Addressing Nutritional Gaps: Simple Steps for the Primary Care Provider

Martin Quan, MD

CONTINUING MEDICAL EDUCATION

LEARNING OBJECTIVES

- Identify common shortfalls in the typical American diet.
- Address the link between poor diet quality and chronic disease.
- Identify patients at risk for vitamin deficiency and potential vitamin–drug interactions.
- Recognize patients with vitamin and mineral deficiencies.
- Partner with patients regarding selection and appropriate use of vitamin and mineral supplements to achieve recommended dietary allowances.

TARGET AUDIENCE

Family physicians and clinicians who wish to gain increased knowledge and greater competency regarding primary care management of diabetes mellitus and kidney disease.

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FACULTY

Martin Quan, MD, Professor of Clinical Family Medicine, Director, Office of Continuing Medical Education, David Geffen School of Medicine at UCLA, Vice Chair for Academic Affairs, UCLA Department of Family Medicine.

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NUTRITIONAL STATUS IN THE UNITED STATES

Although nutrition experts often advise that individuals consuming the standard American diet with 3 square meals a day do not need vitamins or nutritional supplements, it appears the American public disagrees. In fact, in 2019 the Council for Responsible Nutrition reported in its Consumer Survey on Dietary Supplements that 79% of adult females and 74% of adult males used dietary supplements with usage rates highest among those age 35 to 54 (81%) and those age >55 (79%).[1] A multivitamin was found to be the most popular supplement (58%) followed by vitamin D (31%), vitamin C (28%), and protein (21%). The top reason for taking a dietary supplement was to improve overall health and wellness. Notably, supplement users were more likely to practice healthy lifestyle habits than non-users and less than one-quarter of supplements taken by adults were recommended by their physician or other health care provider.[1]

The failure of the American diet to ensure micronutri-

ent intake adequacy was evident in a secondary analysis of nationally representative data from the National Health and Nutrition Examination Survey (NHANES).[2] Using data from the 2003–2004 and 2005–2006 data cycles, one-third of Americans were found to be at risk for 1 or more vitamin deficiency or anemia with significantly higher risk seen in non-Hispanic blacks (55%), individuals from low income households (42%), those without a high school diploma (42%), as well as underweight (42%) or obese individuals (39%). Consumption of an adequate diet based on estimated average requirements offered no guarantee of nutritional adequacy, with a 16% risk of 1 or more nutritional deficiency among those consuming an "adequate" diet compared with 57% in those with an inadequate diet.[2]

The adequacy of the American diet was further called into question by the 2012 US Centers for Disease Control and Prevention *Second National Report on Biochemical Indicators of Diet and Nutrition*.[3] Based on laboratory analysis of 58 biochemical indicators in specimens from a representative sample of the US population during a 4-year period from 2003 through 2006, the report stated that 10.5% of Americans had a vitamin B_6 deficiency (<20 nmol/L), 8.1% had a severe vitamin D deficiency (<30 nmol/L), 9.5% of women age 12 to 49 years had low body iron status (<0 mg/kg), and one-third of pregnant women were marginally iodine deficient.[3] The percentage of those who met recommended levels varied by age, sex, ethnicity, and/or geographic location.

Although *Dietary Guidelines for Americans 2015-2020* released by the US Department of Health and Human Services and the US Department of Agriculture noted that deficiencies of essential nutrients dramatically decreased over the past century, the report also noted that about one-half of all US adults have 1 or more preventable, diet-related chronic diseases.[4] Many of these, such as obesity and type 2 diabetes mellitus, were attributed to unhealthy eating patterns associated with low intakes of vegetables, fruits, whole grains, and dairy products, excess consumption of processed, calorie-dense foods, and lack of physical activity. The report identified potassium, dietary fiber, choline, magnesium, calcium, and vitamins A, D, E, and C as underconsumed nutrients and identified underconsumption of iron to be a particular concern in females age 19 to 50.

