplement (40%), followed by supplements containing vitamin D (26%), calcium (9%) or a vitamin D and calcium combination (13%), vitamin B-12 (8%) and B complex (5%), and vitamin C (11%).<sup>26</sup> About 75% of all pregnant women report using a MVM in NHANES 1999-2006.<sup>27</sup> Folic acid or iron containing supplements are most frequently consumed during pregnancy, but very little is known about supplement use in lactation.<sup>27</sup>

### Motivations for Use

**Dietary Supplements.** Among children, 41% use supplements to “improve overall health,” 37% to “maintain health,” 23% for “supplementing the diet,” 20% to “prevent health problems,” and 14% to “boost immunity.”<sup>24</sup> In children aged  $< 2$  years, the most common reason for using supplements is for tooth health and cavity prevention (14%), whereas children aged 16 to 19 years, “to get more energy” (10%) is the most common reason cited for supplement use.<sup>24</sup> For both men and women, “improve overall health,” “maintain health,” “supplement the diet,” and “prevent health problems” are the most common motivations for general dietary supplement use.<sup>22</sup> Among men and women, “heart health, lower cholesterol” (18%) and “bone health” (36%), respectively, were

the most common organ-specific reasons for supplement use.<sup>22</sup> Similarly, among older adults, the most common motivations for supplement use include to “improve overall health,” “maintain health,” and “bone health.”<sup>22,26</sup>

**Micronutrient Supplements.** The most common motivation for MVM use in children was to “improve overall health” (44%). This same motivation was reported for the use of multivitamin supplements (ie, a combination vitamin product without minerals) (35%).<sup>24</sup> Vitamin C supplements, although low in overall use (2% overall), were reported by about half of those users (47%) to “boost immune system and prevent colds.” MVMs were primarily used by adults to “improve overall health” (48%). The majority of adults who use calcium supplements (4% of men and 19% of women) do so “for bone health” (75%). Similar to children, whereas the proportion of adults using vitamin C was low overall (7%), many did so to “boost immune system and prevent colds” (45%).

## NUTRIENT AND FOOD RECOMMENDATIONS

Optimal nutrient intakes are those that promote health and reduce risk for chronic disease, while minimizing risk of excess. The Food and Nutrition Board (FNB) of the National Academies of Sciences, Engineering, and Medicine, Health, and Medicine Division provides the best available evidence-based standards for estimating optimal nutrient intakes. Dietary Reference Intakes (DRIs) is an umbrella term used to represent four factors relevant to nutrients: the Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs), Estimated Average Requirements (EARs), and Tolerable Upper Intake Levels (ULs).<sup>28</sup> The DRIs are used to assess adequate and excess nutrient intakes and plan diets for groups and individuals.

The DRIs are recommendations for healthy individuals. As such, higher requirements likely exist for individuals who are malnourished or have altered requirements due to a health condition or use of a medication. Clinical status and biochemical indexes should be combined with dietary intake data to assess an

individual's dietary adequacy and nutritional status<sup>28</sup> and need for micronutrient supplementation.<sup>29</sup> A comprehensive nutrition assessment can inform RDNs and NDTRs when a micronutrient supplement is likely to be of benefit or if its consumption places a client at risk of excess.

The EAR is the basis of micronutrient recommendations at the group level (eg, meeting the needs of 50%), whereas the RDA is for use at the individual level (eg, meeting the needs of 97.5%). The RDA is determined as two standard deviations above the EAR. An AI is set when there is not enough information available to estimate an RDA. AIs represent intakes likely to exceed the actual requirements of almost all healthy people. For the same reason, usual intakes that fall below the AI recommendations should not be interpreted as inadequate. Rather, when an individual's usual intake meets or exceeds recommended levels, it is likely that their intake is adequate.

