Position of the American Dietetic Association: Food fortification and dietary supplements

Abstract

Wise food choices provide the necessary foundation for optimal nutrition. Science has not fully identified the specific chemical components that account for the benefits of healthy eating patterns. Selection of a variety of foods, using tools such as the USDA/HHS Dietary Guidelines for Americans and the USDA Food Guide Pyramid, is the best way to provide a desirable balance, without excessive intakes of macronutrients, micronutrients and other beneficial components of foods. Nevertheless, for certain nutrients and some individuals, fortification, supplementation, or both may also be desirable. Nutrient intakes from all these sources should be considered in dietary assessments, planning and recommendations. The recommendations of the National Academy of Sciences' Food and Nutrition Board provide a sound scientific basis for vitamin and mineral intakes. Intakes exceeding those recommendations have no demonstrated benefit for the normal, healthy population. Dietetics professionals should base recommendations for use of fortified foods or supplements on individualized assessment and sound scientific evidence of efficacy and safety. It is the position of the American Dietetic Association that the best nutritional strategy for promoting optimal health and reducing the risk of chronic disease is to wisely choose a wide variety of foods. Additional vitamins and minerals from fortified foods and/or supplements can help some people meet their nutritional needs as specified by science-based nutrition standards such as the Dietary Reference Intakes (DRI).*J Am Diet Assoc.* 2001;101:115-125

INTRODUCTION

Dietary supplements are a timely topic today in the research, legislative, business, and consumer arenas. As a growing number of epidemiological studies point to the importance of diet and nutrition to optimize health and prevent disease, additional scientific research has addressed the potential benefit of supplementing diets with vitamins or minerals. Large, randomized, double-blind supplementation trials have demonstrated positive health benefits of some supplements, but uncertainty with respect to the health effects of others, and ineffectiveness or adverse effects of still others. The National Institutes of Health (NIH) has created an Office of Dietary Supplements to gather information on these substances. For the first time, the Food and Nutrition Board of the National Academy of Sciences has recommended fortified or supplemental nutrient sources to increase the bioavailability of specific vitamins—for example, vitamin B-12 and folic acid—for certain population groups that have altered absorption or very high nutrient needs (1). Today, dietary supplements are heavily marketed and promoted, and consumers can choose from an unprecedented variety of foods, fortified foods, and dietary supplements. Dietetics professionals must carefully evaluate the emerging science, while giving consumers accurate, current advice upon which they can make informed decisions.

The dietary supplement industry has grown rapidly. Total sales of dietary supplements in 1998 have been estimated at $13.9 billion, up from approximately $8.6 billion in 1994 (2). Of these, 40% represent vitamins and 8% minerals. The remainder consists of herbal and botanical supplements, sports supplements, and other specialty products, totaling 29,000 different products (2). Changes in government regulations associated with the Dietary Supplement Health and Education Act (DSHEA) have restricted the role of the Food and Drug Administration (FDA) in the regulation of dietary supplements and associated label claims (3). Media coverage of adverse events associated with some of these products has raised concerns on the part of the public and health professionals that the industry is insufficiently regulated and that some of these products are unsafe (4). New federal legislation about supplement labeling and health claims, including a broadened definition of "dietary supplements," has increased the need for dietetics professionals to learn more about these products to better help consumers make informed decisions based on sound scientific knowledge. This intense scientific, regulatory, and popular interest provides a dynamic climate for this American Dietetic Association position on the role of food fortification and dietary supplements, with special emphasis on vitamin and mineral supplements, in promoting health.

POSITION STATEMENT

It is the position of the American Dietetic Association (ADA) that the best nutritional strategy for promoting optimal health and reducing the risk of chronic disease is to wisely choose a wide variety of foods. Additional vitamins and minerals from fortified foods and/or supplements can help some people meet their nutritional needs as specified by science-based nutrition standards such as the Dietary Reference Intakes (DRI).

GOOD FOOD AS THE BASIS FOR GOOD NUTRITION

There are several reasons why relying on foods is usually the best strategy for optimal nourishment. Research on the relationship between diet and disease has indicated that both macro- and micronutrients are important and has documented the need to avoid dietary excesses and imbalances as well as insufficient nutrient intakes. Some food components, such as dietary fibers, have potential health benefits but are not easily incorporated into supplements. Many unidentified constituents that may have important health benefits are contained in the complex matrix of natural foods. Nutrient-nutrient, drug-nutrient, and other interactions are also important and may affect health; high doses of one nutrient or food constituent may affect the absorption or metabolism of others. These concerns underscore the conclusion that nutrition cannot be optimized simply through fortification or supplementation of the food supply. Wise food choices are also essential and provide the necessary foundation of optimal diets.

Much remains unknown about the biologically active components in food. Research has identified numerous compounds other than essential nutrients in plant and animal foods (phytochemicals and zoochemicals, respectively), with chemical properties or biological effects that suggest health benefits (5). Other natural food constituents may have adverse effects. Because there are so many constituents in foods, it is difficult to specifically identify those responsible for positive health effects observed in epidemiological or clinical studies. There may be more than one active substance, and the matrix in which they appear may also be important. Moreover, standards for characterizing some of these constituents may be lacking. Extracts of the compounds may differ from the forms that appear in foods in physiologically important ways, and the bioavailability of many of the compounds is unknown.

There is no scientific basis for the common assumptions that if a small amount of a food component is beneficial, then more must be better, or that concentrated amounts of a limited number of components will provide greater benefits than the combination of the many different constituents provided by food. For example, a variety of natural pesticides produced by plants to ward off predators have anticarcinogenic properties (6). While these natural pesticides in small amounts may function by preconditioning the body's detoxification systems, they may not be safe or effective when concentrated and taken in larger doses as supplements (6). Concentrated amounts of single substances may also adversely affect the absorption, biological transport, and metabolism of other potentially beneficial substances with similar chemical properties (7,8). In addition, synthetic forms of some nutrients may not be as effective; for some nutrients such as amino acids, only the L(*levo*)- form, and not the D(*dextro*)- and L(*levo*)- forms, are utilized, and supplements providing both D(*dextro*)- and L(*levo*)- forms have low bioavailability. Other synthetic forms may be more bioavailable than the forms in food and may provide greater risk of toxicity or imbalance.

Studies with animals demonstrate the inadequacy of present nutrition knowledge to artificially formulate diets that optimize health in all respects and in all cells, tissues, and organ systems. Scientists know much more about the nutritional requirements of rats than of any other species. Semi-purified diets containing casein, starch, cellulose, corn oil, minerals, and vitamins have been formulated to meet all known requirements to optimize rat growth and health. However, rats fed these semi-purified diets are still at greater risk of developing cancer than those fed commercial "crude" diets containing components such as grain, beet pulp, alfalfa meal, cane molasses, and fish meal (9). These observations suggest that all of the numerous potentially beneficial components of foods, let alone the appropriate amounts and combinations, have not yet been identified.

While researchers have repeatedly observed health benefits associated with high fruit and vegetable consumption, it has not been possible to identify a specific constituent or, more likely, combinations of several constituents acting in concert that may be responsible for these benefits (10,11). Research results are still too incomplete to make sound evidence-based recommendations for specific amounts of individual constituents or combinations of them at present. Given our incomplete knowledge, eating a wide variety of foods is the best way to obtain adequate amounts of beneficial food constituents, while avoiding chemical excesses or imbalances. Supplements and fortified foods can then be used to meet dietary recommendations if dietary patterns still fall short of Recommended Dietary Allowances (RDA) or Adequate Intake Levels (AL) for normal, healthy people. Supplements or fortified foods can also be useful if other factors, such as abnormal absorption, increased requirements, or excessive losses of nutrients or other physiologic abnormalities suggest a science-based need for supplements or fortified foods.