Although balanced consumption of unprocessed, nutrient-dense foods (eg, fruits, vegetables, legumes, whole grains, low-fat dairy, and lean meats) remains the preferred means of attaining recommended intakes of micronutrients, the dietary shortcomings of diets consumed by a large segment of the American public supports a role for vitamin and mineral supplementation. In the NHANES analysis,[2] users of multivitamin/mineral supplements (MVMS) were found to have the lowest risk of micronutrient deficiency (14%) compared with non-users (40%).[2] Similarly, based on data from NHANES 2007-2008 and 2009-2010, MVMS use contributed to a greater number of individuals meeting recommended intakes of almost all micronutrients measured.[5]

In addition to helping prevent micronutrient deficiency, dietary supplement use also could have a role in preventing micronutrient inadequacies, which could lead to development of chronic disease as hypothesized in the "triage theory".[6,7] According to this theory, when the availability of a micronutrient is inadequate, the body ensures that micronutrient-dependent functions required for short-term survival takes priority over more constitutive functions, the lack of which can have long-term consequences.[8] Current recommended daily vitamin intakes are based primarily on the dosage required to ensure that immediate clinical consequences associated with deficiency do not occur; for example, vitamin K to prevent bleeding, vitamin C to prevent scurvy, thiamine to prevent beriberi, and vitamin D to prevent rickets. Whether or not the current intake of micronutrients—which generally is less than the currently recommended intake—is sufficient to optimize their more subtle, long-term health effects has been questioned and remains an area of investigation. For example, although the adequacy of current vitamin K intake recommendations for coagulation function has been well established, it might not be high enough to optimize vitamin K-dependent constitutive functions important to maintain long-term health. Evidence forming the basis of the "triage theory" is presented in a perspective by McCann and Ames that supports the theory that vitamin K "inadequacy" might play a role in the development of age-related diseases such as osteoporosis, cardiovascular disease, and cancer.[8]

AT-RISK GROUPS

When taking a medical history, it is important to identify groups of patients at risk for nutritional deficiency, which can include those who are otherwise healthy, such as pregnant women,[9-11] children and adolescents,[12,13] and geriatric patients.[14,15] Individuals at particular risk for nutritional deficiency include those who are obese,[6,16-18] non-Hispanic black,[19,20] and low income or food insecure.[21,22] Other at-risk groups include individuals with inflammatory bowel disease, cancer, alcohol use disorder, HIV, chronic obstructive pulmonary disease,[23] diabetes,[24] substance use disorder, age-related macular degeneration or other vision impairment, a restricted or suboptimal eating pattern, a gastrointestinal malabsorption syndrome, those who have undergone bariatric surgery, or who have difficulty with manual dexterity such as arthritis.[2,25,26]

Drug-nutrient interactions can contribute to micronutrient deficiencies and should not be overlooked.[27] For example, metformin use has been linked to reduced intestinal absorption of vitamin B_{12} and the American Diabetes Association has recommended periodic measurement of vitamin B_{12} levels in metformin-treated patients.[28] Similarly, vitamin B_{12} deficiency has been reported with use of histamine-2 receptor antagonists.[29] Chronic proton pump inhibitor use has been linked with vitamin B_{12} deficiency and possibly with deficiencies of vitamin C, iron, calcium, and magnesium.[30,31]

Nutritional gaps are common among overweight and obese individuals and might stem from overconsumption of calorie-rich, micronutrient-poor, processed foods. Studies support these individuals being at increased risk for several micronutrient inadequacies/deficiencies, including vitamins A, C, D and E, as well as calcium and magnesium.[6] A history of bariatric surgery has been linked to deficiencies of thiamine, vitamin B_{12}, vitamin E, vitamin D, and copper.[32]

A patient's dentition can impact nutrition. In a small cross-sectional study of older adults, loss of posterior teeth on both sides was associated with less consumption of meat, nut, egg, fish, and dairy products resulting in less than adequate intake of protein, iron, and vitamin B_{12}.[33]

Whether a patient's diet includes animals or animal products also influences nutritional risk. In a Swiss study by Schupbach et al,[34] the intake and status of selected vitamins and nutrients was assessed among adults following vegetarian (n=53), vegan (n=53), or omnivore (n=100) diets for 1 or more year(s). Most participants in all 3 groups were iodine deficient. Other common deficiencies in all 3 groups included folic acid, vitamin B_6, vitamin B_2, niacin, iron, and zinc.