The UL is used both at the individual and at the group level to estimate risk of excessive micronutrient intakes. The UL is an important tool that RDNs and NDTRs can use to educate consumers in the safe use of nutrient supplements. As average daily intakes exceed the UL, the risk of adverse health effects increases. The ULs for vitamin E, niacin, and folic acid apply only to synthetic forms of the nutrients found in supplements and fortified foods.<sup>30</sup> The UL for magnesium applies only to intakes from supplements or pharmacologic agents.<sup>30</sup> The UL for vitamin A is from preformed vitamin A (ie, retinol only).<sup>30</sup> For all other nutrients, ULs apply to total intake from food, beverages, and supplements. For nutrients for which data were insufficient to determine a UL (ie, biotin, carotenoids, pantothenic acid, riboflavin, thiamin, vitamin B-12, and vitamin K) the FNB cautions about consuming large amounts.<sup>30</sup>

The 2015 Dietary Guidelines for Americans (DGA) recommends that nutrition needs should be met primarily from foods. However, the DGA also highlights several nutrients that are a shortfall nutrient or a nutrient for public health concern (eg, vitamins A, C, D, E; folate; calcium; magnesium; and potassium) in Americans aged 2 years and older.<sup>31</sup> This indicates that a high prevalence of inadequate intakes

relative to DRI exists across the population and that underconsumption has been linked to adverse health outcomes in the scientific literature. Iron is of concern for adolescent and premenopausal women, including pregnant women. Many Americans do not consume the amount and types of foods necessary to meet these recommended nutrient intakes. Adherence to the DGAs is low; only about 3% to 4% of Americans follow all of the DGAs.<sup>32</sup> As a result of low intakes of nutrient-rich foods and sedentary lifestyles, many Americans may be meeting or exceeding their energy requirements while falling short of meeting nutrient recommendations. Fortified foods and micronutrient supplements may be useful in bridging the gap of shortfall nutrients as examined in detail below.<sup>33</sup>

## NUTRIENT SUPPLEMENTATION

### Effect on Total Nutrient Intakes

Micronutrient supplements can have a substantial influence on a person's total intakes.<sup>34,35</sup> The extent to which a supplement can improve micronutrient adequacy is influenced by the nutritional profile of the supplement taken. For example, although MVMs provide substantial amounts of some micronutrients (ie, folic acid and vitamin C), they often lack key minerals such as potassium, calcium, and magnesium.

### Filling Dietary Gaps

National survey data have provided insights on total usual micronutrient exposures from all sources (ie, intrinsic nutrients, fortified nutrients, and micronutrient supplements). NHANES data reveal a high proportion of Americans that have at risk intakes (>25% with intakes <EAR) for vitamins A, C, D, and E; calcium; and magnesium without the use of micronutrient supplements.<sup>33,36,37</sup> Overall, smaller proportions of the population had total usual intakes below the EAR for B vitamins, zinc, folate, iron, phosphorus, copper, and selenium (<1%).<sup>35-37</sup>

When adult users and nonusers of micronutrient supplements are examined separately, users tend to have a lower prevalence of inadequate intakes (ie, <EAR) from diet alone.<sup>36,37</sup> Considering total intake (diet and micronutrient supplements), users

were much less likely than nonusers of micronutrient supplements to have inadequate intakes of most minerals: magnesium (21% vs 66%), calcium (20% vs 51%), (copper <0.5% vs 20%), zinc (<0.5% vs 13%), and iron (<0.5% vs 8%) and vitamins: folate (1% vs 14%), vitamin C (3% vs 48%), vitamin A (4% vs 58%), vitamin D (25% vs 96%), and vitamin E (5% vs 96%).<sup>37</sup>

Unlike adults, micronutrient adequacy from foods sources did not vary among children who consumed vs who did not consume dietary supplements (ie, classified by any dietary supplement use).<sup>38</sup> Children aged 2 to 8 years who use dietary supplements are more likely than older children to meet the micronutrient recommendations from foods alone.<sup>38</sup> Dietary supplement use is lowest among adolescents, which is paradoxical because nutrient intakes from food sources among this age group tend to be inadequate for many micronutrients.<sup>38</sup>