RECOMMENDED FOOD AND NUTRIENT INTAKES

During the 1990s, the Food and Nutrition Board of the Institute of Medicine, National Academies of Science, in conjunction with Health Canada, began a thorough evidence-based review of nutrient requirements and their associations with health outcomes. In an ongoing process, Dietary Reference Intakes (DRI) are being established for each of the nutrients and other food constituents judged by expert groups as likely to have health effects. The Food and Nutrition Board determines Estimated Average Requirements (EAR), and Recommended Dietary Allowances for each nutrient based on specific functional outcomes. When EARs are not available from published research data, adequate intakes (AI) are suggested, rather than RDAs. In addition, tolerable upper intake levels (UL) are provided in the DRI for the first time (12). Information on various risks associated with insufficient and excessive amounts of nutrients or food components is summarized with the DRIs. In addition, the various functional outcomes appropriate for each age group are evaluated for each nutrient or food component, and the rationale for choosing a specific outcome is provided. This extensive evidence-based documentation provides a strong scientific rationale for recommendations to reach stated goals safely and effectively with respect to health.

The Dietary Guidelines for Americans (13) issued by the US Department of Agriculture (USDA) and Department of Health and Human Services, the USDA Food Guide Pyramid (14), the FDA's Nutrition Facts Label, and other label information on most processed foods provide useful public guidance for choosing a variety of foods for good health. These guides emphasize the consumption of grain products, vegetables, and fruits, moderate use of meats and low fat dairy products, and sparing use of fats and sweeteners. Good nutrition primarily depends on appropriate food choices. Consuming a wide variety of foods in moderate amounts reduces the risk of inadequate and excessive intakes.

NUTRIENT INTAKES FROM FOOD, AS ESTIMATED FROM DIETARY SURVEYS

A common concern of consumers is that typical diets are unlikely to provide adequate amounts of vitamins and minerals. However, nationally representative surveys (15,16) indicate that median US nutrient intakes meet or exceed recommendations (1,17-19) for several nutrients (protein, vitamin C, thiamin, riboflavin, niacin, and phosphorus) without dietary supplements.

Caution must be applied in interpreting reported intakes that are less than recommended, as survey results likely underestimate true dietary intakes because of limitations in dietary assessment methodology. Self-reported food intakes (the basis of national survey data) commonly underestimate true food intakes by approximately 20%, as indicated by comparing reported energy consumption with measurements of energy expenditure using doubly labeled water techniques (20,21). Although we do not know whether the underestimation of all nutrients is proportional to the underestimation of energy, the foods that are underreported are unlikely to be completely nutrient free. Some vitamins and minerals may be further underestimated because nutrient databases have not kept up with recent increases in food fortification.

While survey results indicate that median intakes of several vitamins and minerals are 70 - 80% of recommended amounts (15), these data are of questionable reliability because median energy intakes are similarly low in the same survey (15). In contrast, there is considerable related evidence that US energy intakes are not generally inadequate: the incidence of obesity in the United States has been increasing (22), 31.7% of adults are overweight, only 6% believe that their diet is "too low in calories" (15), only 3.3% of the population indicate that there is sometimes, and 0.6% indicate that there is often not enough food (22). While food insufficiency is a concern even when it occurs in small segments of the population, it is also clear that the deficit in surveyed energy intakes, and likely the intakes of other nutrients, is unreliable.

Concerns about median intakes also apply to the distribution of energy and nutrient intakes. The distribution of nutrient intakes is even more difficult to accurately determine, in part because a distribution of nutrient intakes from two independent days of recalls is much wider than the distribution of chronic usual nutrient intakes. Promoters of nutrient supplements often cite USDA data indicating the percentage of US adults consuming less than recommended amounts of nutrients (15). However, the USDA survey also shows that 45% of US adults meet less than three-fourths of the recommended amount of energy, an estimate that is clearly unreliable. Although they provide the best data available, dietary surveys provide inexact data, not just for individual intakes, but for group averages and distributions, that are not a sound basis to justify uniform supplementation of diets in the United States with vitamins and minerals.

The clinical assessment of vitamin and mineral status does not generally support inadequacies that may be implied from dietary survey data. For several nutrients, such as magnesium or zinc, sensitive indicators of marginal nutritional status are unavailable, and there is no well-accepted evidence either of deficiency in the population or of beneficial effects of supplemental intakes. For other nutrients, clinical and biochemical indices do not support concerns about insufficiency raised by the dietary data. For example, although median intakes of vitamin A in adults are below RDA values (15), the prevalence of low serum levels of vitamin A is very small (22), and there is evidence of deleterious effects of high levels of supplementation in some instances (see Toxicities, adverse nutrient interactions, and safety, p. x).

As another example, the recently increased RDA for Vitamin E (15 mg/d for healthy adults) is well above NHANES III and CSFII survey mean estimated intakes of about 9.4 and 6.4 mg alpha-tocopherol daily from food for men and women, respectively (19). The report explaining the new RDA (19) emphasizes that these survey data likely underestimate true intakes because of measurement error, and that the "mean intakes of apparently healthy adults in the US and Canada are likely to be above the RDA of 15 mg/d of alpha-tocopherol" (19). In addition, more than 95% of the US population meet or exceed the plasma alpha-tocopherol concentrations used as the criterion for the new estimated average requirement (EAR) (19). Thus, even the relatively large discrepancy between the RDA and dietary survey data does not justify vitamin E supplementation.

The new DRI recommendations identify several circumstances when increased nutrient intake would be beneficial for some population groups (see Circumstances when nutrient supplementation is indicated,p.x). When dietary intakes do not meet science-based dietary recommendations, food fortification and dietary supplementation can make an important contribution. However, dietary supplements are not necessarily formulated to fill the gaps between nutrient intakes from food sources and nutrient recommendations such as the RDA or AI (23,24).

NUTRIENT SUPPLEMENTATION IN THE UNITED STATES

According to recent representative national surveys (partly representing conditions before DSHEA), approximately 40 to 47% of the US population use vitamin or mineral supplements at least occasionally (15,25). Slightly more than two thirds of supplement users take only one supplement, generally a multiple vitamin with or without minerals (25). Current, reliable data are not available to adequately describe the amounts of specific nutrients consumed as supplements. Moreover, supplement use may be commonly underreported or inaccurately reported, especially when determined through self-administered questionnaires (26,27). Consistent with earlier reports (28-30), recent data indicate greater supplement usage among Caucasians, women, older age groups, those with higher personal incomes, those with more education, and those living in the western United States (25). Several reports indicate that supplement users (whether they are daily or occasional users) (31) also have higher intakes of nutrients from foods (31-33), lower dietary fat (31), and higher fruit, vegetable (32,34), and dietary fiber consumption (31). Although these differences vary according to gender, age, and ethnicity (33), the greater nutrient intakes among supplement users, compared with nonusers, persist after adjusting for income, education, employment status, age, sex and ethnicity (33). Use of supplements has been positively associated with a lower body mass index, with agreement that "eating a variety of foods each day gives you all the vitamins and minerals you need," with more frequent exercise (35), with self-described excellent or very good personal health (25), with not smoking, not drinking heavily, and believing that diet affects disease (29).

Because many of the lifestyle characteristics of supplement users are health related, unless studies test nutrient and other supplements in comparison with placebos, randomly and blindly

assigned to volunteers that are otherwise similar, health benefits observed in such studies cannot be reliably attributed to supplement use.

THE NEED FOR STRONG SCIENTIFIC EVIDENCE BASED ON CONTROLLED CLINICAL TRIALS

Epidemiological studies show associations, but are not able to establish cause-and-effect because they do not control for other diet and lifestyle variables. These variables may also influence the results and may not be evident or even suspected. Cause-and-effect relationships can be most conclusively tested with prospective, randomized, double-blind, placebo-controlled supplementation trials. Such trials control for confounding variables by randomly assigning the supplement to participants, who are otherwise identically treated and evaluated by investigators. These experiments are generally better controlled with supplements rather than dietary changes, both because they require fewer and simpler behavioral changes and because the treatment can easily be blinded from both participants and investigators. Such studies must be conducted to provide firm research support for the safety and efficacy of dietary supplements.