Finally, micronutrient deficiencies are common among patients who follow weight-loss diets, such as Dietary Approaches to Stop Hypertension (DASH), Atkins, Ornish, and Weight Watchers.[35-38] For example, high-fat, low-carbohydrate diets provide lower than recommended intakes of vitamin E, vitamin A, thiamine, vitamin B_6, folate, calcium, magnesium, iron, potassium, and dietary fiber. Very low-fat diets (eg, Ornish diet, Pritikin diet) generally are low in vitamin E, vitamin B_{12}, and zinc. Although moderate-fat, balanced nutrition diets (eg, Weight Watchers, Jenny Craig, NutriSystem) can be nutritionally sound provided appropriate and correct food choices are made, patients may be at risk for inadequate intake of several micronutrients. A recent study by Pascual et al found that subjects who lost an average of 29.7 kg over 3.4 years (body mass index 36.5 kg/m^2 at baseline) on Weight Watchers exhibited a healthier dietary pattern, including consumption of foods with higher micronutrient density, than a control group of weight-stable adults with obesity (body mass index 41.1 kg/m^2).[39] Nonetheless, one-quarter or more of the Weight Watchers group remained deficient in calcium, magnesium, zinc, vitamin A, vitamin B1, and folate, and nearly all were deficient in potassium, and vitamins D and E. Recent investigations have shown multiple deficiencies in the hypocaloric vegan Eat to Live-Vegan/Aggressive Weight Loss, high-animal protein low-carbohydrate Fast Metabolism, and weight-maintenance Eat, Drink and Be Healthy diets, particularly vitamin D, calcium, and vitamin B_{12}.[40]

VITAMIN AND MINERAL SUPPLEMENTATION

Micronutrients have distinct biologic functions essential to metabolic functioning, growth and development, and many cellular and organ system functions. It generally is agreed that achieving micronutrient intake levels on a population-wide and individual basis consistent with established reference values is a worthwhile public health goal.[4,41]

In 2018, a panel of 14 international experts in nutritional science and health was convened to clarify the role of multivitamin and mineral supplements in supporting human health.[42] Unsurprisingly, the panel's systematic review found that, on a population basis, the use of MVMS reduced the prevalence of inadequate intake of micronutrients. In addition, the panel concluded that using a daily MVMS with micronutrient amounts not exceeding tolerable upper intake levels was one way to provide the recommended levels of many micronutrients needed for maintaining health without posing a safety risk. However, the panel concluded there was insufficient evidence to indicate that MVMS are effective for primary prevention of chronic medical conditions including cardiovascular disease and cancer, and additional research was necessary to fully define the benefits of MVMS on health promotion and disease prevention.

PREVENTING CHRONIC DISEASE

The 2018 international panel also found insufficient evidence to support the long-term use of MVMS to lower the risk of some chronic diseases, such as cardiovascular disease and some types of cancer.[42] Moreover, the use of supra-dietary dosages of individual micronutrients has demonstrated potential for harm. For example, a meta-analysis by Miller et al reported a higher risk of all-cause mortality associated with dosages of vitamin E ≥400 mg/d.[43] In addition, a higher risk of lung cancer has been reported with beta-carotene supplementation, particularly in heavy smokers.[44]

Other investigators have found no benefit of micronutrient supplementation in reducing risk of chronic diseases. A systematic review and meta-analysis of 18 studies with

18.4 million person-years of follow-up found no association between MVMS use and cardiovascular disease or coronary heart disease mortality.[45] Similarly, a prospective cohort study of 30,899 US adults followed over a median of 6.1 years found dietary supplement use was not associated with a mortality benefit.[46]

In its 2013 systematic evidence review, the US Preventive Services Task Force (USPSTF) found limited evidence supporting any benefit from MVMS for preventing cardiovascular disease or cancer and no evidence supporting a benefit or harm of multivitamin use on cardiovascular disease, cancer, or mortality in healthy individuals without known nutritional deficiencies.[47] For cancer, after pooling findings of 2 randomized controlled trials, the USPSTF noted a 7% reduction (unadjusted pooled relative risk, 0.93 [confidence interval, 0.87 to 0.99]) of all cancer incidence among men who took a multivitamin for ≥10 years but no protective benefit among women.

A lack of cognitive benefit has been reported with use of some over-the-counter supplements. A systematic review of 38 trials evaluated the efficacy of omega-3 fatty acids, soy, ginkgo biloba, B vitamins, vitamin D plus calcium, vitamin C, or β-carotene, and multi-ingredient supplements in preventing cognitive decline, mild cognitive impairment, and Alzheimer-type dementia.[48] The investigators found insufficient evidence to recommend use of any over-the-counter supplement for cognitive protection in adults with normal cognition or mild cognitive impairment.