### Exceeding the ULs

Micronutrient supplements have the potential to fill gaps in the diet but could potentially increase intakes above ULs. Intake from all supplements and foods and beverages must be included when assessing usual nutrient intake of individuals and groups. The prevalence of the population that exceeds the UL is low for most micronutrients (≤5% for folate; calcium; iron; vitamins A, D, C, and E; and zinc) when users and non-users of supplements are combined as a group.<sup>33,35</sup>

US adults typically do not have usual intakes of micronutrients that exceed the UL from foods alone. However, micronutrient supplement users do have an increased likelihood of intakes above the UL for iron (9%), zinc (9%), folic acid (7%), calcium (6%), magnesium (6%), vitamin B-6 (3.5%), vitamin A (3%), and vitamin C (1.6%).<sup>36,37</sup> Among children, use of dietary supplements in general (as previously mentioned is almost exclusively micronutrient supplements) increases the prevalence of usual nutrient intakes above the UL for iron, zinc, copper, selenium, folate, and vitamins A and C.<sup>38</sup> Of most concern are 2- to 8-year-old micronutrient supplement users who exceed the UL for zinc (84%), folic acid (71%), and vitamin A (72%).<sup>38</sup> It should be noted that some children

exceed the UL for folic acid and zinc from food sources alone.<sup>38</sup>

### Effect of Nutrient Supplementation on Chronic Disease Prevention

Although supplementation can be effective in meeting recommended intake of some micronutrients, it has not been proven effective in preventing chronic disease. In 2006, a National Institutes of Health State-of-the-Science Panel, after reviewing evidence on the health benefits and risks of MVM supplements, concluded that there was insufficient evidence to determine whether taking MVM supplements was beneficial for preventing chronic disease in generally healthy people.<sup>39</sup>

The Agency for Healthcare Research and Quality conducted a systematic review on the use of multivitamins or single and functionally related pairs of nutrients (including MVM) for cardiovascular disease and cancer prevention to inform US Preventive Services Task Force (USPSTF) recommendations. Based on this review, the USPSTF concluded in 2014 that the current evidence is insufficient to assess the balance of benefits and harms of the use of multivitamins or single- or paired-micronutrient supplements (including MVM) and recommended against the use of beta carotene or vitamin E supplements for the prevention of cardiovascular disease or cancer.<sup>40</sup>

In 2011, the FNB updated the DRIs for calcium and vitamin D.<sup>41</sup> The FNB reported that although data indicated a key role for calcium and vitamin D in skeletal health and provided a sound basis for determining DRIs, it did not provide convincing evidence of other health outcomes beyond bone or that intakes greater than the DRIs have health benefits. In fact, emerging evidence indicated that too much of these nutrients may result in harmful outcomes.<sup>41</sup>

The American Geriatrics Society advises clinicians to recommend vitamin D supplementation of at least 1,000 IU/day and calcium supplementation to community-dwelling adults aged 65 years or older to reduce risk of fractures and falls.<sup>42</sup> The workgroup recommendation was based on studies in which the most commonly

prescribed amount of calcium was 1,000 to 1,200 mg. In 2012, the USPSTF recommended vitamin D supplementation (based on median dose of 800 IU) to help prevent falls in community-dwelling adults 65 years of age or older who are at increased fall risk.<sup>43</sup> However, in 2018 the USPSTF recommended against daily supplementation of 400 IU or less of vitamin D and 1,000 mg or less of calcium for the primary prevention of fractures in postmenopausal women. They also concluded that evidence was insufficient to assess benefits or harm of higher amounts in postmenopausal women and at any dose for fracture prevention among community-dwelling men and premenopausal women.<sup>44</sup>

## MICRONUTRIENT SUPPLEMENTS IN PRACTICE

### When to Consider Supplementation

Micronutrient supplements can be used to help individuals meet a nutrient requirement or to treat a diagnosed deficiency. A person's micronutrient intake may be inadequate when they are restricting energy intake for weight loss/control, not consuming an adequate amount of food to meet energy requirements resulting from poor appetite or illness, eliminating one or more food groups from their diet on a regular basis, or consuming a diet low in micronutrient-rich foods despite adequate or excessive energy intakes. Groups most vulnerable to micronutrient inadequacy are older adults, pregnant women, alcohol-dependent individuals, strict vegetarians and vegans, and those with increased requirements secondary to health conditions or the chronic use of a medication that alter nutrient absorption, metabolism, or excretion.<sup>45</sup>

Academy of Nutrition and Dietetics position papers that focus on particular segments of the population or conditions often include recommendations on micronutrient supplementation. In addition, some government and professional organizations and expert workgroups provide recommendations for micronutrient supplementation. The following are specific examples of micronutrient supplement recommendations.