As an example, although high fruit and vegetable consumption increases dietary and blood beta-carotene levels, controlled investigations with beta-carotene supplementation were needed to determine whether it accounted for the reduction in cancer risk that is associated with fruit and vegetable intake. Three randomized placebo-controlled trials prospectively investigated whether beta-carotene supplements would reduce cancer incidence (36-38). None of these three trials found beneficial effects of beta-carotene in reducing cancer incidence. Unexpectedly, in the two studies that included smokers or workers exposed to asbestos, beta-carotene supplementation resulted in a higher incidence of lung cancer and of total mortality in these participants (36,37). The third study, which involved US physicians, found no harm but no benefit from beta-carotene supplementation (38). The reason for the adverse effects is unclear. One potential explanation is that beta-carotene supplements increase blood levels to a greater degree than an equal amount of beta-carotene in food (19). Supplements may have different (either higher or lower) bioavailability and may affect body stores differently than foods, and more is not necessarily better. In supplemental amounts, beta-carotene may interfere with the intestinal absorption of other potentially beneficial related compounds, such as canthaxanthin, lutein, and lycopene (7). Or, especially in the lungs of smokers, large amounts of beta-carotene may be readily oxidized into pro-carcinogenic products (39). Only randomized, controlled supplementation trials were able to detect the pro-carcinogenic effect of beta-carotene in smokers. Before these studies, beta-carotene was widely considered safe, because there were no harmful short-term adverse effects, even with very high doses (40).

In addition to giving considerably greater acceptance to the results of randomized controlled trials and recognizing the limitations of descriptive observations, evaluations of the research literature should look for reproducibility of results. Rarely can a single study stand alone as scientific confirmation of a hypothesis. Results obtained from some groups may not be representative of results in other populations (eg, benefits observed in a developing country may not apply to a better-nourished Western population). Results may differ with age and gender. Beneficial effects may require longer studies or more sensitive testing. Conclusions are strengthened when the research measures the true functional or disease endpoints of interest, rather than intermediate biomarkers (eg, fracture incidence vs bone density; or initial myocardial infarction vs platelet aggregation). Similarly, conclusions drawn from experimental work in vitro, in cell-culture or in animal models should not be the basis for using dietary supplements without confirmation in controlled human studies.

In helping consumers with questions about dietary supplement claims, dietetics professionals can readily access an online database of medical research literature (eg, Medline) to determine the amount and kinds of scientific research available and select more in-depth reading as appropriate to the situation. As an example, a recent Medline search for chromium picolinate produced 76 citations. The list was reduced to 16 by searching for chromium picolinate and placebo. Of these, eight described placebo-controlled research on the effects of chromium picolinate on body composition: five found no effect (41-45), two found beneficial effects (46,47) and one found an effect in women but not in men (48). Although additional reading is necessary to make valid conclusions about the relevance and quality of each study, this quick comparison suggests that the beneficial claims for this supplement have not been fully supported by research evidence. The Federal Trade Commission (FTC), which regulates the advertising of dietary supplements, has taken action against unsubstantiated weight loss and health benefit claims for chromium picolinate. Unfortunately, an Internet search also rapidly demonstrates that related claims continue to abound.

CIRCUMSTANCES WHEN NUTRIENT SUPPLEMENTATION IS INDICATED

The latest recommendations from the Food and Nutrition Board, for the first time, include recommendations that supplements or fortified foods be used to obtain desirable amounts of some nutrients (12). Research demonstrated that the risk of bearing children with neural tube defects was reduced by folic acid supplementation (49,50). This and related research led to the recommendation that women capable of becoming pregnant obtain 400 μg of synthetic folic acid daily from either fortified foods or a supplement in addition to consuming food folate from a varied diet (1). It is not known whether lower amounts of synthetic folic acid, or an equivalent amount of folic acid from food would provide a similar protective effect. However, it is known that food folate is not as well absorbed as synthetic folic acid and that to assess folate intake, adjustments must be made for bioavailability (1,51). Further research should help clarify this question.

Atrophic gastritis is a condition that reduces the absorption of food-bound vitamin B-12. Because 10 - 30% of persons older than 50 years have atrophic gastritis, the recommendation for this age group is to obtain vitamin B-12 from supplements or fortified foods (1).

The new recommendations for calcium, 1300 mg for 9-18 year olds, 1000 mg for 19-50 year olds, and 1200 mg for adults greater than 51 years of age (18), are considerably greater than previous recommendations (800 mg for adults) and average US calcium intakes (approximately 700-800 mg) (12,15). Because there was not adequate research data available to determine an EAR or RDA for calcium, the new calcium recommendations are listed as Adequate Intakes. Although such recommendations can be met with generous consumption of (low fat) dairy products (52), some people may prefer to meet the

recommendations with fortification or supplemental sources of calcium.

Meeting the new AI for vitamin D will likely require supplemental sources of vitamin D for the elderly if they do not drink generous quantities of fortified milk. Individualized dietary assessment and counseling can help identify those who are able to obtain recommended levels of calcium and vitamin D from dietary (and sunlight) sources, and those who may benefit from fortified foods or supplements.

When dietary selection is limited, nutrient supplementation can be useful to meet dietary recommendations. Examples include supplemental vitamin B-12 for strict vegans who eliminate all animal products from the diet; vitamin D for those with limited milk intake and sunlight exposure; calcium supplements and/or calcium fortified foods for those with lactose intolerance or allergies to dairy products; and a multivitamin and mineral supplement for those following severely restricted weight-loss diets (eg, <1200 kcal/day).

Iron supplementation during pregnancy is routinely practiced in the United States. Two expert committees have called for more research concerning whether iron supplementation should occur routinely or only on the basis of individual iron status assessment (53,54). A Food and Nutrition Board committee recommended further study into the possibility of adverse outcomes at very low or high hemoglobin levels, but concluded that the practice of routine iron supplementation should not be changed without further research (54), a conclusion confirmed by a more recent expert group (55).

In many areas the research evidence remains equivocal or incomplete. However, recent recommendations from the Food and Nutrition Board provide a useful indication of unbiased, well-considered scientific judgements from nutrition experts. This current evaluation of the available scientific research does not support the efficacy of supplement doses greater than the RDA for such nutrients as vitamin C, vitamin E, or selenium that are commonly marketed for the prevention of chronic disorders such as heart disease or cancer. Randomized, placebo-controlled trials with vitamin E supplementation have not provided evidence of harm, but neither have they provided consistent evidence of effectiveness in prevention of cancer or cardiovascular disease (36,56-61). As new research becomes available, recommendations must be based on a careful consideration of the total scientific literature.

GENERAL MULTIVITAMIN-MINERAL SUPPLEMENTS

Should dietetics professionals advise general multivitamin-mineral supplements at modest doses to help meet dietary recommendations? As already indicated, a variety of good foods wisely selected is the basis of a nutritious diet, will meet dietary recommendations for most nutrients, and is the best way to assure a balance of nutrients and healthy food components for which no recommendations have been established. While there is little scientific evidence of benefit to the average person, there is also little evidence of harm from low-dose multivitamin or multivitamin-mineral supplements in amounts that do not exceed 100% of the RDA. The choice of either a multivitamin or highly-fortified foods (such as some breakfast cereals) can be used to meet the new recommendations to increase synthetic sources of folic acid for women capable of becoming pregnant and synthetic sources of vitamin B-12 for older adults. Otherwise, recommendations for these groups can be met by using specific supplements providing folic acid or vitamin B-12, respectively.

Low-dose multivitamin-mineral supplements may provide benefit to those with limited dietary intakes. Such low-dose supplements improved indices of immune function and reduced infectious illness in a double-blind placebo-controlled investigation of 96 free-living Canadian elderly men and women (62). Similar supplements had no benefit in a double-blind placebo-controlled study of muscle weakness and physical frailty of 100 very elderly people in a Boston nursing home (63). More research in this area should be encouraged.

Professional recommendations to use low-dose multivitamin and mineral supplements should depend on individualized dietary assessments that consider how usual diets can be modified with food, fortification or supplemental sources of nutrients to meet individual needs (64). People using both highly fortified foods and multivitamins, even without other specific nutrient supplements can easily consume 300% of the RDA for many known nutrients. Some would question whether these high intakes of known nutrients are appropriately balanced with other health promoting components of food, many of which are unidentified. The goal should be to meet the RDA or AI while not exceeding the UL. As indicated by the Food and Nutrition Board, "there is no established benefit for healthy individuals if they consume a nutrient in amounts above the recommended intake (RDA or AI)" (18).