Although useful for preventing and treating micronutrient deficiencies, it is unclear whether supplement use by itself offers direct health benefits comparable to nutrients sourced from foods. Chen et al[40] found that supplement use was not associated with mortality benefits among US adults in a recent prospective cohort study of more than 27,000 adults using NHANES data from 1999 to 2010 linked to National Death Index mortality data. Although the study found adequate intake of vitamin K, vitamin A, magnesium, zinc, and copper was associated with reduced all-cause or cardiovascular disease mortality, the associations were restricted to nutrient intake from foods rather than supplements. In addition, the study found evidence of an increased risk of cancer death associated with excess calcium intake in participants who took supplemental dosages of at least 1000 mg/d and no association between cancer risk and calcium intake from foods. The bottom line: Although supplement use contributes to an increased level of total nutrient intake, there appears to be beneficial associations with nutrients from foods that aren't seen with supplements. This underscores the importance of encouraging patients to achieve adequate nutrient intake from eating nutrient-dense, whole, fresh, unprocessed foods within the framework of a healthy, balanced diet rather than relying solely on nutritional supplements to make up for the deficits associated with a poor diet.

SUPPLEMENTS IN CLINICAL PRACTICE

Choosing a supplement

The US Food and Drug Administration (FDA) regulates dietary supplements, but unlike prescription and non-prescription medications, the FDA is not authorized to review dietary supplements for safety and effectiveness before they are sold.[49] Only after a dietary supplement enters the marketplace can the FDA take action against adulterated or misbranded dietary supplements.

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Under the terms of the Dietary Supplement Health and Education Act of 1994, manufacturers of dietary supplements are not required to receive FDA approval before marketing dietary supplements that were sold in the United States prior to 1994. However, they are required to submit a safety-focused new dietary ingredient notification for any ingredient not falling under this clause. Manufacturers are required to ensure that the product label is truthful and not misleading, but for most claims made in labeling dietary supplements, the manufacturer or seller is not required to prove to the FDA that the claim is accurate or truthful before it appears on the product label. It is illegal for a manufacturer to market a dietary supplement product as a treatment or cure for a specific disease or to alleviate symptoms of a disease. Advertising of dietary supplements is under the Federal Trade Commission's jurisdiction.

To assist and inform consumers, the National Institutes of Health has launched an online Dietary Supplement Label Database at https://dsld.od.nih.gov/dsld. This database lists

the ingredients of thousands of dietary supplements and includes information from the label on dosage, health claims, and cautions.

Because the FDA does not validate the quality of supplements, a number of third-party groups have taken on this role, including the nonprofits US Pharmacopeia (USP) and National Science Foundation International, as well as the for-profit ConsumerLab.com and UL (formerly Underwriters Laboratory). Among these, the standards for supplements established by USP are the most widely accepted. USP also sets mandatory standards for pharmaceuticals.

PROVIDING NUTRITIONAL CARE IN PRIMARY CARE

The foundation for providing effective nutritional care in the outpatient setting is grounded in good communication with the patient, including the use of online tools and resources as well as involving a multidisciplinary care team.[50] Because nutrition is heavily influenced by behaviors that occur outside the provider-patient encounter, it is paramount to identify and address behaviors, as well as patient values and concerns, that contribute to nutritional deficiencies.[51] This process is directed toward fostering and supporting patients' motivation and sense of control, thereby boosting patient empowerment.

Because a goal of dietary counseling is for patients to take greater responsibility for and a more active role in decision making referable to their health, structuring the patient encounter using the 5 As construct might be helpful. Applying this framework to dietary counseling calls for: 1) Assessing the patient's diet and associated comorbidities, 2) Advising on the nutritional soundness of their diet and the benefits of selected changes, 3) Assessing readiness for change, 4) Assisting the patient in deciding where to begin making changes and behaviors to focus on, and 5) Arranging for follow-up and/or referral to available resources, as appropriate.[50]

Shared decision making is a key component of patient counseling and engagement to ensure that medical care better aligns with a patient's preferences and values. This approach requires the provider to explore treatment options with the patient to clarify the patient's values and concerns. This might entail discussing various options such as eating a healthy diet, taking 1 or more vitamin and mineral supplement(s), or doing nothing. It is important to keep in mind that the patient must be willing and able to implement the agreed upon treatment and the provider's role is to coach and support the patient.

RESOURCE TOOLKIT

A list of resources that might be helpful in learning about micronutrient-related issues, including those for patient education, is at http://www.pcmg-us.org/nutrition. ●

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