**Infants and Young Children.** The American Academy of Pediatrics recommends 1 mg/kg daily iron supplementation for exclusively breastfed full-term infants from age 4 months until infants begin eating iron-containing complementary foods, such as iron-fortified cereals.<sup>46</sup> They also recommend 1 mg/kg/day supplemental iron beginning at age 4 months for infants who receive more than one-half of their daily feedings as human milk and who are not receiving iron-containing complementary foods.<sup>46</sup>

**Infants and Children, Including Adolescents.** The American Academy of Pediatrics recommends all infants who are exclusively or partly breastfed receive 400 IU of supplemental vitamin D daily beginning the first few days of life, and continued unless infant is weaned to at least 1 qt/day vitamin D-fortified formula or, if older than age 12 months, whole milk or low-fat milk when appropriate; all nonbreastfed infants and older children who consume <1 qt/day vitamin D-fortified formula or milk and adolescents with dietary intakes <400 IU/day.<sup>47</sup> If a baby is drinking at least 32 oz formula, vitamin D supplementation is not needed. Children at an increased risk for vitamin D deficiency, such as those with fat malabsorption and those taking seizure medications, may need higher amounts to achieve normal serum vitamin D levels.<sup>47</sup>

**Women of Childbearing Age Who May Become Pregnant.** The FNB recommends that women who can become pregnant consume 400  $\mu\text{g/day}$  folic acid from fortified foods and/or supplements daily, in addition to folate obtained from eating a varied diet to reduce the risk of neural tube defects (eg, spina bifida and anencephaly).<sup>48</sup> The USPSTF recommends women planning or capable of pregnancy take a daily supplement of 400 to 800  $\mu\text{g}$  folic acid (grade A).<sup>49</sup> Folic acid is the form of the vitamin found in supplements and fortified foods, and folate is the form found naturally occurring in foods.

**Older Adults.** The FNB recommend that people older than age 50 years get 2.4  $\mu\text{g/day}$  vitamin B-12 mainly from the crystalline form found in fortified

foods and supplements.<sup>48</sup> Age is associated with conditions like atrophic gastritis that may reduce a person's ability to digest food-bound vitamin B-12.<sup>48</sup>

**People with Intermediate or Advanced Age-Related Macular Degeneration.** The American Academy of Ophthalmology recommends ophthalmologists consider antioxidant vitamin and mineral supplementation as per the Age-Related Eye Disease Study (AREDS) and AREDS2 trials for patients with intermediate or advanced age-related macular degeneration to slow progression of the disease.<sup>50</sup> AREDS formulation contains vitamin C, vitamin E, beta carotene, zinc, and copper, and the AREDS2 formulation substitutes lutein/zeaxanthin for beta carotene,<sup>51</sup> because beta carotene was associated with increased risk of lung cancer in smokers.<sup>51-53</sup>

**Genetic Polymorphisms and Disorders.** Individuals that have a genetic predisposition that impairs digestion, absorption, or metabolism may benefit from micronutrient supplements under the care and direction of a health care practitioner. However, it is the position of the Academy of Nutrition and Dietetics that nutritional genomics is still emerging and its practice, including the use of commercial or consumer-based nutrigenetic testing, to provide dietary advice is premature.<sup>54</sup>

### Special Considerations for Micronutrient Supplements

Certain forms of micronutrients have differential bioavailability based on their molecular structure and chemical formula. For example, folic acid from supplements and fortified foods is more bioavailable than folate from foods due to the ease of absorption of the unconjugated form.<sup>48</sup> For vitamin E, consumption of about 50% more units of synthetic alpha tocopherol from dietary supplements and fortified foods are needed to obtain the same amount of the vitamin as from the natural form (*dl*-alpha tocopherol).<sup>55</sup> Furthermore, the effectiveness of mineral supplements is influenced by their form and the amount of the elemental mineral present in the mineral salt.