There is a special need for moderation under certain circumstances. For example, preformed vitamin A should not be taken in the first trimester of pregnancy (65). For men and postmenopausal women, who generally have adequate iron stores (66), supplemental iron, without a clinical assessment demonstrating low iron status, has little likelihood of benefit and may be of risk to those with certain genetic characteristics (see section on Toxicities, adverse nutrient interactions, and safety, p.x). In addition to evaluating total intakes for meeting and not greatly exceeding the Recommended Dietary Allowances, dietetics professionals should use the new UL designated by the Food and Nutrition Board to avoid dangerously excessive intakes (12,18).

THE ROLE OF FOOD FORTIFICATION

Food fortification of commonly consumed foods may be a reliable and effective way to attain health benefits by increasing the nutrient intake of a population without relying on individual supplementation practices. However, fortification of the food supply must be moderated to benefit people who need to increase their nutrient intakes without increasing the risk of excessive intakes to others. For instance, because increasing folic acid consumption by either dietary selections or supplementation depends on personal behavioral change, food fortification with folic acid is an effective way to moderately increase folate intake for the entire population. New fortification standards for cereal grain products have increased folate intakes of the population, such that median folate intakes from all sources (expressed as dietary folate equivalents) are now estimated to exceed 400 μg/d (67). However, women capable of becoming pregnant must use additional specific supplemental or fortification sources to meet the new recommendations of 400 μg of folic acid from synthetic sources in addition to food folate from a varied diet (1). This recommendation cannot be met by general fortification of bread and cereal products without risking excessive folate intake that may mask or exacerbate vitamin B-12 deficiency or adversely interact with anticonvulsant or methotrexate medications in other population groups, especially children (68). From na-

tional food survey data, the Food and Drug Administration (FDA) estimates that 20-30% of young children (ages 1-8 y) may exceed the UL for folic acid, because of the frequent use of fortified breakfast cereals, fortified grain products, and dietary supplements (1,67). In some instances the preponderance of many products fortified with the same nutrient may make supplementation unnecessary or undesirable.

The US government sets standards of identity for enrichment or fortification of designated foods with specific amounts of nutrients such as thiamin, niacin, riboflavin, folic acid, and iron in grain products; vitamins A and D in milk; and iodine in salt. Fortification following these standards has made important contributions to nutrient intakes in the United States. The FDA food fortification policy (69) warns that random fortification of foods could result in over- or underfortification and nutrient imbalances. The FDA indicates that it is not appropriate to fortify fresh produce, meat, poultry or fish products, sugars, or snack foods such as candies and carbonated beverages.

Food producers often initiate voluntary food fortification. In many instances, such as the fortification of some nondairy foods with calcium, or of vegetable-based meat substitutes with nutrients commonly supplied by meat, this voluntary food fortification can expand the food choices available to consumers to meet dietary recommendations. However, supplier-initiated food fortification should not reduce consumer choices by limiting access to unfortified foods. It is currently difficult for people concerned about excessive dietary iron to choose a breakfast cereal unfortified with iron. Similar difficulties may arise with the increasingly extensive calcium fortification of foods. Some foods seem to be fortified without an explicit public health rationale. The nutrients provided by both fortified foods and supplements change rapidly, and dietetics professionals must be aware of the changing market when assessing the total dietary intake of clients. Nutrient databases must be updated regularly to reflect these changes. In giving dietary advice, dietetics professionals should present clients with a number of options regarding food selection choices, including fortified foods, as well as supplementation choices. Again, the goal should be to meet dietary recommendations without exceeding the UL, and clients should be aware that there is no known benefit to exceeding the dietary recommendation.

For example, it is possible to meet the new calcium recommendations with regular use of (low-fat) dairy products (52). But for clients who, for whatever reason, limit their use of dairy products, dietetics professionals can help them determine whether the use of calcium-fortified orange juice and bread, or use of a calcium supplement can best fit their lifestyle to meet their calcium needs. For some people, a combination of using dairy products, fortified foods, and supplements would cause them to exceed the UL of 2500 mg calcium daily. Dietetics professionals should help educate clients and the general public on the variety of fortified and supplemental products that would promote adequate without excessive intakes.

Marketplace fortification can substantially change the nutrient content of the food supply. For example, high iron enrichment standards in effect in the mid-to-late 70s were reduced because of concerns about efficacy and safety and have not changed since 1983 (70). Yet the iron content of the food supply has continued to rise (see Figure 1) (71), because of an increased percentage of white flour that is enriched, an increased iron-fortification of breakfast cereals, and an increased use of grains (70). Use of iron compounds for enrichment and fortification increased considerably in the last quarter of the century, with greater use of more bioavailable forms than in the past (72). This increase in food iron may pose a health risk for persons with a genetic risk of high iron stores (see Toxicities, adverse nutrient interactions, and safety, p. x). Fortification is commonly used to sell new food products. FDA's fortification policy encourages and supports the rational addition of nutrients to foods (69). However, unlike the standards for iron enrichment of flour, bread or cereal (originally intended to replace nutrients lost in refinement of flour), there is currently no regulatory limitation on the amount of iron that can be added to many food products that do not have standards of identity (69).

The Canadian government has developed policy recommendations for the addition of vitamins and minerals to foods that suggest the use of mandatory food fortification programs for nutritional problems of public health significance that cannot be addressed through voluntary means. An additional recommendation would expand the range of food products that are fortified. It is further recommended that the addition of vitamins and minerals to foods not be permitted when no adequate nutritional rationale is provided (73).

TOXICITIES, ADVERSE NUTRIENT INTERACTIONS, AND SAFETY

The attention of the nutrition community has traditionally focused on obtaining micronutrients in adequate amounts. Much less research information is available to set standards for the upper limits of safe intake. The Food and Nutrition Board was unable to set a UL for five of the first 17 nutrients reviewed, because studies on the presence of adverse effects from large doses of nutrients had not been conducted or were inadequate. It recommended that in the absence of a UL, "extra caution may be warranted in consuming levels above recommended intakes." (12)

Although suppliers often cite benefits of supplements, consumers must rely on other more objective sources, including dietetics professionals, to learn of possible risks. For instance, the two studies that found increased cancer risk with supplemental beta-carotene tested daily doses of 20 mg (36) or 30 mg (37). Supplements containing at least 15 mg beta-carotene are sold frequently, and without warnings to smokers. Excess beta-carotene from foods is unlikely, because beta-carotene from foods is less bioavailable than supplemental beta-carotene. While a UL was not set for beta-carotene, the DRI committee concluded, "beta-carotene supplements are not advisable for the general population." (19)

The toxicities of high doses of nutrients such as vitamins A, B-6, D, niacin, iron, and selenium are well established. Although vitamin A toxicity has occurred from eating the livers of carnivorous animals or large fish (74), most nutrient toxicities occur through supplementation. Cases of vitamin D toxicity, resulting in hypercalcemia and reduced bone mineral density, have been reported in osteoporosis patients using several nonprescription dietary supplements (75). Excessively high levels of serum calcium, serum 25 (OH) D and serum creatinine have been reported in individuals taking vitamin D supplements at levels of 50,000 IU for as little as six weeks (18). Hypervitaminosis D has been reported from inadvertent overfortification of vitamin D in milk (76). The UL for vitamins and minerals are as low as five times the recommended intake for vitamin D (18), and as high as 25 to 50 or more times the

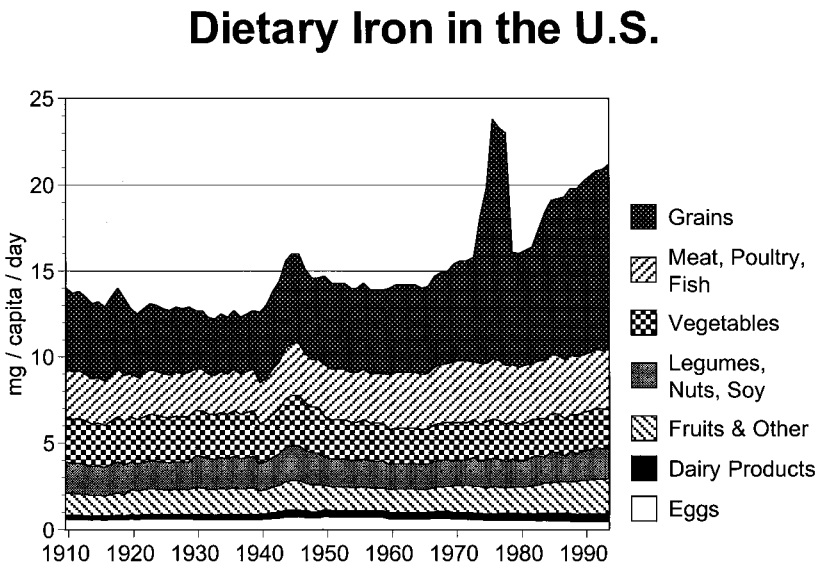

FIG 1: Trends in dietary iron in the US food supply, 1909-94, using food supply data from USDA (71).

recommended intakes for vitamins C and E (19). Although the median amounts of nutrients taken by supplement users in a 1980 national survey were less than three to five times recommended intakes, five percent of supplement users took doses exceeding 25 times the recommended intakes for thiamin, riboflavin, and vitamins B-6, B-12, C, and E (28). Unfortunately, most recent national survey reports do not provide quantitative information about the use of specific supplements. Such quantitative information is planned for future government nutrition surveys, and will be especially important with current trends for increased self-supplementation as well as increased food fortification.