Calcium carbonate has the highest concentration of calcium among calcium salts, but requires an acidic medium for optimal absorption. Thus, it is recommended that it be consumed with meals.<sup>56</sup> Calcium citrate can be taken with or without foods and can be used by those with achlorhydria.<sup>57</sup> Maximum absorption is obtained with doses  $\leq 500$  mg, so splitting a 1,000-mg dose in two is advisable.<sup>41</sup>

### Contraindications of Nutrient Supplement Use

RDNs and NDTRs must be aware of possible situations in which individual clients must temporarily or permanently limit or avoid specific micronutrient supplements due to the potential for adverse effects. For example, people who smoke should avoid supplementation with beta carotene due to an increased risk of lung cancer.<sup>52,53</sup> Health risks from excessive nutrient intake and potential nutrient/nutrient and nutrient/medication interactions are provided for individual vitamins and minerals in the Office of Dietary Supplements (ODS) Fact Sheets for Health Professionals. Some examples are listed below.

**Nutrient Excess.** Healthy postmenopausal women and adult men and individuals homozygous for hemochromatosis generally should avoid iron supplements.<sup>58</sup> In postmenopausal women, intakes  $>1,500$   $\mu\text{g/day}$  retinol (below the UL), but not beta carotene, have been associated with reduced bone mineral density and increased risk of hip fracture.<sup>59,60</sup> Thus, women who take supplements containing vitamin A should consider a product that contains a majority of the vitamin A from the beta carotene form rather than retinol. Excessively high supplemental intakes of vitamin B-6 have been reported to result in sensory neuropathy.<sup>48</sup>

**Micronutrient Interactions.** RDNs and NDTRs must be aware of and document the potential nutrient–nutrient and drug–nutrient interactions that can occur with the chronic use of micronutrient supplements.<sup>61</sup> An imbalance of micronutrients, such that the amount of one nutrient interferes or alters absorption

and/or utilization of another nutrient, can result from the consumption of high-dose or simultaneous consumption of nutrient supplements. For example, high-dose iron supplements can decrease zinc absorption and high amounts of zinc can inhibit copper absorption.<sup>62</sup> The absorption of both heme- and nonheme iron is inhibited by calcium supplements, but the clinical significance of iron status is unclear.<sup>63</sup>

**Medication Interactions.** Medications can interfere with absorption or metabolism of certain nutrients, altering the nutrients requirements and compromising nutritional status. Medication interactions for most micronutrients can be found in the monographs on the ODS website. For example, proton pump inhibitors used to treat gastroesophageal reflux disease slow the release of gastric acid into the stomach have the potential to interfere with vitamin B-12 absorption from food, potentially affecting serum vitamin B-12 levels.<sup>64</sup> Corticosteroids (eg, prednisone) may deplete calcium<sup>64</sup> and impair vitamin D metabolism.<sup>65</sup> Certain diuretics, antibiotics, and proton pump inhibitors can affect magnesium status.<sup>66</sup> Polypharmacy, particularly among older adults, can increase the likelihood of drug–nutrient interactions and influence the need for certain micronutrients. Individuals taking medications on a regular basis should discuss their micronutrient supplements with their health care providers.

Micronutrient supplements can influence the dosage and bioactivity of medications. For example, high doses of vitamin E supplements (likely in doses  $>400$  IU) can inhibit platelet aggregation and therefore interfere with anticoagulant blood thinning medications such as coumadin.<sup>55</sup> Vitamin K supplementation can also interact with the blood-thinning medications; thus, supplementation should be avoided or used with caution and under the care of a health care provider because a consistent intake of the vitamin is critical. Additional resources that provide information on precautions, contraindications, and potential interactions with drugs, food, or other supplements are provided in the [Figure](#).