Large doses of vitamin A may be teratogenic (17). Because of this risk, the Food and Nutrition Board recommends avoiding supplementation with preformed vitamin A during the first trimester of pregnancy unless there is specific evidence of vitamin A deficiency (65). A study of 22,748 pregnant women found that women taking more than 10,000 IU preformed vitamin A had a greater risk of giving birth to babies with cranial neural crest defects (77). Such a risk in early pregnancy raises a need for caution about general vitamin and mineral supplement use by women capable of becoming pregnant. Such women should obtain 400 µg of synthetic folic acid daily (in addition to food folate from a varied diet), without taking preformed vitamin A.

Iron supplements intended for other household members are a common cause of pediatric poisoning deaths in the United States (53). Beyond acute toxicity, iron in moderate doses may have deleterious effects for some people. Unlike childbearing age women, who are more likely at risk of low iron stores or even iron deficiency, adult men and postmenopausal women generally have adequate to high iron stores (78). The additional iron commonly found in multivitamin and mineral supplements is unlikely to benefit them, and high iron stores may increase the risk of chronic disease in some individuals, especially the 12 - 14% of the population of Northern European decent who are heterozygous for hemochromatosis, an iron storage disease (79,80).

Dietary supplements can cause problems related to nutrient excesses, nutrient imbalances, or adverse interactions with medical care (81). Many of the problems associated with high doses of a single nutrient may reflect interactions that result in a "relative deficiency" for another nutrient. High doses of vitamin E can interfere with vitamin K action and enhance the effect of coumarin anticoagulant drugs (82), and high calcium intakes inhibit the absorption of iron (83) and possibly other trace elements (18). Folic acid can mask the hematological signs of vitamin B-12 deficiency, and may exacerbate the irreversible neurological damage resulting from untreated vitamin B-12 deficiency (1). Folic acid can also adversely interact with anticonvulsant medications (1). Zinc supplementation may reduce copper status, impair immune responses, and decrease plasma HDL cholesterol (17). Little research has been done to address nutrient interactions and to determine how complex nutrient combinations in supplemental quantities will affect the absorption and utilization of each.

DIETARY SUPPLEMENTS BESIDES VITAMINS AND MINERALS

DSHEA (3) broadened the regulatory definition of dietary supplements beyond essential vitamins, minerals, and amino acids, and even beyond other food constituents proposed to

optimize nutrition. The definition includes, with some exceptions, any product intended for ingestion as a supplement to the diet, including vitamins, minerals, amino acids, herbs, botanicals, other plant-derived substances, and concentrates, metabolites, constituents, and extracts of these substances. Although regulated as dietary supplements, with associated labeling requirements that limit disease-related claims, some supplement products are marketed in third party "literature and information" for pharmacological, rather than nutritional, purposes, as "natural" treatments for diseases such as cancer, heart disease, AIDS, arthritis, diabetes and multiple sclerosis. Similar promotions make distinctions between nutritional and pharmacological properties especially difficult for some herbal products. Herbal teas are regulated as foods, and herbs promoted for pharmacological properties (in third party literature) may appear in products such as beverages, bars, and other foods.

Conventional foods and dietary supplements are not intended to treat disease. Dietitians' recommendations should be for the purpose of improving nourishment (with essential nutrients as well as other potentially beneficial food components that may help prevent disease). For products intended to treat disease, registered dietitians must evaluate whether their academic preparation and scope of practice (including state licensing regulations for dietitians and other health care professionals) qualifies them to provide advice advocating the use of such products. Recommendations of dietary supplements to treat disease should be under a physician's supervision, but dietitians must know about these products to help answer client questions, identify potential food and drug interactions, and document client use.

Dietetics professionals must recognize when to make appropriate medical referrals for the diagnosis and treatment of disease. For example, in the United States, St. John's Wort (Hypericum) is marketed to help mood and depression. The supportive evidence for this product has been sufficient to justify several randomized, placebo-controlled, double-blind clinical trials now underway to evaluate the effectiveness of Hypericum in comparison with established antidepressant medications (84). At the same time, concerns have been raised about drug interactions with Hypericum (81), including the undesirable use of this supplement by HIV-infected patients treated with certain protease inhibitors (85). This product may be shown to be safe and effective under some conditions. But even though neighbors, friends, or sales personnel can recommend such a product, professional recommendations should be made only by professionals trained to differentially diagnose and treat depression, skills which are not in the training or scope of practice of dietetics.

Certain foods, statutorily classified as "medical foods" under the Food, Drug and Cosmetic Act (FDC Act), are intended and can be used as therapeutic dietary adjuncts to medical treatment. However, such products must provide a distinctive nutritional need that is related to the disease or medical condition that is based on sound science, and the products must be used under the care and advice of a physician. Formulas and foods that are low or absent in phenylalanine and oral rehydration solutions are examples of such medical foods.

DIETARY SUPPLEMENT REGULATIONS

FTC regulates the advertising of dietary supplements. It has taken action against companies whose advertisements contain false and misleading information. In addition to the chromium picolinate example cited above, FTC action also stopped manufacturer claims that an oral nutritional supplement drink was doctor recommended for healthy adults. The FTC has also taken action requiring the makers of a supplement containing the herb ephedra to discontinue false advertising claims of safety, and to warn consumers about potentially serious safety risks to the heart and nervous system (86).

The FDA regulates safety, manufacturing and product information, such as claims, in product labels, package inserts and accompanying literature. The Dietary Supplement Health and Education Act of 1994 (3) placed the burden of proof of unsafe or adulterated products or of false or misleading labeling on the FDA rather than on the manufacturer. The label of a conventional food or dietary supplement cannot make pharmacological claims; such claims would cause the product to be categorized as a drug under the Food, Drug and Cosmetic Act. Similarly, product labels or labeling cannot make claims for treatment or cure of diseases. Certain authorized health claims may be made, relating a substance in the product to a disease, and a reduction in risk of the disease. Health-related structure-function claims for health maintenance may be made if "a statement claims a benefit related to a classical nutrient deficiency disease and discloses the prevalence of such disease in the United States, describes the role of a nutrient or dietary ingredient intended to affect the structure or function in humans, characterizes the documented mechanism by which a nutrient or dietary ingredient acts to maintain such structure or function, or describes general well-being from consumption of a nutrient or dietary ingredient." (3) Such claims must be backed by the manufacturer's substantiation that they are truthful and not misleading, and must be accompanied by the following: "This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease." (3) Specific regulations in this area continue to develop, and dietetics professionals can contribute a valuable service by providing consumers information about the scientific support, or lack thereof, for claims made by the supplement industry.

According to DSHEA (3), dietary supplements must have the identity and strength represented on the label, and meet appropriate specifications for quality (including tablet or capsule disintegration), purity, and composition. The FDA is developing current good manufacturing practice (CGMP) regulations addressing these requirements. Voluntary standards for quality, purity, disintegration, and dissolution have been published by the US Pharmacopeia (87), which also publishes scientific monographs on the safety and efficacy of specific supplements.

POLICY IMPLICATIONS

ADA supports and encourages regular revisions and refinement of the Dietary Reference Intakes by the Food and Nutrition Board, as new research expands nutrition knowledge. ADA encourages private and public support of research into food and nutrient intakes to support optimal health, including the role of dietary supplements in achieving this goal. When research indicates beneficial effects of dietary supplements, further research should be supported to help define the minimum effective dose, possible adverse effects, including interaction with other nutrients, and whether food sources are as effective as synthetic supplemental sources.

ADA encourages the assessment and documentation of dietary supplement and food fortification practices in govern-

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi: Medline Database of medical literature.

http://www.nap.edu: Dietary Reference Intake Reports are available at the National Academy Press site (select Health and Medicine and then Food and Nutrition).

http://odp.od.nih.gov/ods: NIH Office of Dietary Supplements (with IBIDS—International Bibliographic Information on Dietary Supplements).

http://www.cfsan.fda.gov/~dms/supplmnt.html: Dietary Supplements Web site of the US Food and Drug Administration, Center for Food Safety and Applied Nutrition.

http://www.ftc.gov/ftc/complaint.htm: Complaints to Federal Trade Commission about misleading advertising. Consumers can file a complaint with the FTC by contacting the Consumer Response Center by phone: toll-free 1-877-FTC-HELP (382-4357); TDD: 202-326-2502; by mail: Consumer Response Center, Federal Trade Commission, 600 Pennsylvania Ave, NW, Washington, DC 20580; or through the Internet, using the online complaint form. Although the Commission cannot resolve individual problems for consumers, it can act against a company if it sees a pattern of possible law violations.

http://vm.cfsan.fda.gov/~lrd/probfda.html: Reporting adverse reactions and other problems with products regulated by the FDA.

http://vm.cfsan.fda.gov/~dms/aems.html: Obtaining information from the Special Nutritionals Adverse Event Monitoring System of the US Food and Drug Administration.

http://www.fda.gov/fdac/features/1998/dietchrt.html: US Food and Drug Administration listing of Supplements Associated with Illnesses and Injuries.

FIG 2. Useful Reference Web Sites

ment nutrition surveys. These surveys and related nutrient databases should facilitate the detailed quantitative assessment of the distribution of usual intakes of individual nutrients from food, fortification, and supplement sources, and the total intakes from all these sources combined. ADA also encourages federal and state authorities charged with nutrition monitoring to improve the assessment of total nutrient intake distributions among various groups in the population.

As the Food and Nutrition Board designates UL of nutrient intake for the first time, ADA encourages government standards and guidelines to help prevent excessive nutrient intakes from fortified foods and dietary supplements. At present there is little regulation in place that provides guidelines on amounts of nutrients in highly fortified foods (69), meal replacements, or oral nutritional supplements. Given the regulatory limitations of DSHEA (3), such guidance may require creative public education efforts, in conjunction with health and professional organizations.

ADA suggests that Congress conduct oversight hearings on DSHEA to determine if the legislation has accomplished what was intended, and whether consumers understand the meaning of claims allowed under the Act. Moreover, it is important to examine whether the scientific evidence required for making health and other claims under DSHEA is less stringent than for foods regulated under the Nutrient Labeling and Education Act, and, if so, develop mechanisms to change the law or educate consumers about these differences.

ROLES AND RESPONSIBILITIES OF DIETETICS PRACTITIONERS

Dietetics professionals must base their recommendations of dietary supplements on well-accepted scientific evidence. They should be educated to evaluate the scientific evidence for efficacy and safety, and provide information based on quality research and substantial scientific agreement. It is helpful to consult the most recent statements of the Food and Nutrition Board and of government health agencies such as the FDA, FTC, USDA and NIH Office of Dietary Supplements.

Recommendations for the use of nutrient supplements to improve individual diets should come from physicians or registered dietitians applying current scientific knowledge after individual dietary and nutrition assessment. Vitamin and mineral supplementation for curative purposes should only be done under the supervision of a physician. Dietetics professionals must be knowledgeable about the nutrient content of fortified food and supplement products to effectively evaluate clients' dietary intakes from food, fortification and dietary supplement sources and provide counseling to promote good nutrition while preventing excessive intakes, adverse interactions with medical treatment or any delay of effective medical treatments. Dietitians should communicate information about a client's use of dietary supplements, along with potential interactions affecting the client's diagnosis or treatment, to the client's physician. Health professionals should report any harmful effects of dietary supplements to the FDA's Adverse Reaction Monitoring System, and report misleading advertising to the FTC (see Figure 2).

Ethical issues concerning sales of products from a physician's office, raised in recent reports by the ethics committee of the American Medical Association (88) are also relevant to dietetics practice. First, dietitians should not sell or recommend products that have no scientific basis for their claims of safety and/or efficacy (89). Second, the basis upon which a dietitian makes decisions about selling or recommending should be evidence-based and derived from the peer-reviewed literature (88,89). Third, they should avoid financial conflicts of interest that are produced by the in-office sale of products to clients (88,89). If it is not possible to encourage local businesses to offer highly specialized products, they should be provided as free samples or at cost with full financial disclosure.

Dietetics professionals are uniquely qualified to educate and counsel people to choose nourishing foods that supply energy, nutrients, and other health-promoting constituents, satisfying human needs for taste, convenience, and social and cultural acceptability in a cost-effective manner while avoiding dietary excesses and imbalances. Today, dietetics professionals have additional obligations to provide guidance to consumers for optimizing total intakes of nutrients from both fortified and unfortified foods and supplements. In assessing diets, dietetics professionals must consider the nutrient contributions made from foods, fortified foods, and supplements and appropriately apply Dietary Reference Intakes for dietary assessment (64). In making dietary recommendations, they must utilize science-based information to help interpret a variety of product claims and to identify practical and client-personalized choices for improving nutrition, empowering their clients to make informed choices about these products. Dietetics professionals must also recognize the considerable public acceptance of "alternative" medical practices, and the sincere interest of supplement users to take responsibility for their health and be free to choose individual supplement regimens. After provid-

ing individualized, science-based information, dietetics professionals must be sensitive to their client's autonomy to make personal product choices.

Since many Americans who use supplements and fortified foods have little contact with dietitians or physicians, traditional counseling methods must be supplemented with public health policies. Dietetics professionals should support public health measures addressing these issues and additional education for both health professionals and the public.