Organization	Website	Contents
Academy of Nutrition and Dietetics	<a href="http://www.eatrightpro.org">www.eatrightpro.org</a>	<ul style="list-style-type: none"> <li>• Position papers</li> <li>• Evidence Analysis Library</li> <li>• Other documents: Guidelines Regarding the Recommendation and Sale of Dietary Supplements, Code of Ethics for the Profession of Dietetics</li> </ul>
AHRQ <sup>a</sup> Department of Health and Human Services	<a href="https://archive.ahrq.gov/clinic/tp/multivittp.htm">https://archive.ahrq.gov/clinic/tp/multivittp.htm</a>	<ul style="list-style-type: none"> <li>• AHRQ-produced evidence-based reviews on nutrient supplements</li> </ul>
Cochrane Collaboration	<a href="http://www.cochrane.org/reviews/">www.cochrane.org/reviews/</a>	<ul style="list-style-type: none"> <li>• Free access to abstracts and links to full reviews of evidence-based health care topics, including vitamins and minerals used for disease prevention and treatment</li> </ul>
Epocrates	<a href="http://www.epocrates.com/index.html">www.epocrates.com/index.html</a>	<ul style="list-style-type: none"> <li>• Private company with proprietary information on medications and dietary supplements, available free and for purchase for mobile devices and online</li> </ul>
Federal Trade Commission	<a href="http://www.ftc.gov">www.ftc.gov</a>	<ul style="list-style-type: none"> <li>• Site to file a complaint when advertising for a dietary supplement is misleading or false</li> </ul>
Food and Drug Administration	<a href="http://www.fda.gov/Food/DietarySupplements/default.htm">www.fda.gov/Food/DietarySupplements/default.htm</a>	<ul style="list-style-type: none"> <li>• Dietary supplement alerts and safety information</li> <li>• Adverse event reporting</li> <li>• Guidance, compliance, and regulatory information</li> <li>• Other documents: Tips for the Savvy Supplement User: Making Informed Decisions and Evaluating Information, Tips for the Older Dietary Supplement User</li> <li>• Warnings and safety information</li> <li>• Consumer educational materials</li> <li>• Industry information and guidance</li> <li>• Labeling regulations and claims</li> </ul>
National Academy of Medicine	<a href="http://www.nam.edu">www.nam.edu</a>	<ul style="list-style-type: none"> <li>• Tables that include Dietary Reference Intake values and adverse effects of excessive consumption</li> </ul>
MedWatch	<a href="http://www.fda.gov/Safety/MedWatch/">www.fda.gov/Safety/MedWatch/</a>	<ul style="list-style-type: none"> <li>• The Food and Drug Administration Safety Information and Adverse Event Reporting Program. Health professionals and consumers can report adverse events from dietary supplements.</li> </ul>

(continued on next page)

**Figure.** Select evidence-based resources for information related to dietary supplements.

Organization	Website	Contents
Micronutrient Information Center, Linus Pauling Institute, Oregon State University	<a href="http://lpi.orst.edu/infocenter">lpi.orst.edu/infocenter</a>	<ul style="list-style-type: none"> <li>Scientific information on the role of vitamins, minerals, and phytochemicals in preventing disease and promoting health</li> </ul>
National Agricultural Library	<a href="http://www.nutrition.gov/dietary-supplements">www.nutrition.gov/dietary-supplements</a>	<ul style="list-style-type: none"> <li>Listing of resources (bibliographies/databases, books/book chapters, newsletters, web resources, and agencies and organizations) providing technical and professional-level information on dietary supplements, including nutrition information</li> </ul>
National Library of Medicine	<a href="http://www.nlm.nih.gov/medlineplus/vitaminandmineralsupplements.html">www.nlm.nih.gov/medlineplus/vitaminandmineralsupplements.html</a>	<ul style="list-style-type: none"> <li>MedlinePlus for Vitamin and Mineral Supplements</li> </ul>
Office of Dietary Supplements, National Institutes of Health	<a href="http://ods.od.nih.gov">ods.od.nih.gov</a> <a href="https://ods.od.nih.gov/Research/PubMed_Dietary_Supplement_Subset.aspx">https://ods.od.nih.gov/Research/PubMed_Dietary_Supplement_Subset.aspx</a> <a href="https://ods.od.nih.gov/Research/CARDS_Database.aspx">https://ods.od.nih.gov/Research/CARDS_Database.aspx</a>	<ul style="list-style-type: none"> <li>Expert reviewed facts sheets on vitamins, minerals, and product types (eg, multivitamins and sports supplements) that include information on medication interactions, signs, and symptoms of deficiency and toxicity</li> <li>Subset of PubMed specific to information on dietary supplements, Office of Dietary Supplements and National Library of Medicine</li> <li>Computer Access to Research on Dietary Supplements database of federally funded research projects pertaining to dietary supplements</li> </ul>
Operation Supplement Safety	<a href="http://hprc-online.org/dietary-supplements/opss">http://hprc-online.org/dietary-supplements/opss</a>	<ul style="list-style-type: none"> <li>Provides interactive tools to assess potential adverse effects for some types of dietary supplements</li> </ul>
Office of Dietary Supplements, National Institutes of Health, and Department of Agriculture, and other federal agencies	<a href="https://dietarysupplementdatabase.usda.nih.gov">https://dietarysupplementdatabase.usda.nih.gov</a> <a href="https://dslid.nlm.nih.gov/dslid/">https://dslid.nlm.nih.gov/dslid/</a>	<ul style="list-style-type: none"> <li>Dietary Supplement Ingredient Database estimates levels of ingredients in dietary supplement products</li> <li>Dietary Supplement Label Database offers label information for &gt;70,000 different product types</li> </ul>
Therapeutic Research Center	<a href="http://www.naturaldatabase.com">www.naturaldatabase.com</a>	<ul style="list-style-type: none"> <li>Natural Medicines Comprehensive Database (subscription required) includes evidence-based monographs that contain information on ingredient safety, effectiveness, adverse reactions, and interactions</li> </ul>

*(continued on next page)***Figure.** *(continued)* Select evidence-based resources for information related to dietary supplements.

Organization	Website	Contents
<b>Books</b>		
Coates PM, Betz JM, Blackman MR, Cragg GM, et al. <i>Encyclopedia of Dietary Supplements</i> . 2nd ed. New York, NY: Marcel Dekker; 2010.		
Institute of Medicine, Food and Nutrition Board. <i>Dietary Reference Intakes: The Essential Guide to Nutrient Requirements</i> . Washington, DC: National Academies Press; 2006.		
<sup>a</sup> AHRQ=Agency for Healthcare Research and Quality.		

**Figure.** (continued) Select evidence-based resources for information related to dietary supplements.

**Reporting Adverse Effects**

RDNs and NDTRs are urged to counsel clients to report adverse reactions of micronutrient supplements to the manufacturer and to the FDA. Health care professionals are also encouraged to report adverse effects experienced by their clients from the use of any dietary supplements using the FDA’s MedWatch program.<sup>8</sup> The Health Insurance Portability and Accountability Act Privacy Rule permits health care professionals to report adverse events and other information related to the quality, effectiveness, and safety of FDA-regulated products both to the manufacturers and directly to FDA.<sup>67</sup>

**PROFESSIONAL RESOURCES AND TRAINING OPPORTUNITIES**

The ODS, which was created in part to promote research aimed at determining the health benefits and risks of dietary supplements, provides several tools that researchers, RDNs, and NDTRs can use to increase their knowledge of dietary supplements, including micronutrient supplements. These include the Dietary Supplement Research Practicum on dietary supplement issues for academic faculty and students<sup>68</sup>; the PubMed Dietary Supplement Subset,<sup>69</sup> which allows a literature search limited to dietary supplements, a Dietary Supplement Labels Database (<https://www.dslid.nlm.nih.gov/dslid-mobile/index.jsp>) and expert-reviewed fact sheets on dietary supplement ingredients and specific product classes, like the MVM.<sup>45</sup> These and other resources such as those listed in the Figure can be used by RDNs and NDTRs to stay informed on issues related to dietary and micronutrient supplements.