References

1. Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid Biotin, and Choline*. Washington, DC: National Academy Press; 1998.
2. Sarubin A. *The Health Professional's Guide to Popular Dietary Supplements*. Chicago, IL: American Dietetic Association; 2000.
3. Dietary Supplement Health and Education Act of 1994, Public Law 103-417 (S. 784) (1994) (codified at 42 USC 287C-11).
4. Halsted CH. Dietary supplements and the American Journal of Clinical Nutrition. *Am J Clin Nutr*. 2000;71:399-400.
5. Decker EA. The role of phenolics, conjugated linoleic acid, carnosine, and pyrroloquinoline quinone as nonessential dietary antioxidants. *Nutr Rev*. 1995;53:49-58.
6. American Medical Association Council on Scientific Affairs. Diet and cancer: where do matters stand? *Arch Intern Med*. 1993;153:50-56.
7. van den Berg H. Carotenoid interactions. *Nutr Rev*. 1999;57:1-10.
8. World Health Organization. *Trace Elements in Human Nutrition and Health*. Geneva, Switzerland: WHO; 1996:343.
9. Wattenberg LW. Inhibition of carcinogenesis by minor dietary constituents. *Cancer Res*. 1992;52:2085s-2091s.
10. Willett WC. Diet, Nutrition, and the Prevention of Cancer. In: Shils ME, Olson JA, Shike M, Ross C, eds. *Modern Nutrition in Health and Disease*. Baltimore, MD: Wlilliams & Wilkins; 1998:1243-1253.
11. Schorah CJ. Micronutrients, vitamins, and cancer risk. *Vitam Horm*. 1999;57:1-23.
12. Yates AA, Schlicker SA, Suitor CW. Dietary Reference Intakes: the new basis for recommendations for calcium and related nutrients, B vitamins, and choline. *J Am Diet Assoc*. 1998;98:699-706.
13. US Departments of Agriculture and Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans*. 5th ed. Washington, DC: 2000.
14. US Department of Agriculture. *The Food Guide Pyramid*. Hyattsville, MD: Human Nutrition Information Service; 1996.
15. Beltsville Human Nutrition Research Center FSRG. Results from USDA's 1994-1996 Continuing Survey of Food Intakes by Individuals and 1994-96 Diet and Health Knowledge Survey; Table Sets 10 & 12. Available at: http://www.barc.usda.gov/bhnrc/foodsurvey/home.htm. 1999.
16. Alaimo K, McDowell MA, Briefel RR, Bischof AM, Caughman CR, Loria CM, Johnson CL. *Dietary intake of vitamins, minerals, and fiber of persons ages 2 months and over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91*. Advance Data From Vital and Health Statistics, No. 258. Hyattsville, MD: National Center for Health Statistics; 1994.
17. Food and Nutrition Board: National Research Council. *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy of Sciences; 1989.
18. Food and Nutrition Board: Institute of Medicine. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academy Press; 1997.
19. Food and Nutrition Board: Institute of Medicine. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, DC: National Academy Press; 2000.
20. Black AE, Prentice AM, Goldberg GR, Jebb SA, Bingham SA, Livingstone MB, Coward WA. Measurements of total energy expenditure provide insights into the validity of dietary measurements of energy intake. *J Am Diet Assoc*. 1993;93:572-579.
21. Martin LJ, Su W, Jones PJ, Lockwood GA, Tritchler DL, Boyd NF. Comparison of energy intakes determined by food records and doubly labeled water in women participating in a dietary-intervention trial. *Am J Clin Nutr*. 1996;63:483-490.
22. Life Sciences Research Office: Prepared for the Interagency Board for Nutrition Monitoring and Related Research. *Third Report on Nutrition Monitoring in the United States: Executive Summary*. Washington, DC: US Government Printing Office; 1995:51.
23. Wood RJ. Rational design of multi-nutrient supplements. *Nutr Clin Care*. 1999;2:327-328.
24. Booth SL, Nelson ME, Mason JB, Angelo G, Meydani SN. Dietary supplements for peri- and early post-menopausal women: a quantitative proposal based on disparities between recommendations and dietary intakes. *Nutr Clin Care*. 1999;2:361-374.
25. Ervin RB, Wright JD, Kennedy-Stephenson J. Use of dietary supplements in the United States, 1988-94. *Vital Health Stat* 11. 1999:i-iii, 1-14.
26. Hensrud DD, Engle DD, Scheitel SM. Underreporting the use of dietary supplements and nonprescription medications among patients undergoing a periodic health examination. *Mayo Clin Proc*. 1999;74:443-447.
27. Patterson RE, Kristal AR, Levy L, McLerran D, White E. Validity of methods used to assess vitamin and mineral supplement use. *Am J Epidemiol*. 1998;148:643-649.
28. Stewart ML, McDonald JT, Levy AS, Schucker RE, Henderson DP. Vitamin/mineral supplement use: A telephone survey of adults in the United States. *J Am Dietet Assoc*. 1985;85:1585-1590.
29. Subar AF, Block G. Use of vitamin and mineral supplements: demographics and the amounts of nutrients consumed; the 1987 Health Interview Survey. *Am J Epidemiol*. 1990;132:1091-1101.
30. Bender MM, Levy AS, Schucker RE, Yetley EA. Trends in prevalence and magnitude of vitamin and mineral supplement usage and correlation with health status. *J Am Diet Assoc*. 1992;92:1096-1101.
31. Slesinski MJ, Subar AF, Kahle LL. Dietary intake of fat, fiber and other nutrients is related to the use of vitamin and mineral supplements in the United States: the 1992 National Health Interview Survey. *J Nutr*. 1996;126:3001-3008.
32. Looker AC, Sempos CT, Johnson C, Yetley EA. Vitamin-mineral supplement use: association with dietary intake and iron status of adults. *J Am Diet Assoc*. 1988;88:808-814.
33. Pelletier DL, Kendall A. Supplement use may not be associated with better food intake in all population groups. *Family Economics and Nutrition Review*. 1997;10:32-44.
34. Looker AC, Sempos CT, Johnson C, Yetley EA. Comparison of dietary intakes and iron status of vitamin-mineral supplement users and nonusers, aged 1-19 years. *Am J Clin Nutr*. 1987;46:665-672.
35. Nayga RM, Reed DB. Factors associated with the intake of dietary supplements. *Family Economics and Nutrition Review*. 1999;12:43-48.
36. Alpha-tocopherol beta carotene cancer prevention study group. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. *N Engl J Med*. 1994;330:1029-1035.
37. Omenn GS, Goodman GE, Thornquist MD, Balmes J, Cullen MR, Glass A, Keogh JP, Meyskens FL, Valanis B, Williams JH, Barnhart S, Hammar S. Effects of a combination of beta carotene and vitamin A on lung cancer and cardiovascular disease. *N Engl J Med*. 1996;334:1150-1155.
38. Hennekens CH, Buring JE, Manson JE, Stampfer M, Rosner B, Cook NR, Belanger C, LaMotte F, Gaziano JM, Ridker PM, Willett W, Peto R. Lack of effect of long-term supplementation with beta carotene on the incidence of malignant neoplasms and cardiovascular disease. *N Engl J Med*. 1996;334:1145-1149.
39. Wang XD, Russell RM. Procarcinogenic and anticarcinogenic effects of beta-carotene. *Nutr Rev*. 1999;57:263-272.
40. Hathcock JN. Vitamins and minerals: efficacy and safety. *Am J Clin Nutr*. 1997;66:427-437.
41. Clancy SP, Clarkson PM, DeCheke ME, Nosaka K, Freedson PS, Cunningham JJ, Valentine B. Effects of chromium picolinate supplementation on body composition, strength, and urinary chromium loss in football players. Int *J Sport Nutr*. 1994;4:142-153.
42. Trent LK, Thieding-Cancel D. Effects of chromium picolinate on body composition. *J Sports Med Phys Fitness*. 1995;35:273-280.
43. Lukaski HC, Bolonchuk WW, Siders WA, Milne DB. Chromium supplementation and resistance training: effects on body composition, strength, and trace element status of men. *Am J Clin Nutr*. 1996;63:954-965.
44. Walker LS, Bemben MG, Bemben DA, Knehans AW. Chromium picolinate effects on body composition and muscular performance in wrestlers. *Med Sci Sports Exerc*. 1998;30:1730-1737.
45. Campbell WW, Joseph LJ, Davey SL, Cyr-Campbell D, Anderson RA, Evans WJ. Effects of resistance training and chromium picolinate on body composition and skeletal muscle in older men. *J Appl Physiol*. 1999;86:29-39.
46. Bahadori B, Wallner S, Schneider H, Wascher TC, Toplak H. Effect of chromium yeast and chromium picolinate on body composition of obese, non-diabetic patients during and after a formula diet. *Acta Med Austriaca*. 1997;24:185-187.
47. Hoeger WW, Harris C, Long EM, Hopkins DR. Four-week supplementation with a natural dietary compound produces favorable changes in body composition. *Adv Ther*. 1998;15:305-314.
48. Hasten DL, Rome EP, Franks BD, Hegsted M. Effects of chromium picolinate on beginning weight training students. *Int J Sport Nutr*. 1992;2:343-350.
49. MRC Vitamin Study Research Group. Prevention of neural tube defects: results of the Medical Research Council Vitamin Study. *Lancet*. 1991;338:131-