**PRACTICE POINTERS**

**Total Micronutrient Intakes**

Intake assessment must include all micronutrient sources, including those naturally occurring and fortified in foods and beverages and dietary supplements. Both micronutrient adequacy and excess could be biased in the case that only conventional and fortified food sources are considered. To accomplish this, practitioners should routinely collect use of micronutrient supplements as part of any dietary assessment, including the frequency of use, typical dose, and the duration of use. Given the potential for interactions, collecting information on all dietary supplements used is of utility.

**Stacking and Similar Practices**

Clients using multiple supplements can be asked to bring in the containers of supplements used, particularly when products with multiple ingredients are used. Using multiple supplements that have common ingredients could result in levels that exceed the UL.

**How to Discuss Use of Supplements with Clients and Patients**

Given the high use of micronutrient supplements by the public, RDNs and NDTRs need to keep up to date on the safety and efficacy of these products to assist consumers in the safe and appropriate use of these supplements. The roles and responsibilities of the NDTRs under the supervision of the RDN and RDNs within their individual scope of practice may include:

- assessing nutritional status of clients to determine likelihood of inadequate or excessive intake of vitamins and minerals;

- evaluating the potential benefit or harm of micronutrient supplementation given the client’s nutritional and health status;
- evaluating the safety of the micronutrient supplement given the form, dose, its potential for interaction with food, other dietary supplements, and over-the-counter and prescribed medications;
- educating clients as to the potential benefit of receiving micronutrients through conventional and fortified foods;
- recommending micronutrient supplementation when the client does not consume the amount of types of foods necessary to obtain recommended micronutrient intakes;
- evaluating research regarding micronutrient supplementation; and
- being aware of regulatory, legal, and ethical issues of recommending and selling of micronutrient supplements.

Continuing education and inclusion of dietary supplements and specifically micronutrient supplements in didactic curricula are essential to ensuring RDNs and NDTRs have the skills necessary to perform these functions.

**CONCLUSIONS**

The dietary intakes of many Americans are inadequate in some micronutrients. It is among the roles and responsibilities of RDNs and NDTRs under the supervision of an RDN to help educate the public on healthful dietary patterns and on the safe and appropriate selection and use of micronutrient supplements to meet their micronutrient needs and optimize

health. To this end, RDNs and NDTRs must keep abreast of research findings on potential benefits and safety of micronutrient supplements, and on the regulatory issues that influence the use of these products.

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**AUTHOR INFORMATION**

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**STATEMENT OF POTENTIAL CONFLICT OF INTEREST**

R. L. Bailey has received funding from the National Institutes of Health/National Cancer Institute (grant no. U01CA215834) and serves as a scientific consultant to the National Institutes of Health, Office of Dietary Supplements; she has received a travel support from the Council of Responsible Nutrition to present her research.

**FUNDING/SUPPORT**

There is no funding to report.

*Reviewers:* Mary Beth Arensberg, PhD, RDN, LDN, FAND (Abbott Nutrition, Division of Abbott, Columbus, OH); Feon Cheng, PhD, MPH, RDN (Academy Research, International and Scientific Affairs, Chicago, IL); Emily K. Farina, PhD, RD (Henry Jackson Foundation/US Army Research Institute of Environmental Medicine, Natick, MA); Sharon Denny, MS, RD (Libertyville, IL); Sarah Picklo Halabu, RDN, LDN (Academy Publications and Resources, Chicago, IL); Lisa Moloney, MS, RD (Academy Research, International, and Scientific Affairs, Chicago, IL); Dietitians in Integrative and Functional Medicine Dietetic Practice Group (Kelly Morrow, MS, RDN, Bastyr University, Kenmore, WA); Tracy L. Oliver, PhD, RDN, LDN (Villanova University, Villanova, PA); and Medical Nutrition Therapy Dietetic Practice Group (Colene Stoernell, MS, RD, Scripps Health, La Jolla, CA).

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**ACKNOWLEDGEMENTS**

The authors thank the reviewers for their many constructive comments and suggestions. The reviewers were not asked to endorse this position or the supporting paper.