137.
50. Czeizel AE, Dud'as I. Prevention of the first occurrence of neural-tube defects by periconceptional vitamin supplementation. *N Engl J Med*. 1992;327:1832-1835.
51. Suitor CW, Bailey LB. Dietary folate equivalents: interpretation and application. *J Am Diet Assoc*. 2000;100:88-94.
52. Heaney RP, McCarron DA, Dawson-Hughes B, Oparil S, Berga SL, Stern JS, Barr SI, Rosen CJ. Dietary changes favorably affect bone remodeling in older adults. *J Am Diet Assoc*. 1999;99:1228-1233.
53. US Preventive Services Task Force. Routine iron supplementation during pregnancy; policy statement and review article. *JAMA*. 1993;270:2846-2848.
54. Committee on the Prevention, and Management of Iron Deficiency Anemia Among U.S. Children and Women of Childbearing Age. *Iron Deficiency Anemia: Recommended Guidelines for the Prevention, Detection, and Management Among U.S. Children and Women of Childbearing Age*. Washington, DC: Food and Nutrition Board, Institute of Medicine, National Academy Press; 1993.
55. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. *MMWR Morb Mortal Wkly Rep*. 1998:30.
56. Stephens NG, Parsons A, Schofield PM, Kelly F, Cheeseman K, Mitchinson MJ. Randomised controlled trial of vitamin E in patients with coronary disease: Cambridge Heart Antioxidant Study (CHAOS). *Lancet*. 1996;347:781-786.
57. Heinonen OP, Albanes D, Virtamo J, Taylor PR, Huttunen JK, Hartman AM, Haapakoski J, Malila N, Rautalahti M, Ripatti S, Maenpaa H, Teerenhovi L, Koss L, Virolainen M, Edwards BK. Prostate cancer and supplementation with alpha-tocopherol and beta-carotene: incidence and mortality in a controlled trial. *J Natl Cancer Inst*. 1998;90:440-446.
58. GISSI-Prevenzione Investigators. Dietary supplementation with n-3 polyunsaturated fatty acids and vitamin E after myocardial infarction: results of the GISSI-Prevenzione trial. Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto miocardico. *Lancet*. 1999;354:447-455.
59. Lee IM. Antioxidant vitamins in the prevention of cancer. *Proc Assoc Am Physicians*. 1999;111:10-15.
60. Leppala JM, Virtamo J, Fogelholm R, Huttunen JK, Albanes D, Taylor PR, Heinonen OP. Controlled trial of alpha-tocopherol and beta-carotene supplements on stroke incidence and mortality in male smokers. *Arterioscler Thromb Vasc Biol*. 2000;20:230-235.
61. Yusuf S, Dagenais G, Pogue J, Bosch J, Sleight P. Vitamin E supplementation and cardiovascular events in high-risk patients. The Heart Outcomes Prevention Evaluation Study Investigators. *N Engl J Med*. 2000;342:154-160.
62. Chandra RK. Effect of vitamin and trace-element supplementation on immune responses and infection in elderly subjects. *Lancet*. 1992;340:1124-1127.
63. Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, E. NM, Roberts SB, Kehayias JJ, Lipsitz LA, Evans WJ. Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Engl J Med*. 1994;330:1769-1775.
64. Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington, DC: National Academy Press; 2000.
65. Food and Nutrition Board, Institute of Medicine. *Nutrition During Pregnancy; Weight Gain; Nutrient Supplements*. Washington, DC: National Academy Press; 1990.
66. Custer EM, Finch CA, Sobel RE, Zettner A. Population norms for serum ferritin. *J Lab Clin Med*. 1995;126:88-94.
67. Lewis CJ, Crane NT, Wilson DB, Yetley EA. Estimated folate intakes: data updated to reflect food fortification, increased bioavailability, and dietary supplement use. *Am J Clin Nutr*. 1999;70:198-207.
68. Mills JL. Fortification of foods with folic acid—how much is enough? *N Engl J Med*. 2000;342:1442-1445.
69. Title 21, Food and Drugs: Fortification Policy. 45 *Federal Register* 6323 (1980), as amended at 58 *Federal Register* 2228 (1993)(codified at 21 CFR §104.20).
70. Guthrie JF, Schwek NE. Current issues related to iron status: Implications for nutrition education and policy. *Family Economics and Nutrition Review*. 1996;9:2-19.
71. Gerrior S, Bente L. *Nutrient content of the US Food Supply, 1909-1994*. U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, Home Economics Research Report No. 53; 1997.
72. Whittaker P. Iron and zinc interactions in humans. *Am J Clin Nutr*. 1998;68:442S-446S.
73. Health Canada. *The Addition of Vitamins and Minerals to Foods: Proposed Policy Recommendations*. Ottawa: Bureau of Nutritional Sciences, Food Directorate, Health Protection Branch; 1999:55.
74. Bendich A, Langseth L. Safety of vitamin A. *Am J Clin Nutr*. 1989;49:358-371.
75. Adams JS, Lee G. Gains in bone mineral density with resolution of vitamin D intoxication. *Ann Intern Med*. 1997;127:203-206.
76. Blank S, Scanlon KS, Sinks TH, Lett S, Falk H. An outbreak of hypervitaminosis D associated with the overfortification of milk from a home-delivery dairy. *Am J Public Health*. 1995;85:656-659.
77. Rothman KJ, Morre LL, Singer MR, Uyen-Sa DTN, Mannino S, Milunsky A. Teratogenicity of high vitamin A intake. *N Engl J Med*. 1995;333:1369-1373.
78. Cook JD, Skikne BS, Lynch SR, Reusser ME. Estimates of iron sufficiency in the US population. *Blood*. 1986;68:726-731.
79. Tuomainen TP, Kontula K, Nyyssonen K, Lakka TA, Helio T, Salonen JT. Increased risk of acute myocardial infarction in carriers of the hemochromatosis gene Cys282Tyr mutation : a prospective cohort study in men in eastern Finland. *Circulation*. 1999;100:1274-1279.
80. Roest M, van der Schouw YT, de Valk B, Marx JJ, Tempelman MJ, de Groot PG, Sixma JJ, Banga JD. Heterozygosity for a hereditary hemochromatosis gene is associated with cardiovascular death in women. *Circulation*. 1999;100:1268-1273.
81. Fugh-Berman A. Herb-drug interactions. *Lancet*. 2000;355:134-138.
82. Bendich A, Machlin LJ. Safety of oral intake of vitamin E. *Am J Clin Nutr*. 1988;48:612-619.
83. Cook JD, Dassenko SA, Whittaker P. Calcium supplementation: effect on iron absorption. *Am J Clin Nutr*. 1991;53:106-111.
84. Stevinson C, Ernst E. Hypericum for depression. An update of the clinical evidence. *Eur Neuropsychopharmacol*. 1999;9:501-505.
85. Piscitelli SC, Burstein AH, Chaitt D, Alfaro RM, Falloon J. Indinavir concentrations and St John's wort. *Lancet*. 2000;355:547-548.
86. Federal Trade Commission. Claims that herbal ecstacy is absolutely safe and will not cause side effects are false, FTC says [press release]. Available at: http://www.ftc.gov/opa/1997/9707/ecstacy.htm; July 29, 1997.
87. *The United States Pharmacopeia: The National Formulary*. Rockville, MD: US Pharmacopeial Convention, Inc.; 1995.
88. American Medical Association Council on Ethical and Judicial Affairs. *Sale of health-related products from physicians' offices*. CEJA Opinion 8.063. Available at: http://www.ama-assn.org/ethic/ceja/webrpt.htm; June 1999.
89. American Dietetic Association. Code of Ethics for the Profession of Dietetics. *J Am Diet Assoc*. 1999;99:109-113.

■ ADA Position adopted by the House of Delegates on October 29, 1995, and reaffirmed on September 28, 1998. This position is in effect until December 31, 2004 The American Dietetic Association authorizes republication of this position, *in its entirety*, provided full and proper credit is given. Requests to use portions of the position must be directed to ADA Headquarters at 800/877-1600, ext. 4896.

■ Recognition is given to the following for their contribution:
Authors:
Janet Hunt, PhD, RD (USDA, Agricultural Research Service, Grand Forks Human Nutrition Research Center, Grand Forks, ND)
Johanna Dwyer, DSc, RD (Frances Stern Nutrition Center, New England Medical Center, Boston, MA)

Reviewers:
Katherine Chauncey, PhD, RD, FADA (Texas Tech University Health Services Center, Lubbock, TX); Rebecca B. Costello, PhD; Nancy Crane, MPH, RD; Sharon Denny, MS, RD (ADA Knowledge Center, Chicago, IL); Helen Lane, PhD, RD (Johnson Space Center, Houston, TX); Research dietetic practice group (Cindy J. Fuller, PhD, RD; Dorothy W. Hagen, PhD, RD; Maureen Leser, MS, RD); and Robert Russell, MD (USDA Human Nutrition Research Center on Aging, Tufts University, Boston, MA).

Members of ADA Association Positions Committee Work Group:
Valerie Duffy, PhD, RD (Workgroup Chair); Nancy Wooldridge, MS, RD; Pauline Landhuis, MS, RD; and Bernadette M. Marriott, PhD (Content Advisor).